Sponges from the 2010-2014 *Paamiut* Multispecies Trawl Surveys, Eastern Arctic and Subarctic: Class Demospongiae, Subclass Heteroscleromorpha, Order Poecilosclerida, Families Mycalidae and Isodictyidae

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Sponges from the 2010-2014 *Paamiut* Multispecies Trawl Surveys, Eastern Arctic and Subarctic: Class Demospongiae, Subclass Heteroscleromorpha, Order Poecilosclerida, Families Mycalidae and Isodictyidae

by

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ABSTRACT

Bouchard Marmen, M., Odenthal, B., Murillo, F. J., Tompkins, G., Baker, E., Savard-Drouin, A., Walkusz, W., Siferd, T. and Kenchington, E. 2021. Sponges from the 2010-2014 *Paamiut* Multispecies Trawl Surveys, Eastern Arctic and Subarctic: Class Demospongiae, Subclass Heteroscleromorpha, Order Poecilosclerida, Families Mycalidae and Isodictyidae. Can. Tech. Rep. Fish. Aquat. Sci. 3452: v + 60 p.

Sponges (phylum Porifera) are benthic filter feeding animals that play an important role in nutrient cycling and habitat provision in the deep sea. Sponges collected between 2010 and 2014 during annual multispecies trawl surveys conducted by Fisheries and Oceans Canada in Baffin Bay, Davis Strait and portions of Hudson Strait were taxonomically examined. In total ~2500 specimens were identified, comprising ~100 known sponge taxa. Sponges from the order Poecilosclerida comprised nearly half of the identified species. Sponges from the poescilosclerid families Coelosphaeridae, Crellidae, Dendoricellidae, Myxillidae, Tedaniidae, Microcionidae, Acarnidae and Esperiopsidae are described in previous reports. This report adds descriptions of five sponge species from two poescilosclerid families: Mycalidae and Isodictyidae (class Demospongiae, subclass Heteroscleromorpha, order Poecilosclerida). Described species include *Mycale (Mycale) lingua*, *Mycale (Mycale)* cf. *toporoki*, *Mycale (Mycale)* cf. *loveni* and *Mycale (Rhaphidotheca) marshallhalli*, all from the family Mycalidae, and *Isodictya* aff. *palmata* from the family Isodictyidae. Descriptions include physical description of the sponges, descriptions and dimensions of their spicules, and taxonomic discussion.

RÉSUMÉ

Bouchard Marmen, M., Odenthal, B., Murillo, F. J., Tompkins, G., Baker, E., Savard-Drouin, A., Walkusz, W., Siferd, T. and Kenchington, E. 2021. Sponges from the 2010-2014 *Paamiut* Multispecies Trawl Surveys, Eastern Arctic and Subarctic: Class Demospongiae, Subclass Heteroscleromorpha, Order Poecilosclerida, Families Mycalidae and Isodictyidae. Can. Tech. Rep. Fish. Aquat. Sci. 3452: v + 60 p.

Les éponges (phylum Porifera) sont des animaux filtreurs benthiques qui jouent un rôle important dans le cycle des éléments nutritifs et qui augmentent la disponibilité d’habitats benthiques en eaux profondes. Les éponges collectées au cours des relevés plurispécifiques annuels au chalut effectués entre 2010 et 2014 par Pêches et Océans Canada dans la baie de Baffin, le détroit de Davis et certaines portions du détroit d’Hudson ont été examinées sur le plan taxonomique. Au total, environ 2500 spécimens ont été identifiés, appartenant à ~100 taxons d’éponges connus. Presque la moitié des espèces recensées appartiennent à l’ordre Poecilosclerida. Parmi elles, les éponges des familles Coelosphaeridae, Crellidae, Dendoricellidae, Myxillidae, Tedaniidae, Microcionidae, Acarnidae et Esperiopsidae ont été décrites dans nos précédents rapports. Ce présent rapport ajoute les descriptions de cinq espèces d’éponges de deux familles de poecilosclérides : Mycalidae et Isodictyidae (classe Demospongiae, sous-classe Heteroscleromorpha, ordre Poecilosclerida). Les espèces décrites sont *Mycale (Mycale) lingua*, *Mycale (Mycale)* cf. *toporoki*, *Mycale (Mycale)* cf. *loveni* et *Mycale (Rhaphidotheca) marshallhalli* de la famille Mycalidae et *Isodictya* aff. *palmata* de la famille Isodictyidae. Les descriptions comprennent la description physique des éponges, la description de leurs spicules incluant les dimensions de celles-ci, ainsi qu’une discussion taxonomique.

INTRODUCTION

Sponges are mostly benthic filter-feeding animals that play an important role in nutrient cycling (reviewed in Maldonado et al. 2012, 2017). They also create biogenic structures which provide important habitats in deep-sea ecosystems and locally increase the diversity of epibenthic megafauna (Beazley et al., 2013, 2015). Despite these key functional roles, sponge communities in Arctic marine environments are still poorly known. In the eastern Canadian Arctic, particularly western Baffin Bay, Davis Strait, portions of Hudson Strait and Ungava Bay, invertebrate species, including sponges, are routinely collected during Fisheries and Oceans Canada (DFO) shrimp and Greenland halibut multispecies trawl surveys. Approximately 2500 sponge specimens from 479 trawl sets (Figure 1) collected between 2010 and 2014 on the research vessel (RV) *Paamuit* have been examined. Sponges from the order Poecilosclerida (class Demospongiae) comprised nearly half of the ~100 species identified. Four 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 *Semisuberites*). This fifth report in our series provides descriptions of four species from the family Mycalidae (subgenera *Mycale (Mycale)* and *Mycale (Rhaphidotheca)*) and one species from the family Isodictyidae (genus *Isodictya*). Species include: *Mycale (Mycale) lingua* (Bowerbank, 1866), *Mycale (Mycale)* cf. *toporoki* Kolton, 1958, *Mycale (Mycale)* cf. *loveni* (Fristedt, 1887), *Mycale (Rhaphidotheca) marshallhalli* (Kent, 1870) and *Isodictya* aff. *palmata* (Ellis & Solander, 1786). The species *Mycale (Mycale) lingua* has been previously identified as an indicator species of Vulnerable Marine Ecosystems (VMEs; FAO, 2009) by the Northwest Atlantic Fisheries Organization (NAFO, 2019). 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 [2004]). Spicules of demosponges are very diverse, but always have one, two or four axes (never triaxonic) (Hooper and Van Soest, 2002 [2004]). 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** (Van Soest et al., World Porifera Database, Accessed July 9th, 2021). Families represented within the 2010-2014 *Paamiut* 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 are distinguished by the presence of chelae. However, chelae may be missing in some cases. Other microsclere spicules may include sigmas, sigmancistra-derivatives, toxas, forceps, raphides, onychaetes, microrhabds, discorhabds, spinorhabds, thraustoxeas, spirosigmata, thraustosigmata or microstyles (Hooper and Van Soest, 2002 [2004]). 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 distributed worldwide, from intertidal habitats to abyssal depths, and are mostly viviparous (Hooper and Van Soest, 2002 [2004]). Four suborders within order Poeciloscleorida are listed in the Systema Porifera (Hooper and Van Soest, 2002 [2004]): Microcionina, Mycalina, Myxillina and Latrunculina. These suborders are no longer accepted because of their polyphyletic nature discovered through recent phylogenetic studies (Morrow and Cárdenas, 2015) and therefore the Mycalina suborder that formerly regrouped Mycalidae and Isodictyidae families will be only briefly discussed in this report.

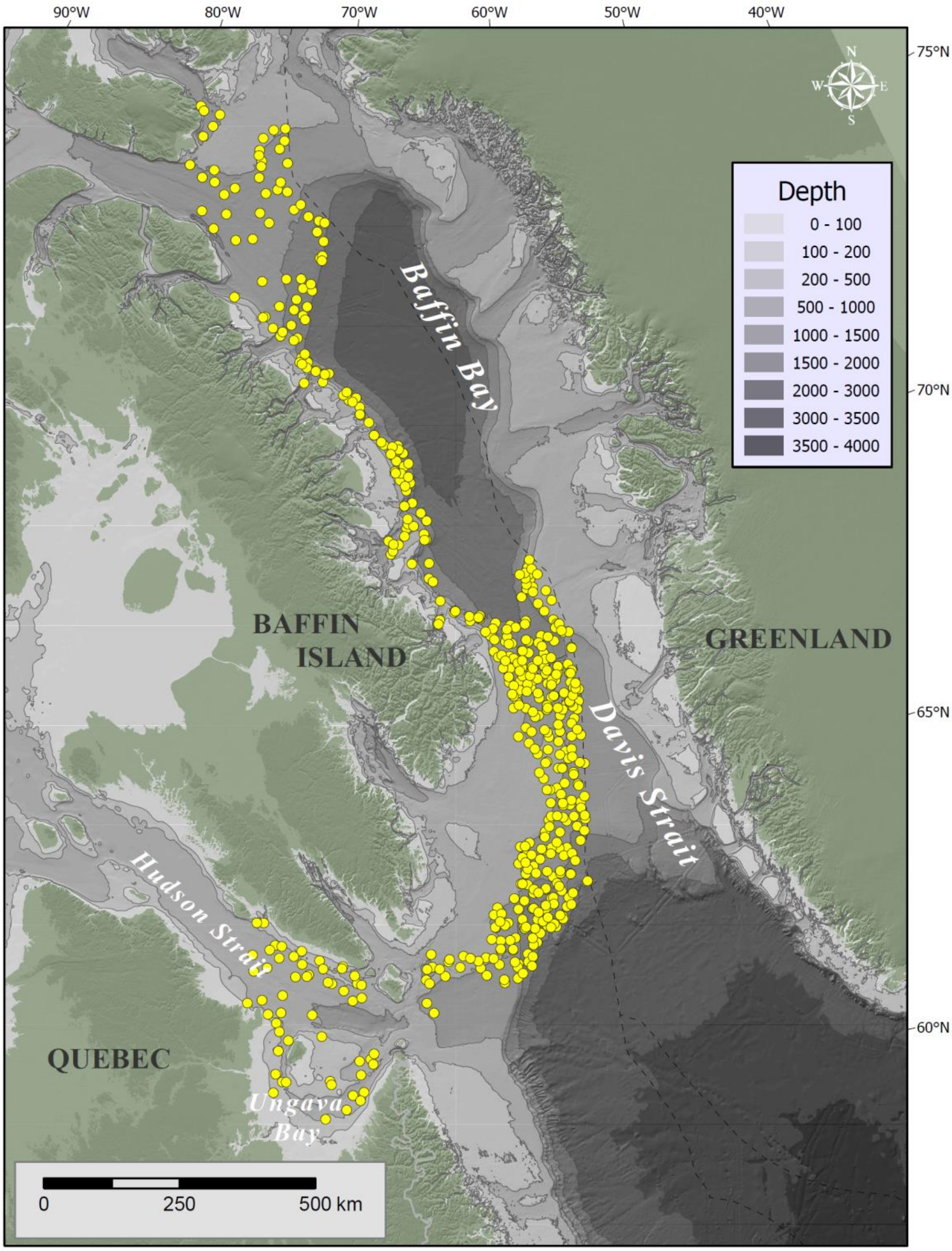

Figure 1. Locations of *Paamiut* 2010-2014 trawl sets (N = 479) with sponge catch, spanning Baffin Bay, Davis Strait, Ungava Bay and Hudson Strait. Northwest Atlantic Fisheries Organization (NAFO) Divisions are indicated in black. The exclusive economic zones of Canada and Greenland are delimited in red. Depth contours at 500 m intervals (500 to 3000 m) are in light grey. Note that the species listed in this report were found in a subset of these locations.

Suborder Mycalina Hajdu, Van Soest & Hooper, 1994 (unaccepted)

The Mycalina suborder (unaccepted) previously regrouped the Mycalidae and Isodictyidae families, which are presented in this report, as well as the Esperiopsidae, Cladorhizidae, Podospongiidae, Merliidae, Hamacanthidae, Desmacellidae and Guitarridae families. In the past, Mycalina sponges were characterized by the presence of palmate chelae or their derivates (although could be absent) and by the megasclere complement reduced to only one spicule type, which was mycalostyles in most cases (Hooper and Van Soest, 2002 [2004]). Mycalostyles are smooth styles slightly constricted a little before the rounded blunt extremity, forming a handle-shaped end. Other characteristics of Mycalina sponges were the absence of acanthostyles (or other echinating spicules), the usual presence of sigmas or their derivates and their plumose or plumoreticulate structural organization of spicules. Within the last decade, molecular tools have improved drastically and their use in phylogenetic analyses have become more and more popular. Such tools have recently been used to demonstrate that Mycalina, a suborder previously based on morphological characters, is not monophyletic and therefore is not accepted anymore (Hajdu et al., 2013; Morrow and Cárdenas, 2015).

Family Mycalidae Lundbeck, 1905

The family Mycalidae includes sponge taxa with palmate chelae and a tangential ectosomal skeleton, in which spicules may be slightly smaller than the spicules from the choanosome (Hooper and Van Soest, 2002 [2004]). Like the vast majority of former Mycalina sponges, Mycalidae species possess one kind of megascleres which are generally mycalostyles, which can occasionally be replaced or accompanied by strongyles, oxeas or exotyles. Their megascleres are organized in a plumose, plumoreticulate or confused structural pattern. In terms of microscleres, the following types may be seen in Mycalidae members: palmate chelae, sigmas, toxas, spined microxeas and raphides. According to Hooper and Van Soest (2002 [2004]), the most common growth forms for the Mycalidae family are encrusting, massive, fan-shaped and branching. Mycalidae sponges often exhibit a textured surface marked by crests and crevices. The Mycalidae family currently contains 244 accepted species (Van Soest et al., World Porifera Database, Accessed July 9th, 2021), and it is assumed that many Mycalidae species are still to be discovered based of the impressive diversity of this group and its omnipresence in the oceanic and coastal environments all around the globe (Hooper and Van Soest, 2002 [2004]). Upcoming phylogenetic changes for the Mycalidae family are also to be expected according to recent molecular studies (Morrow and Cárdenas, 2015) revealing the potential polyphyletic nature of Mycalidae.

Mycalidae sponges are divided into the two genera *Mycale* and *Phlyctaenopora* depending on the type of megascleres present. *Phlyctaenopora* species have a combination of strongyles and oxeas, whereas species belonging to the *Mycale* genus have either mycalostyles or oxeas. More precisely, Hooper and Van Soest (2002 [2004]) described the *Phlyctaenopora* as "Mycalidae with a megasclere complement of oxeas and strongyles in combination with a microsclere complement which may include peculiar amphiaster-like spined microxeas and anisochelae, to which sigmas may be added". With only five accepted species split in two subgenera (Van Soest et al., World Porifera Database, Accessed July 9th, 2021), *Phlyctaenopora* is a relatively small group that was not encountered among our Arctic collections. On the other hand, the genus *Mycale* includes the remaining 239 Mycalidae species (98 % of the accepted Mycalidae species) that are organized into the 12 accepted subgenera (Van Soest et al., World Porifera Database, Accessed July 9th, 2021). The *Mycale* subgenera are probably not all monophyletic and there is overlap between characters differentiating them, but they provide a system to classify the numerous *Mycale* species which helps in the identification of specimens. Only specimens from the subgenera *Mycale (Mycale)* and *Mycale (Rhaphidotheca)* have been identified within our Arctic collections (*Paamiut* 2010-2014). We cannot say with certainty that other species and even subgenera from the *Mycale* genus are not present in the area surveyed, as the sampling methodology may bias our collections toward the identification of larger and/or more robust taxa. Therefore, a list of the defining characteristics of each subgenus, adapted from Hooper and Van Soest (2002 [2004]) and Van Soest et al. (2021) is provided below. In the list, certain distinguishing characteristics that could help to differentiate some of the subgenera are in **bold**, however we recommend using the identification keys available in the cited literature (Hooper and Van Soest, 2002 [2004]; Van Soest et al., 2021) to correctly identify a specimen, as a combination of characters is often needed.

Mycale (Aegogropila): Only subtylostyles/mycalostyles in terms of megascleres. Microscleres are palmate anisochelae, regular sigmas, toxas, raphides and micracanthoxeas. Ectosomal skeleton composed of triangular or polygonal meshes of megasclere bundles. Plumose or plumoreticulate organization of the choanosomal skeleton.

Mycale (Anomomycale): Only subtylostyles/mycalostyles in terms of megascleres. **Presence of anomochelae** (modified palmate anisochelae with a very large and wide frontal ala at the smaller end of the chelae).

Mycale (Arenochalina): Only subtylostyles/mycalostyles in terms of megascleres. Microscleres are limited to palmate anisochelae and regular sigmas, but both may be absent or rare. No coherent ectosomal skeleton. Choanosomal skeleton organized in a rectangular reticulation which is often cored by filamentous algae or other material. Slimy sponges when out of the water.

Mycale (Carmia): Only subtylostyles/mycalostyles in terms of megascleres. Possible forms of microscleres for this subgenus are palmate anisochelae, sigmas, toxas, raphides and micracanthoxeas. No coherent ectosomal skeleton. Choanosomal skeleton composed of plumose arrangements of megascleres. Sponges are generally soft and encrusting.

Mycale (Grapelia): Only subtylostyles/mycalostyles in terms of megascleres. Presence of **polydentate unguiferate chelae** (alae could be reduced to spines). Confused tangential ectosomal skeleton.

Mycale (Kerasemna): External surface is characterized by a reticulation of spicule tracts organized in a web-like design which are supported by branching coralline algae (symbiosis). **Presence of spirally twisted double toxodragmas.** Microscleres could also include sigmas, anisochelae and trichodragmas. *Note that the genus Kerasemna Pulitzer-Finali, 1982, is now recognized as an accepted Mycale subgenus following a recent review of Mycale species from the tropical Indo-West Pacific (Van Soest et al., 2021). It was previously considered as a synonym from Mycale (Arenochalina) or Mycale (Mycale).*

Mycale (Mycale): Only subtylostyles/mycalostyles in terms of megascleres. Microscleres are mostly palmate anisochelae, regular sigmas and raphides. Ectosomal skeleton present but without clear organization in mesh or bundles.

Mycale (Naviculina): Only subtylostyles/mycalostyles in terms of megascleres. **Presence of naviculichelae** (modified chelae with incomplete or complete fusion of both frontal alae, among other characteristics). Reticulated tangential ectosomal skeleton.

Mycale (Oxymycale): **Only oxeas (or anisoxeas) in terms of megascleres**.

Mycale (Paresperella): Only subtylostyles/mycalostyles in terms of megascleres. Microscleres are palmate anisochelae, **serrated sigmas** and occasionally toxas. Plumose or plumoreticulated choanosomal skeleton and ectosome is composed of a tangential reticulation of megascleres.

Mycale (Rhaphidotheca): **Presence of exotyles** (styles with expanded end) going through the external tissue layer of the sponge. Other spicules are mycalostyles, anisochelae, sigmas and raphides.

Mycale (Zygomycale): Only subtylostyles/mycalostyles in terms of megascleres. **Presence of small isochelae**, along with palmate anisochelae, sigmas, raphides and toxas. Dense reticulated tangential skeleton forming the ectosome. Plumose or plumoreticulated choanosomal skeleton.

Subgenus *Mycale (Mycale)* Gray, 1867

The subgenus *Mycale (Mycale)* is found all around the world and includes species from polar to tropical waters. According to the recent review from Van Soest et al. (2021), Indian Ocean and some Antarctic regions contain the most important *Mycale (Mycale)* species densities worldwide (Van Soest et al., 2021). Of course, this pattern is influenced by the sampling effort which is highly variable from one region to another. More work on Mycalidae in the northern hemisphere is needed to understand the biodiversity and distribution patterns of these species. Cold water species are particularly under studied (Van Soest et al., 2021). A total number of 55 species are currently accepted worldwide (Van Soest et al., World Porifera Database, Accessed July 9th, 2021). While this number is thought to be an underestimation according to recent review (Van Soest et al., 2021), it is important to mention that this subgenus is probably not monophyletic, and some accepted species might end up being synonymized. The *Mycale (Mycale)* species have a tangential ectosomal skeleton without organization or pattern (Van Soest et al., 2021; Hooper and Van Soest, 2002 [2004]). The spicule complement is composed of mycalostyles (or subtylostyles), palmate anisochelae, sigmas and raphides, the later being organized in trichodragmas. Toxas are rare for this subgenus and palmate anisochelae usually exist in several size classes (Van Soest et al., 2021; Hooper and Van Soest, 2002 [2004]). These characteristics could be shared with other *Mycale* subgenera and therefore caution is recommended during the identification process. It is often the absence of certain spicule types such as exotyles (in *Mycale (Rhaphidotheca)*) or oxeas (in *Mycale (Oxymycale)*) that lead to the larger *Mycale (Mycale)* subgenus. Different size categories of mycalostyles are used for describing certain species when the length difference is clear, however differences in width and tip shape (blunt or pointed) commonly vary, partly in function of growth stage, and are not helpful for differentiating species (Van Soest et al., 2021).

Subgenus *Mycale (Rhaphidotheca)* Kent, 1870

The subgenus *Mycale (Rhaphidotheca)* is mostly found in northern colder waters, with a few records in the tropics (Van Soest et al., 2021). A total of five accepted species are in this subgenus (Van Soest et al., World Porifera Database, Accessed July 9th, 2021). The spicule complement for *Mycale (Rhaphidotheca)* species is composed of mycalostyles, anisochelae, sigmas and raphides, which is very similar to sponges from other *Mycale* subgenera (Van Soest et al., 2021; Hooper and Van Soest, 2002 [2004]). However, within the Mycalidae family, the presence of exotyles is a distinguishing characteristic that belong only to the *Mycale (Rhaphidotheca)* species. The exotyles are modified subtylostyles with one of their ends swollen in a bulbous extremity (with or without crown of spines) or shaped into a large cup. These large spicules are piercing the ectosome, giving to the *Mycale (Rhaphidotheca)* sponges a hispid feel to the touch (Van Soest et al., 2021; Hooper and Van Soest, 2002 [2004]).

Family Isodictyidae Dendy, 1924

Such as other former Mycalina sponges (unaccepted suborder), species from the Isodyctidae family have typically only one type of megasclere, here mostly represented by oxeas (rarely styles and strongyles) (Hooper and Van Soest, 2002 [2004]). The Isodyctyidae family regroups sponge species which for the most part have a reticulated choanosomal skeleton composed of oxeas, combined to the presence of palmate isochelae (Hooper and Van Soest, 2002 [2004]). The Isodictyidae family regroups three accepted species belonging to the *Coelocarteria* genus and 39 accepted species from the *Isodictya* genus, for a total of 42 species (Van Soest et al., World Porifera Database, Accessed July 9th, 2021). The genus *Coelocarteria* seems limited to the Indian Ocean and Pacific Ocean and the genus *Isodictya* is more widely dispersed in the World oceans, but especially present and diverse in the Southern Ocean (Ríos et al., 2020). In terms of growth forms, the *Coelocarteria* sponges are fistulose whereas the *Isodictya* species do not have fistules (Hooper and Van Soest, 2002 [2004]). Moreover, for *Coelocarteria* species, the ectosomal skeleton consists in a dense reticulation of strongyles and/or oxeas organized in several tracts, while, for *Isodictya* species, strongyles are absent and the ectosome is much thinner (Hooper and Van Soest, 2002 [2004]). For the Isodictyidae family, only one specimen from the *Isodictya* genus was found in our Arctic collections (*Paamiut* 2010-2014).

***Isodictya* Bowerbank, 1864**

Belonging to the Isodictyidae family, the *Isodictya* species exhibit a reticulated choanosomal skeleton, which is, to be more specific, reticulate or plumoreticulate (Hooper and Van Soest, 2002 [2004]). Their megascleres are mostly oxeas but could also be styles in rare cases (Hooper and Van Soest, 2002 [2004]). The isochelae characterize the *Isodictya* genus by their very singular shape with “poorly developed lateral alae and plate-like inwardly projected falces” (Van Soest, Marine Species Identification Portal - Sponges of the NE Atlantic, Accessed June 7th, 2021), the later being, in other words, an extension located under the frontal alae and oriented inward. The common growth forms for *Isodictya* species are flabellate and digitiform.

METHODOLOGY

Sponge Collection

Sponges described in this series of reports were collected during five annual multispecies trawl surveys (2010-2014) with the Greenland Institute of Natural Resources (GINR) research vessel *Paamiut*. The missions examined were coded as PAA2010-009, PAA2011-007, PAA2012-007, PAA2013-008 and PAA2014-007. These surveys were 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 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 containing the mission and set numbers, 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 cruise. Therefore, the combination of the cruise details (vessel, year, cruise) and the collection number was a unique identification code for every sponge analyzed. Sponge species were sometimes identified by analysis of gross morphology and arrangement of the skeleton. However, in most cases, identification was based on microscopic analysis of the sponge spicules. Taxonomic resources frequently consulted for spicule comparison included, but were not limited to, Ridley and Dendy (1887), Lundbeck (1902, 1905, 1909, 1910), Topsent (1904, 1913), Koltun (1959), Ackers et al. (2007), Hooper and Van Soest (2002 [2004]), the Marine Species Identification Portal - Sponges of the NE Atlantic website (Van Soest) and the World Porifera Database website (Van Soest et al.).

Light Microscopy

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 overnight in full strength bleach in microtubes. After vortexing and briefly spinning down spicules (~3000 rpm for 1 min) the supernatant was replaced with distilled water. This was repeated after 30 minutes for a total of two water washes. In the final wash step the spicules were suspended in 95% ethanol. 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). Typically, for each taxon presented, 30 length and width measurements were recorded for each spicule type for a single reference specimen. From additional supporting specimens typically 10 length and width measurements per spicule type were obtained. Width measurements were typically taken at the midpoint of the spicule, unless mentioned otherwise in the body of the report.

Descriptions

The remainder of this report is comprised of descriptions of five species (or taxa) collected in the multispecies trawl surveys: four from the family Mycalidae (subgenera *Mycale (Mycale)* and *Mycale (Rhaphidotheca)*) and one from the family Isodictyidae (genus *Isodictya*).

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 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

RESULTS

Family Mycalidae

For the family Mycalidae, three species of the subgenus *Mycale (Mycale)* and one species of the subgenus *Mycale (Rhaphidotheca)* were identified from our eastern Arctic collection, respectively *Mycale (Mycale) lingua* (Bowerbank, 1866), *Mycale (Mycale)* cf. *toporoki* Kolton, 1958, *Mycale (Mycale)* cf. *loveni* (Fristedt, 1887) and *Mycale (Rhaphidotheca) marshallhalli* (Kent, 1870). Because of time constraints and limited resources, we did not perform thick sections of the sponge tissue to observe its skeletal organization and thus spicule morphologies and dimensions were primarily used to identify Mycalidae specimens. Since no strongyles or oxeas were observed for our Mycalidae specimens and since mycalostyles were present, we determined that they all belong to the genus *Mycale*, following the Mycalidae key to genera from Hooper and Van Soest (2002 [2004]). Most of these *Mycale* specimens fell under the subgenus *Mycale (Mycale)* as their megascleres are exclusively mycalostyles, combined with microscleres such as palmate anisochelae, raphides and normal shaped sigmas. For four specimens from our sample collection, the presence of exotyles was very characteristic. These specimens were therefore placed under the subgenus *Mycale (Rhaphidotheca)*. The identification of the specimens at the species level was done thereafter. It is important to mention here that the presence of exotyles is a criterion that should be used cautiously, since it is not an exclusive characteristic of the *Mycale (Rhaphidotheca)* subgenus. The presence of these styles with inflated heads was therefore solely used to narrow the search of potential families, genera or species during the identification process. Then, for each specimen, the whole spicule complement was carefully examined. In combination with the external morphology of our specimens, these data were compared to the original species descriptions and other published descriptions (see the taxonomic remarks sections of each species descriptions).

Family Isodictyidae

In our eastern Arctic collection, we identified one specimen of *Isodictya* aff. *palmata* (Ellis & Solander, 1786), a species that belongs to the family Isodictyidae. Even though we did not perform thick sections to observe the skeletal organization, the presence of peculiar isochelae with curved extensions and the oxeas present as the only megascleres led us to the *Isodictya* genus. Then, 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 (Van Soest et al.) 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) Megascleres are exclusively oxeas (273-327 µm). Microscleres are palmate isochelae (35-42 µm) with alae curved outwards.……………………..…....………*Isodictya* aff. *palmata*
Megascleres are mostly mycalostyles (could be subtylostyle-like). Exotyles could be present..…...2

(2) Presence of very long exotyles (737-1580 µm) combined with mycalostyles, anisochelae, sigmas and raphides……..*Mycale (Rhaphidotheca) marshallhalli*
Absence of exotyles. The megasclere complement consists exclusively of mycalostyles (could be subtylostyle-like)…………………………………………..……………..….......3

(3) Microscleres are exclusively composed of anisochelae (in two size classes: 20-44 µm, 58-86 µm). Mycalostyles are short (394-483 µm), thicker in their middle (mid-length) and their rounded extremity may be slightly inflated (subtylostyle-like)……..*Mycale* cf. *loveni*
Microscleres include anisochelae, sigmas and raphides (rarely trichodragmas)………..…..……..4

(4) Presence of large sigmas, up to 146 µm (15-146 µm). Large raphides are also common, up to 185 µm (46-185 µm). Anisochelae in two size classes (11-50 µm, 50-97 µm) and mycalostyles (405-986 µm) are also present…..…………..……*Mycale (Mycale)* cf. *toporoki*
Small sigmas only (17-28 µm). Raphides are 36-90 µm long. Anisochelae in two size classes (20-46 µm, 60-96 µm) and mycalostyles (414-921 µm) are also present…........……..………………………..….............................*Mycale (Mycale) lingua*

Descriptions of Family Mycalidae

Mycale

ITIS TSN 48202 (species)
Mycale (Mycale) lingua **(Bowerbank, 1866)** WORMS AphiaID 168640 (species)

Physical description

Our reference specimen of *Mycale (Mycale) lingua* (PAA2010-009 Set 111 Col 254) is 7.5 cm long, 6.5 cm wide and 2 cm thick (Figure 2). The material was torn in some places, so the overall growth form is unclear. The external surface is irregularly furrowed. It has a rough, shaggy texture due to large spicules sticking out of the surface. There are dispersed 1 mm oscula on the tips of the furrows on one area of the external surface. The colour of the surface (after being preserved in ethanol) is greyish beige, and the spicule tracts are light yellow. The sponge is easily compressed.

Habitat information

Hudson Strait, Ungava Bay, Davis Strait and Baffin Bay at 118-1435 m depth (Figure 3, Appendix 1). Murillo et al. (2018) reported that *Mycale (Mycale) lingua* was the second most frequently occurring species in the area (21% of the sets) and constituted an indicator species. It was found together with several polymastiid species and *Phakellia bowerbanki*, forming a similar assemblage to those *Phakellia*-dominated sponge assemblages from the northern continental shelf of Norway (Kutti et al. 2013, 2015). *Mycale (Mycale) lingua* has been found at the top of the Flemish Cap and the upper slope of the Grand Banks on sandy and silty-sand bottoms with gravel at 130-666 m depth (Murillo et al., 2016). This species is also common in the Bay of Fundy in shallow waters (Goodwin, 2017).

Spicules (Table 1, Figure 4)

Megascleres: Mycalostyles are 414-976 µm long and 9-21 µm wide (Table 1, Figure 4A). They are straight or very lightly curved, with a slightly constricted neck. The thickest part is located approximately at mid-length, which is where the width measurements were taken.

Microscleres: Palmate anisochelae are distributed into two distinct size classes. The large ones being 60-104 µm long and 6-12 µm wide, and the small ones measuring 20-57 µm long and 2-8 µm wide (Table 1, Figure 4B-C). The width measurements of the two size classes overlap when we compare the combined measurements of all six analyzed specimens (Table 1). However, within each individual specimen, the dimension ranges for chelae do not overlap and therefore the two size classes are easily differentiated on an individual basis. Sigmas are 17-28 µm long (Table 1, Figure 4D). Raphides (rarely trichodragmas) are 34-94 µm long (Table 1, Figure 4E).

Distinguishing characteristics

Frequently encountered in our study area, *Mycale (Mycale) lingua* has a pale yellow/grey surface with furrows which is highly characteristic (Ackers et al., 2007). However, also found in our Arctic collections, *Mycale (Mycale)* cf. *toporoki* has a very similar surface layer. Therefore, it is necessary to check the spicule complement of our specimens in order to confidently identify them to the species level. *Mycale (Mycale) lingua* is different from the other *Mycale* species in our Arctic collections due to its combined presence of styles (mycalostyle type), anisochelae in two size classes, sigmas smaller than 29 µm and raphides shorter than 95 µm. *Mycale (Mycale)* cf. *toporoki* has a very similar spicule complement, but dimensions are different with significantly larger raphides and sigmas.

Taxonomic remarks

Mycale lingua was originally described by Bowerbank in 1866 under the name *Hymeniacidon lingua* as a pallid grey sponge with a furrowed external surface containing large spicules. The sponges were found in deep water off the Western Islands in Scotland. Bowerbank (1866) mentioned the presence of mycalostyles, raphides, sigmas, and large and small anisochelae in these specimens. However, he did not give the measurements of these spicules. In the same 1866 paper, Bowerbank described another *Mycale lingua* specimen under the name *Desmacidon constrictus*. This specimen was only a small fragment (5 cm wide), and its external layer was damaged and almost entirely missing. It had light grey colour when dried. Bowerbank (1866) found mycalostyles, sigmas and raphides. He did not give the measurements of his observed spicules.

In 1876, Carter documented other *Mycale lingua* specimens under the name *Esperia placoides*. The sponges were yellowish grey with an external surface which was “divided into plates” “separated from each other by deep grooves”. The surface had spicules which projected externally. The samples were found 40 miles NW off the Shetland Islands at 345 fathoms. They had mycalostyles (847 µm long and 18 µm wide), anisochelae (76 µm long), sigmas (18 µm long) and raphides which are bundled as trichodragmas (72 µm). In 1887, Levinsen described *Mycale (Mycale) lingua* under the name *Esperella vosmaeri*. He observed styles (560-740 µm), chelae (10-90 µm), and sigmas (20 µm). He did not mention the presence of raphides. These spicule measurements fall into the size range observed in our *Mycale (Mycale) lingua* samples.

In 2019, Dinn et al. described two *Mycale lingua* specimens from the Canadian Arctic near our collection sites. When alive, the sponges were bright yellow with a furrowed external surface. They had styles (400-779 µm long and 12-20 µm wide), large anisochelae (52-97 µm long), small anisochelae (29-50 µm long), sigmas (12-27 µm long), and raphides/trichodragmas (30-75 μm). Dinn et al. (2019) noted that their specimens did not contain the third size class of chelae (< 20 μm) observed by Boury-Esnault et al. (1994) and Van Soest et al. (2014). Dinn et al. (2019) suggested this may be due to their samples being collected further north.

The spicule measurements of our *Mycale (Mycale) lingua* specimens fall in the same range as the spicules described by Dinn et al. (2019). While some of our styles (> 780 μm) and raphides (> 76 μm) are larger than the maximum lengths obtained by Dinn et al. (2019), these bigger spicules do fall in the size range of 530-1150 μm observed by Ackers et al. (2007) for their specimens of *Mycale (Mycale) lingua*.

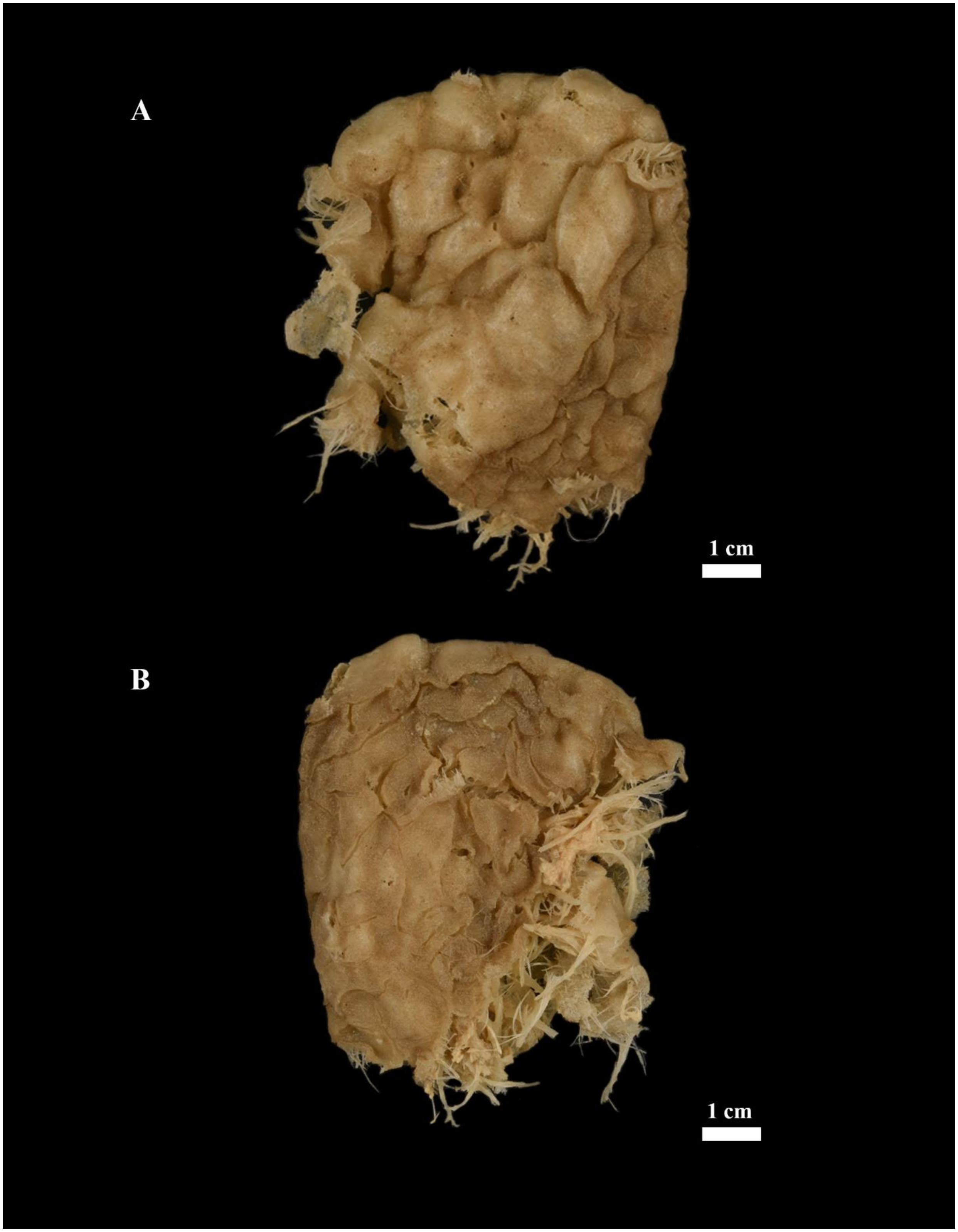

Figure 2. *Mycale (Mycale) lingua* specimen PAA2010-009 Set 111 Col 254 showing opposite surfaces.

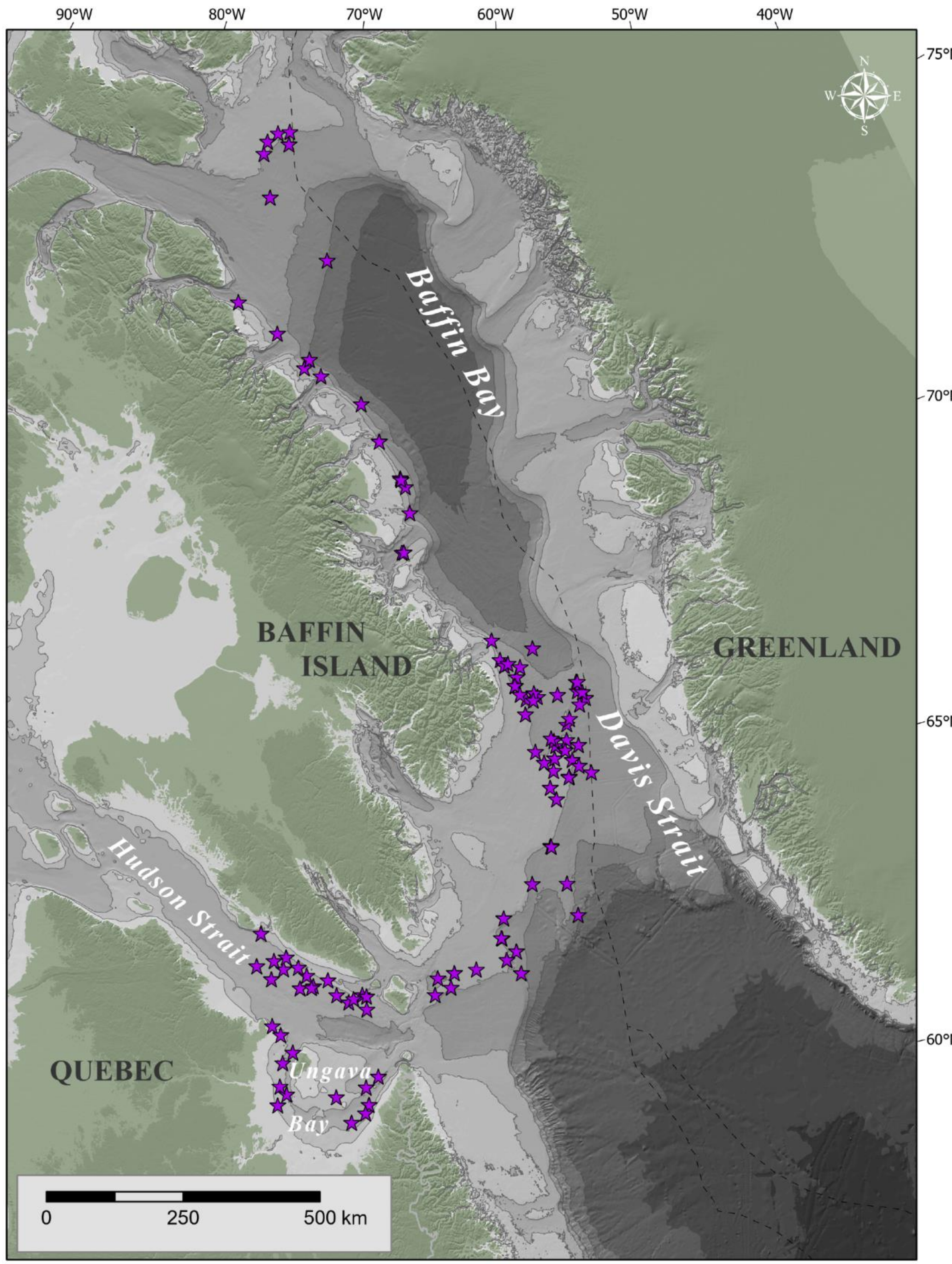

Figure 3. *Mycale (Mycale) lingua* collection locations (see Appendix 1 for details).

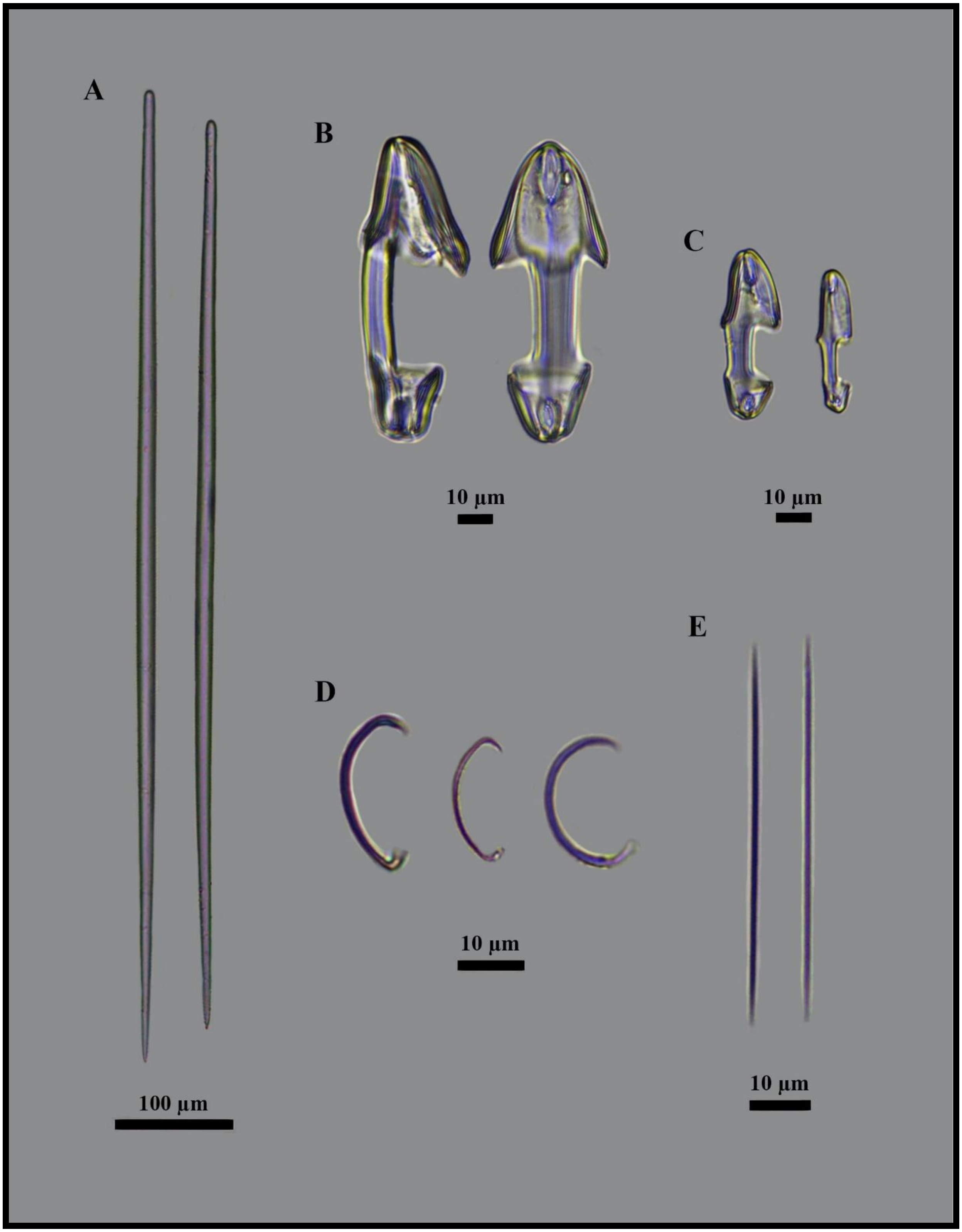

Figure 4. *Mycale (Mycale) lingua* spicules from PAA2010-009 Set 111 Col 254. Styles (A), Large anisochelae (B), Small anisochelae (C), Sigmas (D) and Raphides (E).

Table 1. Spicule measurements from specimens of *Mycale (Mycale) lingua* 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	Large Anisochelae	Small Anisochelae	Sigmas	Raphides
PAA2010-009 Set 111 Col 254	638.8-(808.7)-921.2 × 12.1-(17.7)-21.4 n = 30	74.6-(83.7)-96.4 × 8.2-(9.2)-11.0 n = 30	23.7-(45.0)-56.7 × 1.5-(4.7)-7.5 n = 44	19.9-(23.6)-27.9 n = 30	33.8-(71.5)-88.3 n = 30
PAA2011-007 Set 45 Col 133	503.7-(592.7)-664.6 × 12.6-(14.4)-16.8 n = 10	74.9-(81.7)-90.2 × 6.4-(7.2)-8.5 n = 10	25.2-(39.7)-50.4 × 1.9-(2.9)-3.9 n = 11	16.9-(22.2)-28.2 n = 10	59.2-(73.0)-87.0 n = 10
PAA2012-007 Set 3 Col 341	566.1-(603.9)-654.4 × 14.1-(16.2)-18.3 n = 10	79.3-(84.0)-93.6 × 7.6-(9.3)-10.2 n = 10	20.1-(34.6)-46.3 × 2.4-(4.2)-6.4 n = 10	19.2-(22.7)-27 n = 10	66.1-(76.8)-89.8 n = 10
PAA2012-007 Set 11 Col 10	475.0-(499.4)-529.9 × 9.9-(11.7)-13.0 n = 10	60.2-(70.3)-74.2 × 7.3-(8.7)-9.6 n = 10	27.4-(35.1)-49.0 × 2.5-(3.7)-6.2 n = 10	18.6-(21.8)-24.1 n = 10	35.7-(55.9)-64.8 n = 10
PAA2013-008 Set 46 Col 170	413.8-(635.1)-762.3 × 8.6-(14.7)-18.8 n = 10	76.2-(85.2)-94.3 × 7.3-(8.6)-9.3 n = 10	28.2-(35.5)-50.6 × 1.5-(2.5)-4.0 n = 11	19.3-(21.5)-25.2 n = 10	62.7-(72.8)-83.2 n = 10
PAA2014-007 Set 69 Col 108	490.1-(591.7)-644.8 × 8.8-(15.4)-17.3 n = 10	66.4-(81.4)-88.9 × 7.8-(9.5)-11.6 n = 10	28.7-(36.9)-43.3 × 2.5-(3.9)-4.8 n = 10	17.3-(19.7)-22.5 n = 10	48.7-(75.8)-94.1 n = 30
PAA2011-007 Set 163 Col 485	616.9-(838.0)-976.1 × 14.4-(18.8)-21 n = 10	67.9-(84.1)-103.5 × 6.2-(7.8)-10.1 n = 10	32.6-(45.7)-51.9 × 2.6-(4.8)-6.6 n = 10	17.2-(23.1)-25.4 n = 10	40.8-(58.7)-78.5 n = 10

ITIS TSN 48216 (species)

Mycale (Mycale) **cf.** ***toporoki*** **Kolton, 1958**

WORMS AphiaID 168660 (species)

Physical description

Our reference specimen of *Mycale (Mycale)* cf. *toporoki* (PAA2013-008 Set 20 Col 71) is 9.3 cm long, 6.1 cm wide and 2.5 cm thick (Figure 5). The external surface and spicule tracts are pale beige for this frozen sponge. That same specimen in its fresh state was also beige but of a darker tone according to at-sea photos. The specimen was torn in some places, so the overall growth form could not be described. The surface is mostly flat with what appears to be some flattened out furrows (possibly due to the sample being frozen). The surface feels rough due to the spicules sticking out of it.

Habitat information

Davis Strait, south of Davis Strait and Hudson Strait at 239-1078 m depth (Figure 6, Appendix 1).

Spicules (Table 2, Figure 7)

Megascleres: Mycalostyles are 405-996 µm long and 10-31 µm wide (Table 2, Figure 7A). They are straight or very lightly curved, with a slightly constricted neck. The thickest part is located approximately at mid-length, which is where the width measurements were done.

Microscleres: Large anisochelae are 50-97 µm long and 5-13 µm wide (Table 2, Figure 7B). Small anisochelae are 11-50 µm long and 1-6 µm wide (Table 2, Figure 7C). Sigmas are 15-146 µm long (Table 2, Figure 7D). Sigmas larger than 100 µm are not common among the analyzed samples. They were only found in two samples, with just one observed in each. Raphides are 46-185 µm long (Table 2, Figure 7E). No trichodragmas were found on the examined slides.

Distinguishing characteristics

Following examination of frozen or preserved specimens and at-sea photos showing their fresh state, we could confirm that *Mycale (Mycale)* cf. *toporoki* has a beige (sometimes grey) external surface with furrows, making it very similar to *Mycale (Mycale) lingua*, which is abundantly found in the study area. Therefore, spicule examination is needed. Similarly to *Mycale (Mycale) lingua*, *Mycale (Mycale)* cf. *toporoki* has mycalostyles, anisochelae in two size classes, sigmas and raphides. However, *Mycale (Mycale)* cf. *toporoki* has significantly larger raphides (46-185 µm) and sigmas (15-146 µm) than *Mycale (Mycale) lingua*.

Taxonomic remarks

In 1958, Koltun described *Mycale (Mycale) toporoki* as a greyish yellow sponge with a surface irregularly divided by small furrows. The dermal skeleton is "in the form of a fairly irregular or (more frequently) unfused meshwork consisting of fibers and tufts of spicules". His samples were found in the Bering Sea, Sea of Okhotsk, and Sea of Japan at 9.5-228 meters deep. The sponges had mycalostyles (270-811 µm), large anisochelae (63-103 µm), small anisochelae (21-31 µm), sigmas (21-136 µm) and raphides (72-103 µm). Some of his observed styles had slightly bulbous ends. Most of the measured spicules in our *Mycale (Mycale)* cf. *toporoki* specimens fall within the size ranges observed by Koltun (1958), but we observed larger mycalostyles and larger and smaller raphides. Some of our chelae and sigmas are also out of the length ranges given by Koltun (1958), but since the differences are quite small (less than 20 µm), this could be due to the natural variation between samples. Even if our specimens of *Mycale (Mycale)* cf. *toporoki* share important similarities with *Mycale (Mycale) toporoki*, such as large sigmas, we do not feel that it matches perfectly with Koltun's description. Moreover, the lack of literature on this species and its distribution that seems currently limited to the North Pacific are other reasons to avoid hasty conclusions. Therefore, our specimens were designated "cf.".

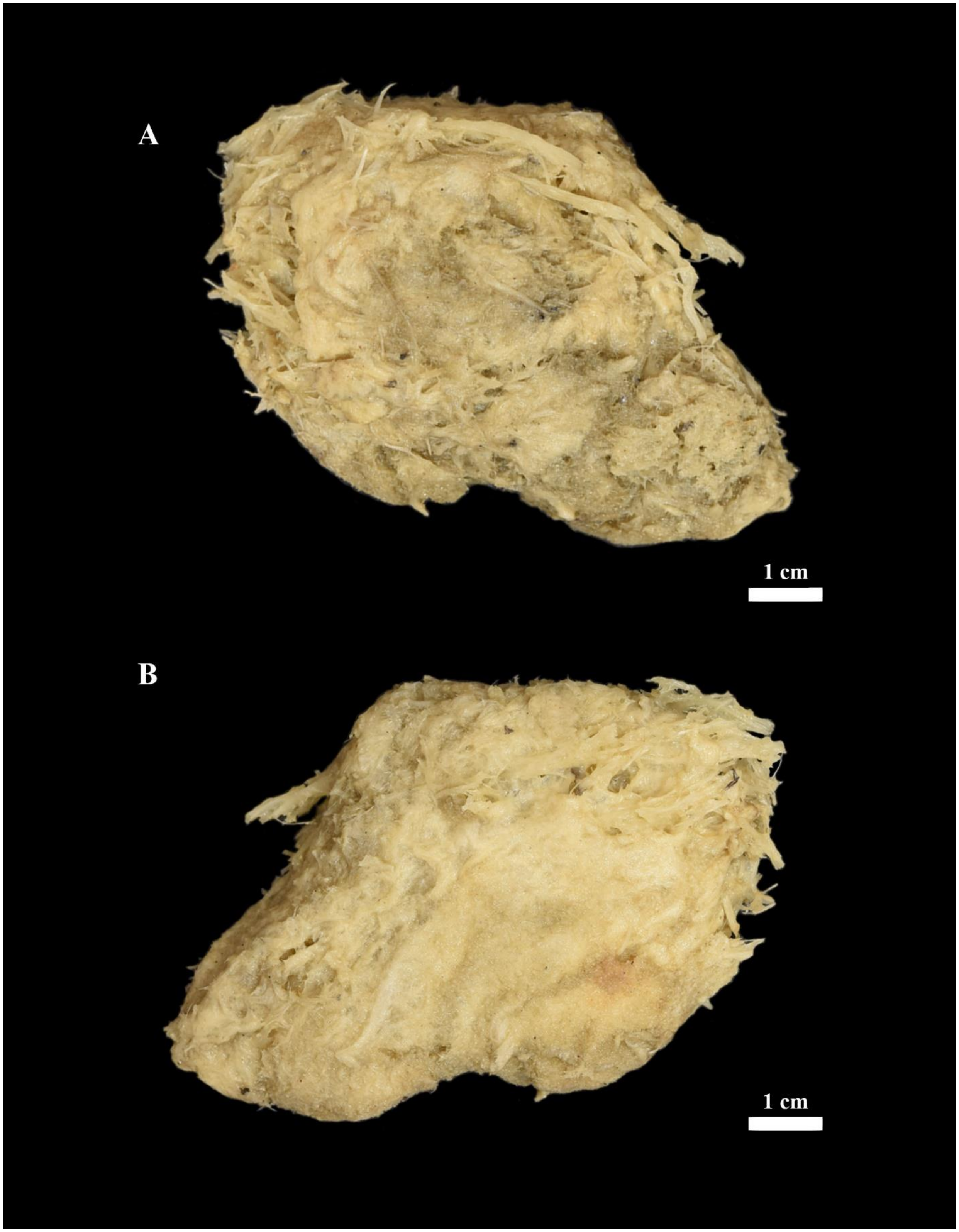

Figure 5. *Mycale (Mycale)* cf. *toporoki* specimen PAA2013-008 Set 20 Col 71 showing opposite surfaces.

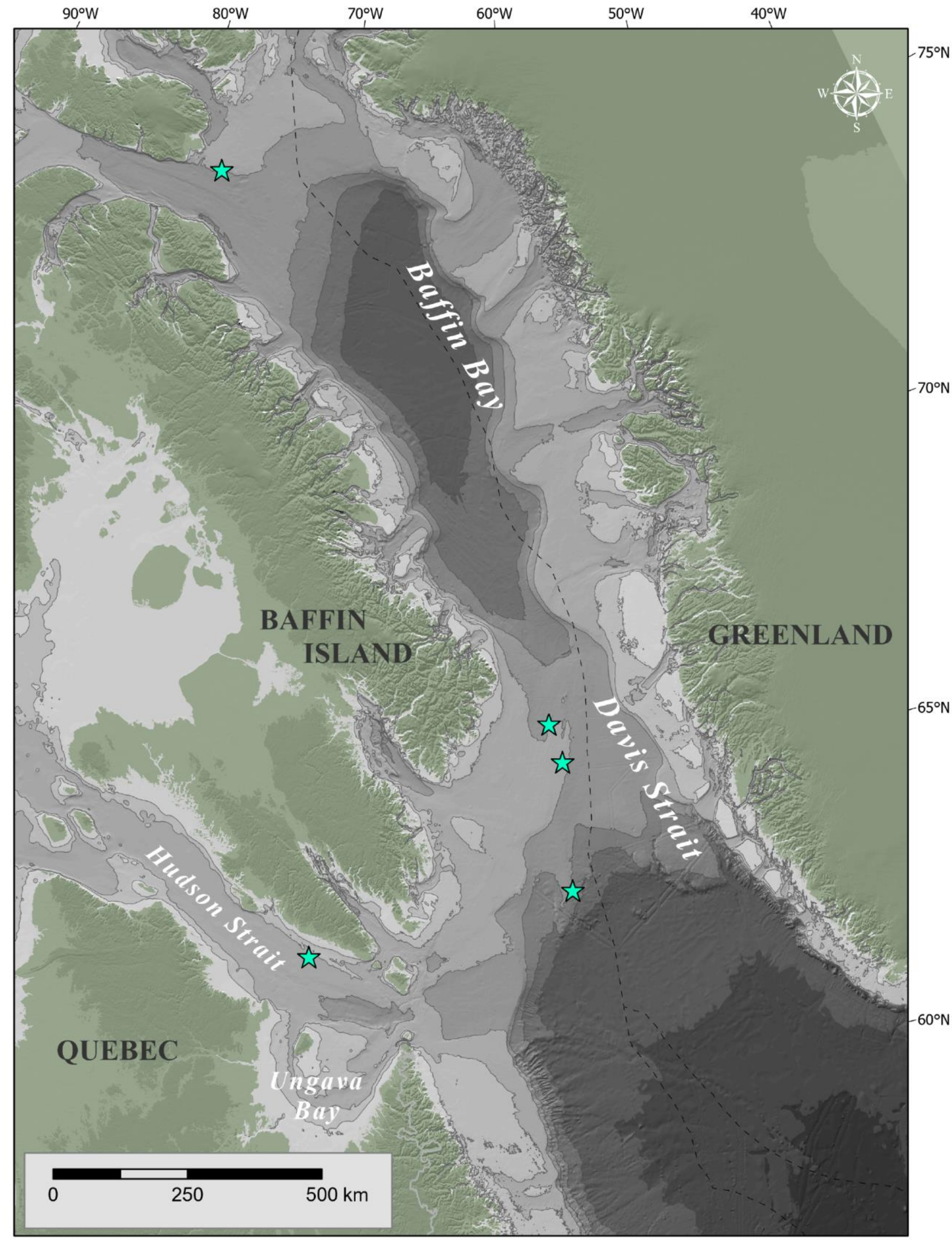

Figure 6. *Mycale (Mycale)* cf. *toporoki* collection locations (see Appendix 1 for details).

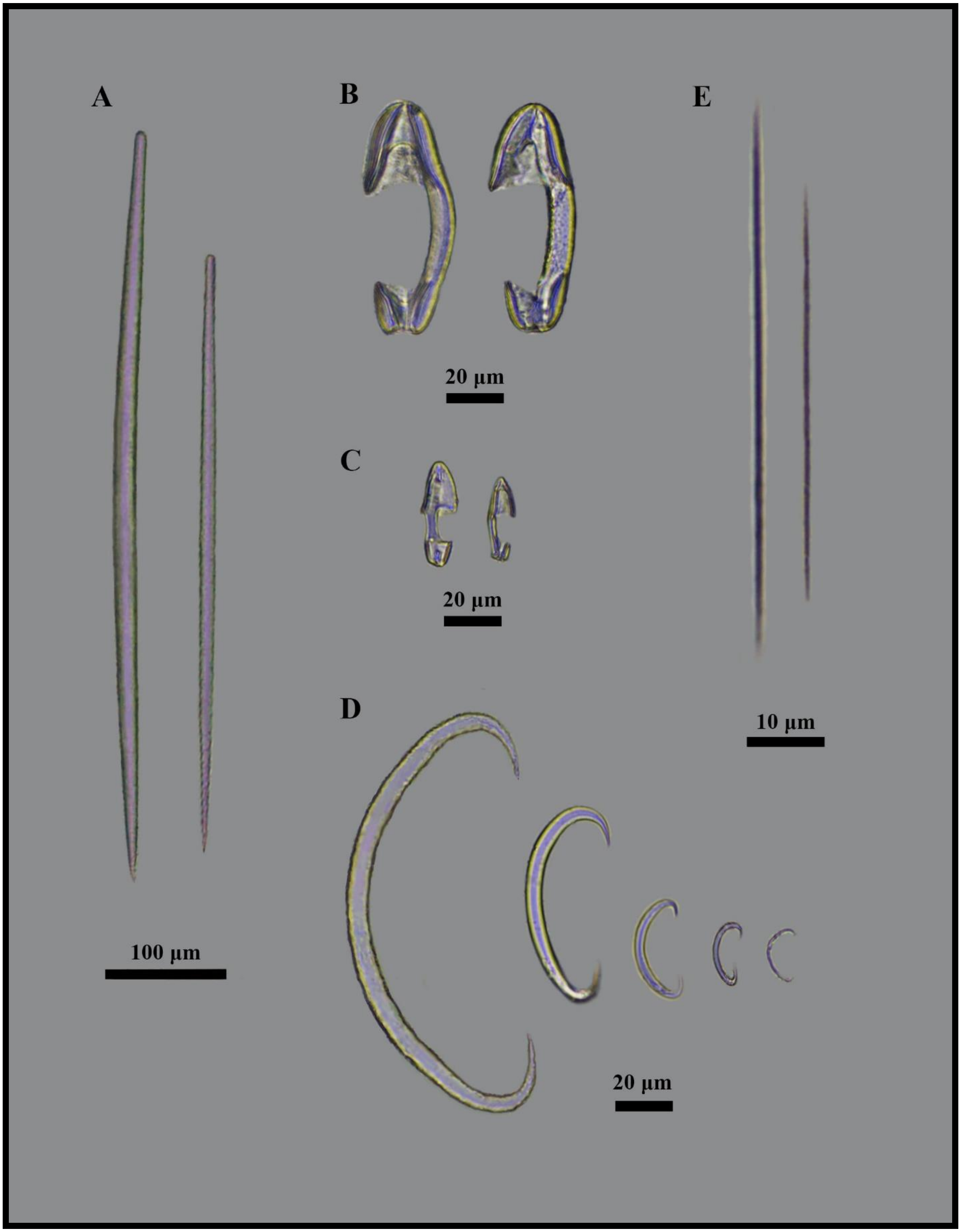

Figure 7. *Mycale (Mycale)* cf. *toporoki* spicules from PAA2013-008 Set 20 Col 71. Styles (A), Large anisochelae (B), Small anisochelae (C), Sigmas (D) and Raphides (E).

Table 2. Spicule measurements from specimens of *Mycale (Mycale)* cf. *toporoki* 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**	**Large Anisochelae**	**Small Anisochelae**	**Sigmas**	**Raphides**
PAA2013-008 Set 20 Col 71	496.5-(603.7)-675.4 × 11.6-(16.8)-20.6 n = 30	72.6-(82.3)-88.6 × 7.7-(9.5)-12.3 n = 19	18.8-(35.7)-45.7 × 1.6-(3.9)-5.8 n = 30	15.1-(50.7)-145.7 n = 30	45.9-(70.3)-89.9 n = 30
PAA2014-007 Set 164 Col 486	468.2-(606.6)-701.5 × 12.5-(15.8)-18.0 n = 10	50.4-(71.4)-91.8 × 5.7-(9.9)-13.3 n = 10	13.3-(27.7)-44.3 × 1.4-(2.8)-5.8 n = 10	33.9-(53.3)-82.5 n = 10	47.4-(82.5)-151.0 n = 10
PAA2012-007 Set 37 Col 30	478.0-(612.8)-985.6 × 13.5-(17.9)-31.3 n = 10	51.2-(61.4)-73.6 × 5.1-(6.8)-10.1 n = 9	30.7-(36.8)-46.5 × 2.3-(3.4)-5.7 n = 10	18.9-(38.3)-80.8 n = 10	47.2-(140.3)-185.4 n = 10
PAA2011-007 Set 60 Col 149	405.1-(524.0)-598.9 × 10.4-(13.1)-16.2 n = 10	63.6-(67.8)-74.6 × 6.5-(7.7)-8.7 n = 10	10.9-(31.0)-49.5 × 1.2-(2.9)-5.2 n = 10	14.6-(41.7)-81.3 n = 10	45.8-(117.5)-154.1 n = 10
PAA2011-007 Set 17 Col 46	790.6-(846.4)-995.9 × 12.3-(13.7)-14.9 n = 10	76.4-(81.6)-96.9 × 5.8-(6.7)-8.2 n = 10	33.4-(43.4)-48.1 × 2.3-(4.1)-5.0 n = 10	19.0-(55.3)-144.7 n = 10	52.8-(80.4)-147.5 n = 10

ITIS TSN 48208 (species)
WORMS AphiaID 168642 (species)

***Mycale (Mycale)* cf. *loveni* (Fristedt, 1887)**

Physical description

Our reference specimen of *Mycale (Mycale)* cf. *loveni* (PAA2010-009 Set 61 Col 246) is approximately 4.5 cm long by 3 cm wide and no more than 0.5 cm thick (Figure 8). All of the specimens collected are pieces only a few centimeters long, therefore no description of the whole organism could be given in this report. The reference specimen is composed of tough ramified fibres forming a network with large open cavities where tufts of softer tissue are nested. The colour (after being preserved in ethanol) of the thick and fibrous skeleton is almost white or light yellow whereas the soft tissue is yellow to light grey (Figure 8).

Habitat information

Baffin Bay at 442-677 m depth (Figure 9, Appendix 1).

Spicules (Table 3, Figure 10)

Megascleres: The spicule complement of *Mycale (Mycale)* cf. *loveni* is quite simple with only mycalostyles and chelae present (Figure 10). The megascleres are exclusively mycalostyles that are 394-483 µm long and 12-18 µm wide (Table 3, Figure 10A). These mycalostyles are generally straight, but some are slightly curved. The thickest part is located approximately at mid-length, which is where the width measurements were done. From the middle it then gradually tapers to a sharply pointed extremity. In some instances, the thickest section is more pronounced and the rounded extremity can be slightly inflated, therefore these spicules might resemble subtylostyles.

Microscleres: Palmate anisochelae are distributed into two distinct size classes. The large ones are 58-86 µm long and 5-9 µm wide and these are organized in rosettes in the soft tissue portions, while the small ones are 21-44 µm long and 1-5 µm wide and seem to be randomly distributed in the sponge soft tissue (Table 3, Figure 10B-C). The width measurements for chelae here represent the diameter of the shaft. For the two anisochelae size classes presented for this species, there is no overlap even when including measurements from all specimens. The gap between these two categories is obvious and therefore the size classes are truly distinct. Currently included in our smaller size class, few tiny chelae from 20 to 24 µm long could potentially be distinct from the other small chelae that are generally larger than 29 µm (Figure 10C). However, based on their similar shapes and on the narrow gap (5 µm or less, variable from one specimen to another) that would distinguish that hypothetical third size class (20-24 µm) from the next one (29-44 µm), we considered them indistinguishable and grouped them for the purpose of this description. It is possible that these very small chelae could be developmental forms.

Distinguishing characteristics

Mycale (Mycale) cf. *loveni* can be distinguished from the well known and frequently encountered in eastern Canadian waters *Mycale (Mycale) lingua* by its external appearance if the specimens are in good condition. The tougher skeletal ramified system characterizing our *Mycale (Mycale)* cf. *loveni* specimens appears to differ from the fibrous part of our specimens identified as *Mycale (Mycale) lingua*. That being said, after being trawled for some time, the specimens from both species are often quite damaged and spicule examination is therefore needed. *Mycale (Mycale)* cf. *loveni* is the only Mycalidae species from our collection with only anisochelae in the microsclere complement (neither sigmas nor raphides). Moreover, its short mycalostyles (394-483 µm) slightly thicker at mid-length are quite characteristic and they distinguish this species from other similar species in our Arctic collections.

Taxonomic remarks

Mycale (Mycale) loveni is a commonly encountered species in North Pacific waters and the type specimen was collected in the Chukchi Sea along the Arctic Ocean margin (Fristedt, 1887). However, it has also been recorded in the northwest Atlantic (Fuller, 2011; Murillo et al., 2016). The four specimens that we listed here as *Mycale (Mycale)* cf. *loveni* were previously documented as *Mycale (Mycale) loveni* in 2018 by Murillo et al. More recently, a specimen of *Mycale* sp. from the Gulf of St. Lawrence was described (Dinn, 2020), exhibiting similar but not identical characteristics to *Mycale (Mycale) loveni*. Taxonomic investigations are underway to determine if the northwest Atlantic specimens actually belong to a new species based on some differences with the North Pacific species *Mycale (Mycale) loveni* (Dinn et al. in prep.).

In the original description from Fristedt in 1887, *Mycale (Mycale) loveni*, which was originally named *Clathria loveni*, was described as an erect and irregularly ramified specimen with several slender branches of a very firm consistency. According to Fristedt (1887), some softer tissue was found in the defined spaces formed by the intersection of the fibrous branches. This description of the external appearance of *Mycale (Mycale) loveni* corresponds with our reference specimen (Figure 8). Fristedt (1887) also described very similar styles: "... straight or slightly curved, smooth, tapering from the middle towards the base and the sharp point". From this statement, our understanding is that the styles described have their thickest section in the middle, which also matches our findings. In the same text, it was mentioned that styles could be slightly inflated at the "base" (which for Fristedt corresponds the rounded end) matching our observations of subtylostyle shapes in some cases. Fristedt's measurements for styles are ranging from 350 to 450 µm. This range includes most of the styles measurements for our specimens of *Mycale (Mycale)* cf. *loveni* and the maximal values that we obtained are only slightly bigger (Table 3). The smaller chelae, with an average length of 35 µm according to Fristedt (1887), are similar to our measurements for this spicule type. However, an important difference lies in the larger chelae measurements, as Fristedt (1887) found an average length of 100 µm, while the maximal length value for our specimens is 86 µm. The rosette formations for larger chelae were described by Fristedt (1887) and match our observations.

Lambe (1905) and de Laubenfels (1926) described sponges from Pacific waters that were respectively named *Esperella bellabellensis* and *Esperella fisheri*, and that are now both synonymized as *Mycale (Mycale) loveni* (Stone et al., 2011). Lambe (1905) presented longer styles than the ones described by Fristedt (1887) with a range of 432-491 µm, which includes our maximal values. He also specified that the styles were stout, straight, smooth and pointed, with their thickest section being at mid-length. The same rosettes of larger chelae were observed by Lambe (1905), with these spicules measuring between 85 to 91 µm. de Laubenfels (1926) found straight and smooth styles from 390 to 425 µm that are therefore similar to what Fristedt (1887) described and quite smaller than the ones seen by Lambe (1905). These dissimilarities in these two descriptions of *Mycale (Mycale) loveni* shows how variability between specimens of a same species could be non-negligible. Nevertheless, Lambe (1905) and de Laubenfels (1926) both mentioned that the thickness of the styles is generally 12-13 µm which fits only our smallest width measurements (12-18 µm). Interestingly, de Laubenfels (1926) described the sharp point of these styles as "hastately pointed", which would suggest an enlargement just before the point. Concerning the large chelae, de Laubenfels (1926) wrote about an average length of 75 µm, which is much closer to what we observed.

In 1929, Hentschel also described *Mycale (Mycale) loveni* and his findings are quite similar to Fristedt's with straight or slightly curved styles (350-465 µm), larger chelae in rosettes (72-100 µm) and smaller chelae as well (35 µm). He also observed sigmas, but their presence is probably due to contamination.

A few decades later, Koltun (1959) examined 25 specimens from Chukchi, Bering and Okhotsk Seas. He described *Mycale loveni* as a large funnel on a tough stem attached to hard substrate. He illustrated what he called "straight, less often gently curved brevi-mucronate styli (or substyli)", and his drawing shows the largest part of the style just before the point. In that sense, his description of the styles is similar to the one written by de Laubenfels (1926) and different from what we observed. The styles measurements given by Koltun (1959) are comparable to ours and range from 350 to 509 µm in length and 13 to 16 µm in thickness, but their shape is clearly different. He also described two size classes of apically asymmetrical palmate chelae ranging from 72 to 111 µm and from 31 to 54 µm.

More recently, Stone et al. (2011) also described *Mycale (Mycale) loveni* in Aleutian Islands, Bering Sea and Gulf of Alaska. The styles of these specimens had the largest diameter just before the point and were ranging from 370 to 495 µm by 10 to 15 µm. These authors found large anisochelae going from 80 to 110 µm long, and small ones measuring 30-42 µm.

Overall, our observations match well with *Mycale (Mycale) loveni* descriptions from Fristedt (1887), Lambe (1905) and Hentschel (1929), except for large chelae measurements. The large chelae missing from the 90-100 µm range is the main reason why our specimens were left at "cf.". We did not observe the wide pointed extremity described by de Laubenfels (1926) and Stone et al. (2011) and also drawn by Koltun (1959). It seems that authors do not quite agree on the shape of the styles which is definitely adding to our doubts. A detailed comparison with type material and other Pacific and Atlantic specimens would allow us to confirm or deny if these Arctic specimens are *Mycale (Mycale) loveni* and our team is currently involved in this undergoing and important work (Dinn et al. in prep.). In future Arctic collection events, we hope to collect specimens in better condition in order to also describe and compare external morphology and growth forms.

Figure 8. *Mycale (Mycale)* cf. *loveni* specimen PAA2010-009 Set 61 Col 246 showing opposite surfaces.

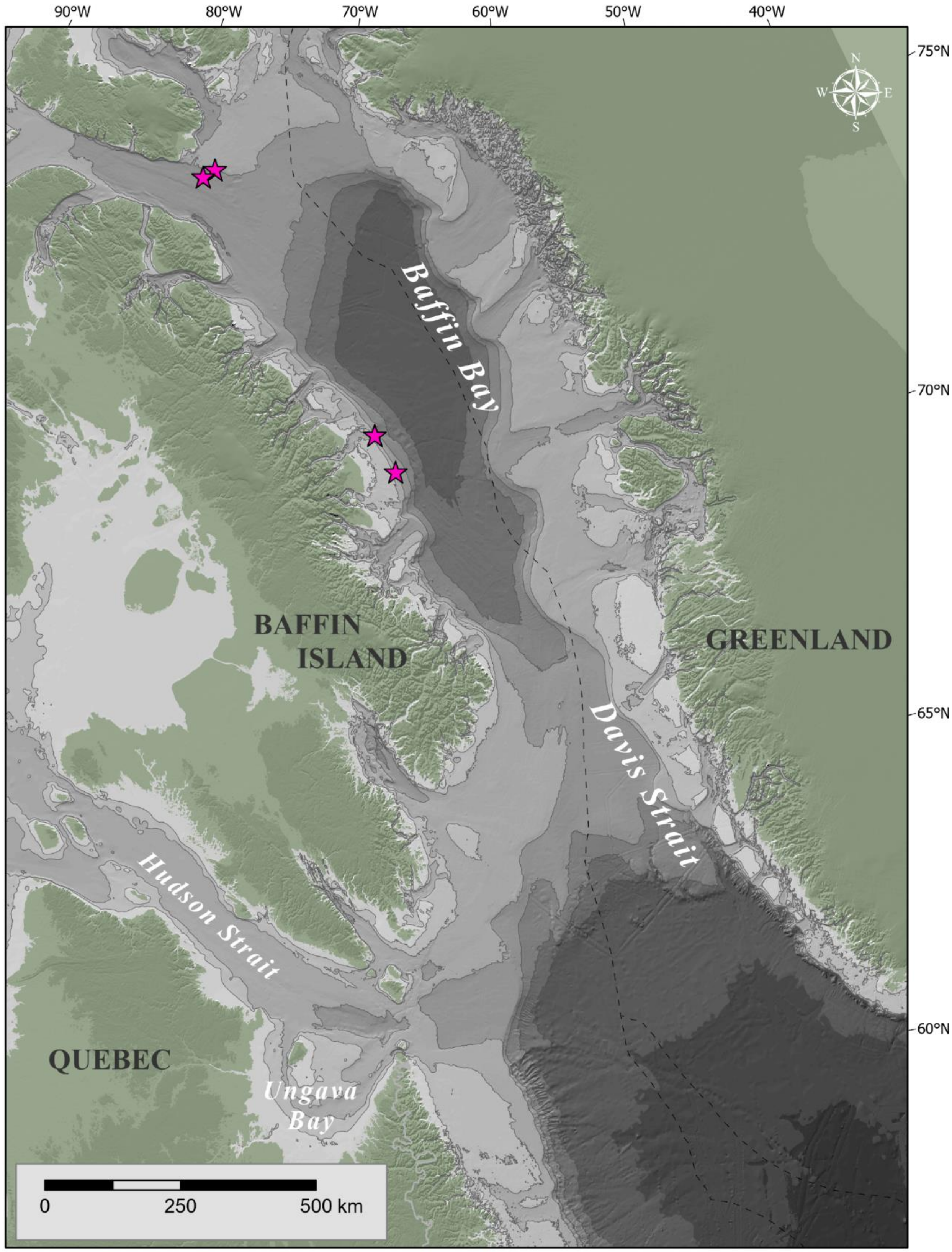

Figure 9. *Mycale (Mycale)* cf. *loveni* collection locations (see Appendix 1 for details).

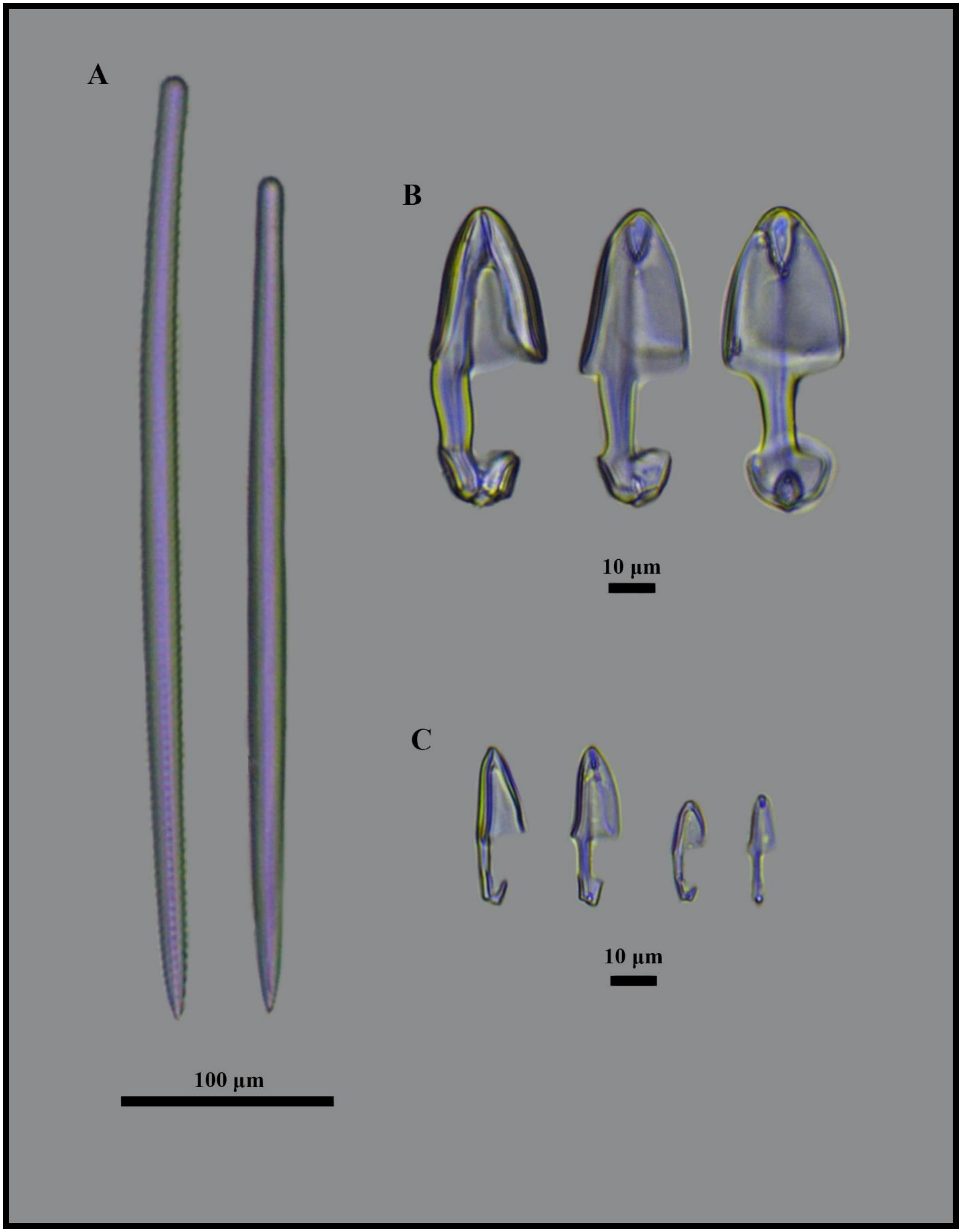

Figure 10. *Mycale (Mycale)* cf. *loveni* spicules from PAA2010-009 Set 61 Col 246. Styles (A), Large anisochelae (B) and Small anisochelae (C).

Table 3. Spicule measurements from specimens of *Mycale (Mycale)* cf. *loveni* 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**	**Large Anisochelae**	**Small Anisochelae**
PAA2010-009 Set 61 Col 246	415.2-(453.6)-480.1 × 12.9-(16.0)-18.3 n = 30	60.5-(65.7)-73.7 × 5.4-(6.9)-7.9 n = 30	22.7-(32.6)-37.1 × 1.5-(2.2)-3.1 n = 30
PAA2010-009 Set 67 Col 237	403.8-(440.6)-472.3 × 13.5-(15.8)-17.4 n = 10	58.6-(65.5)-70.8 × 5.8-(6.6)-7.8 n = 10	23.7-(32.3)-35.6 × 1.5-(2.0)-2.8 n = 10
PAA2012-007 Set 38 Col 33	394.3-(447.7)-472.9 × 13.8-(14.9)-16.6 n = 10	63.3-(67.4)-72.5 × 4.8-(6.1)-7.9 n = 10	20.9-(29.4)-44.0 × 1.4-(2.5)-4.6 n = 10
PAA2012-007 Set 37 Col 332	404.1-(452.1)-482.8 × 12.1-(15.0)-16.4 n = 10	57.7-(69.1)-85.7 × 6.2-(7.2)-8.8 n = 10	24.3-(33.3)-44.2 × 1.8-(2.9)-3.8 n = 10

ITIS TSN 659726 (subgenus)

Mycale (Rhaphidotheca) marshallhalli (Kent, 1870) WORMS AphiaID 168696 (species)

Physical description

The piece of *Mycale (Rhaphidotheca) marshallhalli* that was selected as our reference specimen (PAA2011-007 Set 132 Col 303) has a somewhat circular shape with an irregular contour, a diameter of approximately 2.5 cm (Figure 11) and a thickness of 0.5 cm. This specimen is damaged in a few places, but some ridges and furrows observed on its surface seem to belong to its original appearance. The interior is partially hollow and therefore the material examined is fragile and easily compressible. Visible at low magnification (microscope not necessary), large, elongated spicules with enlarged extremities called exotyles (Figure 13A-B) are projecting through the surface, conferring to the sponge a rough, hispid, almost spiky texture. The color following freezing is light brown. No definite oscula or pores were seen. Unidentified eggs, likely from sepiolid cephalopods (*Rossia* sp.), were attached to the sponge surface (Figure 11), as has been found on other sponges (Hayes et al., 2010; Dinn, 2020).

Habitat information

Baffin Bay, Davis Strait and south of Davis Strait at 699-1476 m depth (Figure 12, Appendix 1).

Spicules (Table 4, Figure 13)

Megascleres: Very long exotyles with largely inflated heads protrude through the surface of the sponge (Figure 13A). They are straight or curved and, from the neck to the tip, they gradually taper into a blunt extremity. The dimensions of these spicules are quite variable from one specimen to another and range from 737 to 1590 µm in length and from 8 to 21 µm in thickness (measured at mid-length) (Table 4). Their heads are exhibiting a variety of different shapes even within a given specimen, going from globular to pyriform with more or less flattened or depressed tips (Figure 13B). Mycalostyles are straight or slightly curved (Figure 13C) and generally shorter than exotyles but mycalostyles overlap in length as they range from 515 to 1102 µm (Table 4). Their heads are followed by a slight constriction giving these styles the classic handle-shaped head characterizing mycalostyles (Figure 13C). They are 10-20 µm wide at their thickest part located at mid-length (Table 4). In some instances, the thickest middle section is more pronounced, therefore these spicules might resemble subtylostyles. They finish into an acutely pointed extremity.

Microscleres: Anisochelae are present in two size classes, with the large chelae being 69-113 µm long by 7-13 µm wide and the small ones being 28-58 µm by 2-6 µm, with the width representing the diameter of the clearly visible portion of the shaft (Table 4, Figure 13D-E). The gap is clear between these two size classes and no overlap exists even when considering measurements from all four specimens as a whole. Additionally, shape differences differentiate the two size classes. The large anisochelae have short alae on their upper end which length correspond to a third of the chelae total length (Figure 13D). For the small class of anisochelae, the alae are about half the length of the chelae and their lateral alae seem curved posteriorly (Figure 13E). Sigmas are 17 to 29 µm long (Table 4, Figure 13F) and raphides are 56 to 93 µm long (Table 4, Figure 13G).

Distinguishing characteristics

Our *Mycale (Rhaphidotheca) marshallhalli* specimens can be distinguished from the other Mycalidae specimens collected so far in our Arctic surveys by its morphology and by the spicules protruding from the surface. These exotyles are visible at low magnification or could be felt by touch. However, similar hispid surfaces could be seen for other sponge families in our collections and therefore spicule examination is needed. Moreover, *Mycale (Rhaphidotheca) marshallhalli* is quite fragile and it is represented in our Arctic collections by small and damaged pieces, which could make the identification process difficult based on physical appearance alone. Furthermore, the Arctic species *Mycale (Rhaphidotheca) ernsti,* which was not found in our Arctic collections but might be encountered in the area, can be differentiated from *Mycale (Rhaphidotheca) marshallhalli* by the absence of raphides and its shorter exotyles not exceeding 686 µm according to literature (Koltun, 1959; Hentschel, 1929). The potential presence of this species reinforces our recommendation of spicule examination for identification purposes. *Mycale (Rhaphidotheca) marshallhalli* is characterized by its very long exotyles combined to the presence of mycalostyles, anisochelae, sigmas and raphides (Figure 13).

Taxonomic remarks

First described by Kent in 1870, *Rhaphidotheca marshallhalli*, now accepted as *Mycale (Rhaphidotheca) marshallhalli,* was found in Atlantic waters off the shore of Sesimbra (Portugal) attached to a coral. Kent (1870) described it as encrusting and "cavernous interiorly" with "dividing fascicles of spicula which form the upright supporting pillars to the pin-cushion-like cortex". Except for the missing sigmas, the author described the same spicule complement that we presented: pin-shaped spicules with slightly depressed pyriform extremities, acerate spicules of two types (which we interpret as styles and raphides), and "palmated inequianchorate" chelae. His length measurements mostly match ours, with an average of 1100 µm for exotyles, a maximum of 85 µm for raphides and a range of 25-100 µm for chelae. Identical to the average length for exotyles, the average given by Kent (1870) for mycalostyles is 1100 µm, which corresponds to our maximal length (1102 µm) for this spicule type. However, Kent (1870) also illustrated and described exotyles as the largest spicules of this sponge; his drawing of mycalostyle being a little shorter than the one for exotyle even with the magnification difference taken into consideration.

In 1879, a sponge sampled on the Faroe Plateau was named *Rhaphidotheca affinis* and described by Carter. Although this species was later synonymized with *Mycale (Rhaphidotheca) marshallhalli*, Carter (1879) affirmed back then that his specimen was different from the one described by Kent (1870), arguing that his had flask-shaped elongate exotyle heads whereas the spicules described by Kent (1870) had globular oblate heads. While it is true that variability exists between our specimens of *Mycale (Rhaphidotheca) marshallhalli*, we observed exotyle heads with a variety of different shapes within each individual (Figure 13B). Still comparing his specimen to the one described by Kent (1870), Carter (1879) also mentioned differences in the shape of anisochelae, which seem to be the same shape differences between large and small chelae classes that we described above.

In 1920, Stephens (1920 [1921]) compared two new specimens to the ones described by Carter (1879) and Kent (1870). She concluded that the differences outlined by Carter (1879) were not significant enough to vouch for two distinct species and that all these specimens would probably belong to the same species. Our observations match well the more detailed spicule description by Stephens (1920 [1921]). More specifically, the author explained how the large and the small anisochelae have different proportions (length of alae versus total length of chelae) exactly as we observed. She also noted how the shaft is curved for larger chelae and how the frontal ala at the smaller end is wide compared to the narrow frontal ala at the larger end. These remarks are consistent with our observations (Figure 13D-E). In regards to her measurements, Stephens (1920 [1921]) presented the following length ranges (two specimens combined): 800-1400 µm for exotyles, 570-770 µm for mycalostyles, 25-40 µm and 75-90 µm for small and large chelae, 13-20 µm for sigmas and 60-80 µm for raphides.

In 1905, Lundbeck mentioned that a specimen collected in the waters off Upernivik Island (Baffin Bay, Arctic) and identified as *Mycale lingua* was characterized by the presence of, what he called, “peculiar spicules that may be designated as tylostrongyla”. Lundbeck (1905) also used the terms “rounded” or “pyriform” to describe the variable shape of the swollen ends but he considered them as abnormalities back then. A few years later, *Mycale lingua* var. *lundbecki*, was found in Kara Sea (Arctic) and described by Rezvoi (1924) who named it after Lundbecki’s findings from 1905. This species is also synonymized now with *Mycale (Rhaphidotheca) marshallhalli*. He showed through his drawings the variably shaped exotyles and the differences between the two size classes of anisochelae. His measurement ranges are 889-1056 µm long by 11-30 µm wide for exotyles, 662-965 µm long by 10-20 µm wide for mycalostyles, 52-95 µm for anisochelae, 22-26 µm for sigmas and 59-74 µm for raphides. Compared to our findings, the length range from Rezvoi (1924) appear narrow as they are missing the smallest and largest spicules that we observed, but otherwise our description matches *Mycale (Rhaphidotheca) marshallhalli* once again.

More recently, *Mycale (Rhaphidotheca) marshallhalli* was presented in Systema Porifera from Hooper and Van Soest (2002 [2004]) and the measurement ranges provided then were almost identical to the ones given by Stephens (1920 [1921]), except a larger length range for mycalostyles (500-1000 µm), which fits even better our findings as it accounts for the variability between individuals that we observed. Morphologically, Hooper and Van Soest (2002 [2004]) described this species has a fragile cushion or thick encrustation of only a few centimeters wide and of soft consistency with a hispid surface and a beige color. This deep-water species (≥ 75 m) typically attached to hard substrate could be encountered in European waters from Portugal to Norway and was also recorded in Arctic waters (Hooper and Van Soest, 2002 [2004]). As mentioned above, Lundbeck (1905) recorded *Mycale (Rhaphidotheca) marshallhalli* in Baffin Bay (off Greenland coast) before, but to our knowledge this report presents the first records of this species in Canadian waters. Note that three Arctic specimens presented here (PAA2011-007 Set 132 Col 303, PAA2010-009 Set 156 Col 508, PAA2010-009 Set 031 Col 239) were previously published in Murillo et al. (2018) under the name *Mycale* cf. *arctica*. While our specimens match the *Mycale (Rhaphidotheca) marshallhalli* descriptions currently available, it should be noted that the wide distribution range of this species does raise some doubts about its many synonymies. We may be dealing with cryptic species where barcoding would be helpful to gain more knowledge.

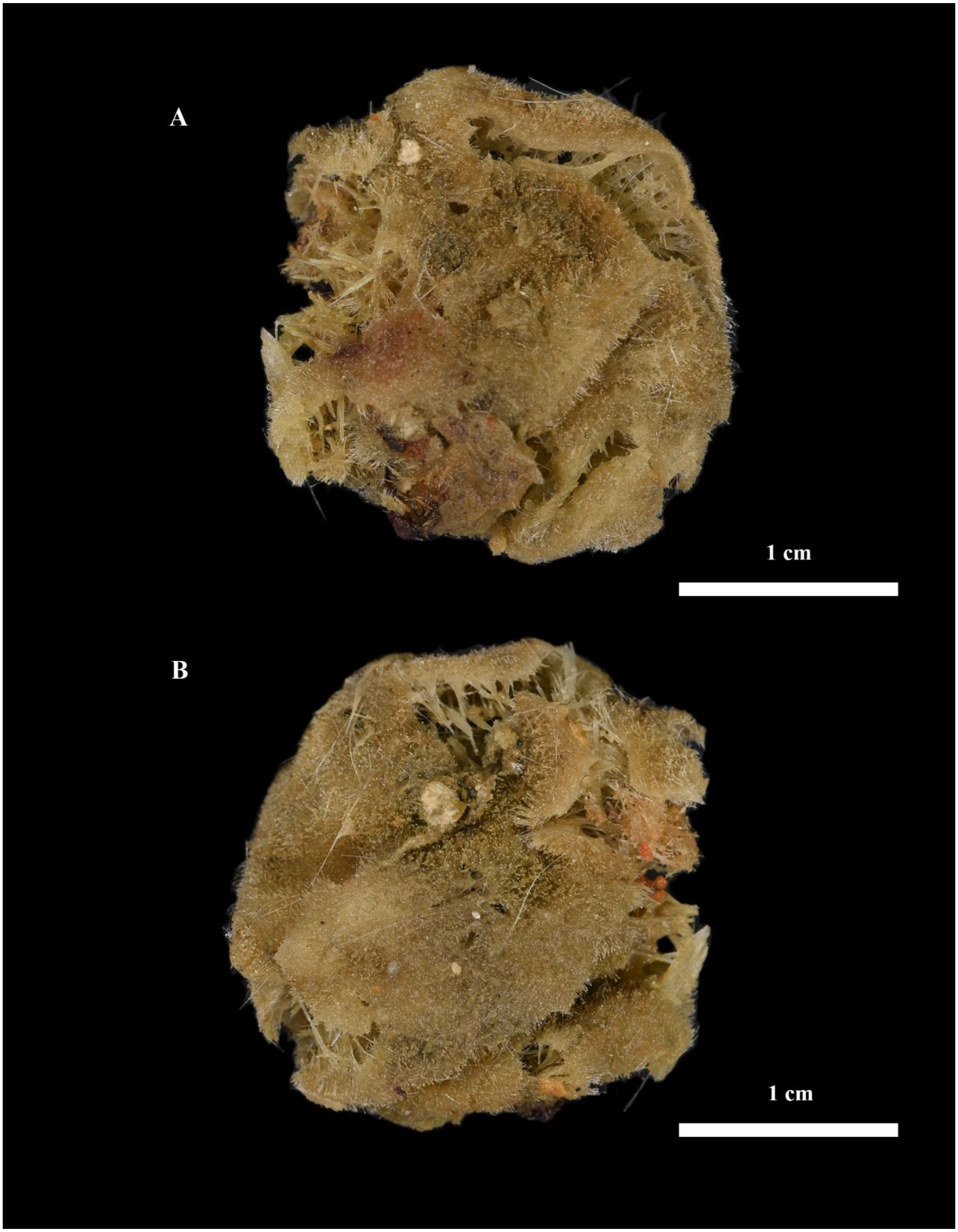

Figure 11. *Mycale (Rhaphidotheca) marshallhalli* specimen PAA2011-007 Set 132 Col 303 showing opposite surfaces.

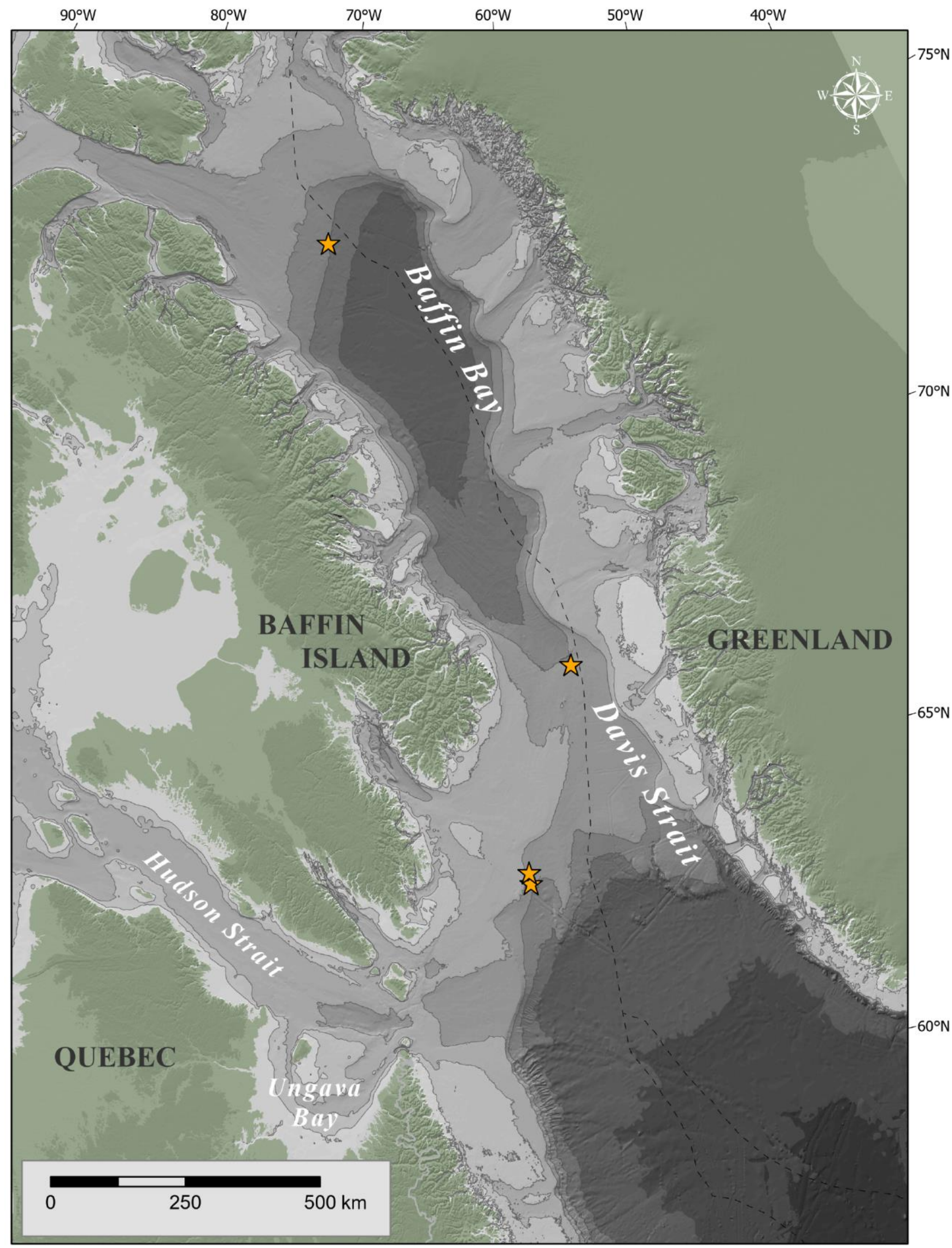

Figure 12. *Mycale (Rhaphidotheca) marshallhalli* collection locations (see Appendix 1 for details).

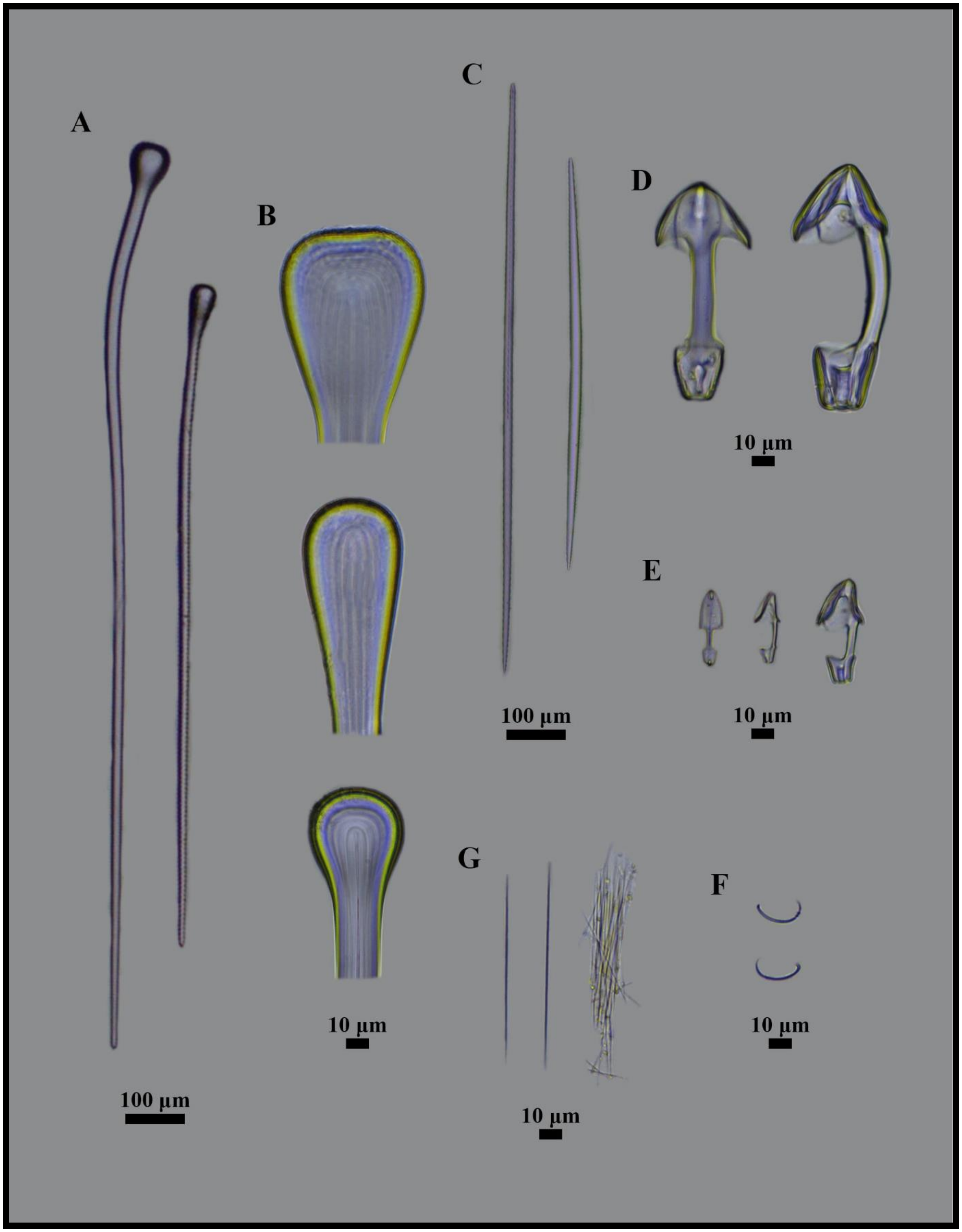

Figure 13. *Mycale (Rhaphidotheca) marshallhalli* spicules from PAA2011-007 Set 132 Col 303. Exotyles (A), Exotyle heads (B), Styles (C), Large anisochelae (D), Small anisochelae (E), Sigmas (F) and Raphides (G).

Table 4. Spicule measurements from specimens of *Mycale (Rhaphidotheca) marshallhalli* 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	Exotyles	Styles
PAA2011-007 Set 132 Col 303	1078.8-(1399.5)-1590.3 × 13.2-(17.4)-20.9 n = 30	549.7-(816.8)-1062.0 × 9.8-(15.2)-20.0 n = 30
PAA2010-009 Set 156 Col 508	737.0-(936.5)-1160.9 × 11.7-(13.8)-16.2 n = 11	625.3-(779.4)-879.1 × 10.0-(14.3)-16.1 n = 12
PAA2010-009 Set 031 Col 239	784.1-(888.2)-976.4 × 8.4-(15.3)-18.1 n = 33	550.4-(761.4)-896.0 × 12.5-(14.1)-16.2 n = 31
PAA2011-007 Set 133 Col 314	852.7-(983.3)-1214.9 × 14.3-(17.6)-20.9 n = 10	515.3-(900.1)-1101.8 × 11.9-(15.2)-17.0 n = 10

Specimen	Large Anisochelae	Small Anisochelae	Sigmas	Raphides
PAA2011-007 Set 132 Col 303	92.3-(100.2)-113.2 × 7.4-(9.8)-11.2 n = 30	27.8-(35.8)-50.0 × 1.6-(2.7)-4.6 n = 30	17.0-(20.2)-24.0 n = 30	62.9-(73.8)-93.1 n = 30
PAA2010-009 Set 156 Col 508	68.9-(78.8)-91.7 × 6.8-(7.9)-9.5 n = 15	35.9-(46.3)-57.7 × 3.2-(4.2)-4.9 n = 17	17.3-(22.8)-28.4 n = 10	55.8-(67.4)-88.1 n = 14
PAA2010-009 Set 031 Col 239	76.0-(88.9)-97.1 × 7.3-(8.8)-10.0 n = 14	47.1-(52.9)-57.3 × 4.4-(5.0)-5.9 n = 10	21.4-(24.9)-28.5 n = 14	56.7-(69.0)-78.7 n = 10
PAA2011-007 Set 133 Col 314	93.1-(99.6)-107.9 × 7.5-(10.4)-13.1 n = 10	31.0-(42.4)-50.0 × 2.4-(4.3)-5.7 n = 10	20.0-(23.1)-28.0 n = 10	59.5-(65.7)-72.4 n = 10

Description of Family Isodictyidae

Isodictya

ITIS TSN 47852 (species)

***Isodictya* aff. *palmata* (Ellis & Solander, 1786)** WORMS AphiaID 133247 (species)

Physical description

The sponge presented in this report as *Isodictya* aff. *palmata* is the only specimen of this species that was collected in our Arctic surveys. It is a small piece of 4.3 cm long by 2.8 cm wide and approximately 1.4 cm thick (Figure 14). The general shape of this piece is ficiform (fig-shaped), which means that it is erect and lobed with the attachment point much narrower than the distal part of the sponge body. The base of the specimen is attached on a calcareous bryozoan skeleton (Figure 14). Several oscula were visible on the surface, and they seemed evenly scattered. However, due to the small size of the specimen, this might not be representative of the pattern of oscula for this species. The surface is porous with spicule tracts that are numerous and dense, which gives the sponge a fuzzy “bread crumb” appearance (Figure 14). The specimen is yellow-beige after being frozen. The specimen is variably compressible and it is moderately fragile.

Habitat information

Hudson Strait, at 244 m depth (Figure 15, Appendix 1).

Spicules (Table 5, Figure 16)

Megascleres: The megasclere complement is exclusively constituted of stout oxeas with acerate extremities that are 273 to 327 µm long by 16 to 23 µm wide (Table 5, Figure 16A). Width was measured at the thickest point which is located at mid-length and is often characterized by having a slight bend.

Microscleres: Palmate isochelae are 35 to 42 µm and the visible portion of their shaft is 2 µm wide on average (Table 5, Figure 16B). From a frontal view when using light microscopy, these chelae appear regular in shape with two equally conical ends. However, when viewed laterally, they exhibit a characteristic shape with tips of the frontal alae curved outwards (Figure 16B). Along the shaft, on the back side of the chelae, there are also ridges oriented outwards that we interpret as poorly developed lateral alae.

Distinguishing characteristics

Spicule examination is recommended as this sponge could be confused with other flabelliform sponges, e.g., *Cladocroce spatula*, when identification is based on physical appearance alone, as has been seen elsewhere in the NW Atlantic (Dinn et al., 2020; Nozères et al., 2020) which is particularly true when specimens are small. Among our Arctic collections, this specimen is distinct because of the combined presence of oxeas and palmate isochelae with outwardly curved alae. The morphology of the isochelae alone is very peculiar and characteristic, however other *Isodictya* species with similar chelae might also be in the area; therefore, caution is advised and all spicule types should be examined and measured.

Taxonomic remarks

Present in boreal and sub-arctic North Atlantic waters, *Isodictya palmata* is a sponge species known for its large digitate form. According to the original description by Ellis and Solander (1786), *Isodictya palmata*, originally named *Spongia palmata*, is “like a hand with fingers, which are a little divided at the top”. These authors also wrote that “the mouths are a little prominent, and irregularly disposed on the surface”. While we also observed conspicuous oscula dispersed on the surface, the general shape of our specimen is not digitiform. However, this could be because of its small size. Small specimens of *Isodictya palmata* can be formed as a single compressed branch, lobate or even almost globular (Lundbeck,1905).

Lundbeck (1905) described the megascleres of *Isodictya palmata* as “straight or slightly curved, and evenly, middle long or rather long pointed” oxeas which were 150 to 229 µm long and 8 to 17 µm thick. They were coupled to the occasional styles which would be abnormal/mutant forms according to the author. For the microscleres, he only found palmate isochelae which were 24 to 30 µm long. In 1958, Hartman published measurements from four different specimens of *Isodictya palmata* collected from Maine (United States), Nova Scotia (Canada) and New Brunswick (Canada). He reported similar length ranges to Lundbeck, with 116 to 277 µm long oxeas and 23 to 33 µm long chelae. Measurements summarized and presented more recently by Hooper and Van Soest (2002 [2004]) follow the same trends, with 116-277 µm long and 4.5-16.8 µm thick oxeas and 23-35 µm long palmate isochelae. For both oxea and chelae spicules, we obtained significantly larger measurement ranges that do not even overlap with the ranges in the literate discussing *Isodictya palmata*. While it has been suggested that high latitude specimens could have larger spicules than the ones collected at lower latitudes for a given species (Hentschel, 1929), we doubt that it would be the only reason explaining such major differences and we suspect that there are several *Isodictya* species present.

Formerly named *Homeodictya palmata*, *Isodictya palmata* was also described by Koltun in 1959. He wrote about an elastic body with a rough surface, finger-like branches, and the presence of numerous oscula from 1 to 6 mm in diameter. While no measurements were given by Koltun (1959), his drawings are informative and represent in detail the lateral view of the palmate isochelae that we also observed with the tips curved to the exterior. However, the frontal view illustrated by Koltun (1959) shows rounded frontal alae, whereas ours are more conical in shape. Before him, Lundbeck (1905) and de Laubenfels (1942) described a similar lateral view with curved tips and a frontal view with rounded alae for *Isodictya palmata*. Lundbeck (1905) described the chelae in detail. His description matches what we observed, except for the oval plate formed by the frontal alae when seen frontally.

Overall, the gaps between measurement ranges led us to conclude that our specimen is probably not *Isodictya palmata*. However, this species and our specimen share the characteristic shape of their palmate isochelae with outwardly curved alae. This important affinity led us to identify our specimen as *Isodictya* aff. *palmata* in the present report. By doing so, we follow the definition of the qualifier “aff.” as given by Sigovini et al. (2016), which is defined as “has affinity with” and generally implies distinction more than a possible identity.

On a different note, de Laubenfels (1942) also described *Isodictya histodermella* which was collected in Arctic waters, one specimen on the West Greenland Shelf and a second one in Eastern Canadian Arctic. Interestingly, de Laubenfels (1942) represented the palmate isochelae of this species in a frontal view which appears much more similar to the shape that we observed, which was characterized by conical ends. However, his drawing of the lateral view does not show the characteristic curved tips that we have seen both on our slides and in the literature about *Isodictya palmata*. The spicule complement of *Isodictya histodermella* is composed of 270 µm by 14 µm oxeas and 30-40 µm long chelae, which is similar to our measurements. According to de Laubenfels (1942), the external appearance of both species seems almost identical, except that *Isodictya histodermella* is more cavernous interiorly than *Isodictya palmata*. Comparison with type material would be needed to go further, with a thorough examination of the isochelae morphology in order to conclude if the shape difference is real or not. Without more specimens to compare to and because of the lack of documentation on *Isodictya histodermella*, the taxa name *Isodictya* aff. *palmata* was retained for the purpose of this report for the reasons mentioned above, but we emphasize that our specimen might be *Isodictya histodermella*.

Figure 14. *Isodictya* aff. *palmata* specimen PAA2013-008 Set 128 Col 247 showing opposite surfaces.

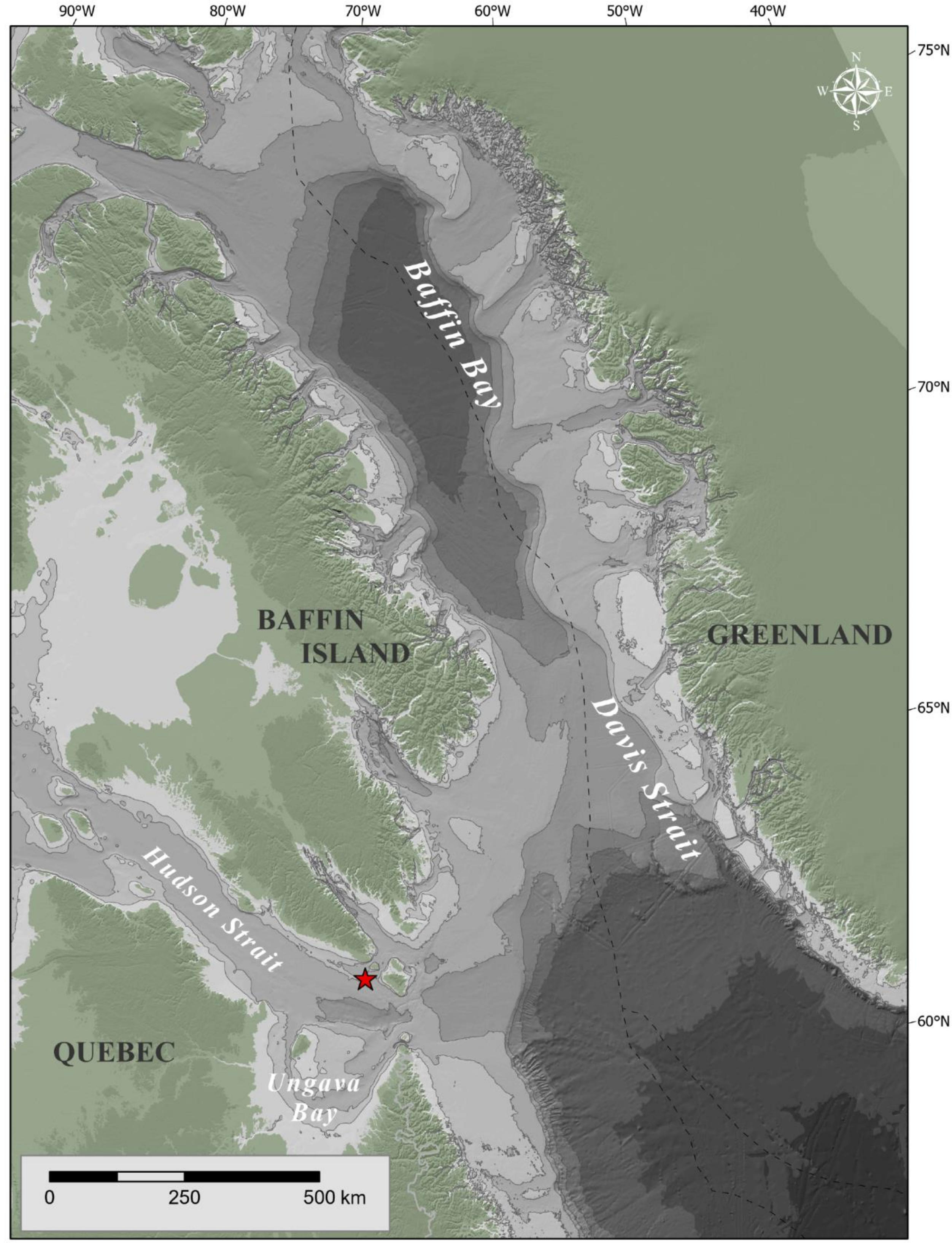

Figure 15. *Isodictya* aff. *palmata* collection location (see Appendix 1 for details).

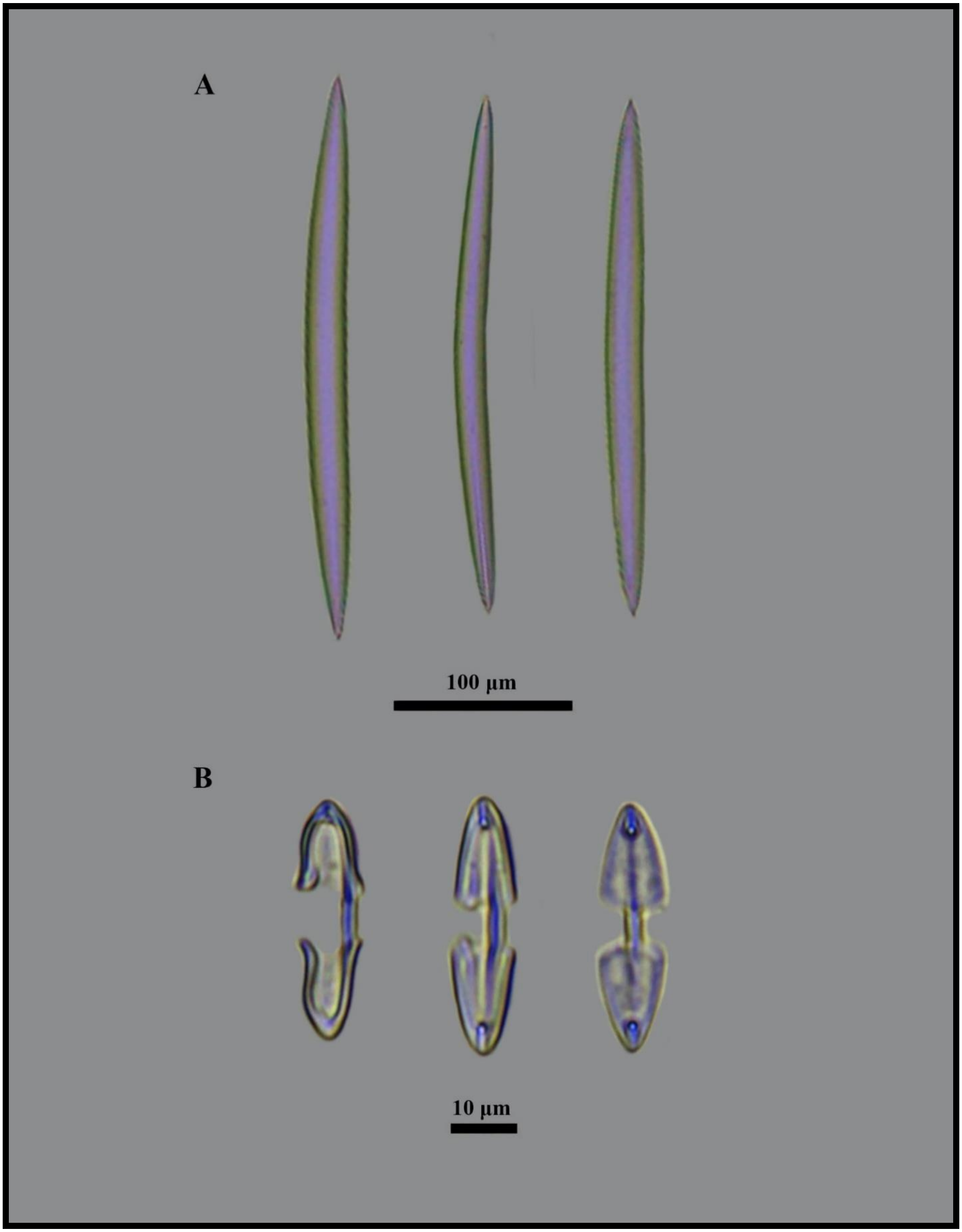

Figure 16. *Isodictya* aff. *palmata* spicules from specimen PAA2013-008 Set 128 Col 247. Oxeas (A) and Isochelae (B).

Table 5. Spicule measurements from our specimen of *Isodictya* aff. *palmata* 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	**Oxeas**	**Isochelae**
PAA2013-008 Set 128 Col 247	272.9-(299.1)-326.7 × 16.3-(20.1)-22.8 n = 30	35.0-(38.6)-41.7 × 1.5-(2.4)-3.9 n = 30

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APPENDIX 1

Lab_Mission_Set_ColNo	Lab_ID	Trawl_Start_Date	Trawl_Start_Latitude	Trawl_Start_Longitude	Trawl_Depth_m
PAA2010009003478	*Mycale (Mycale) lingua*	17-Oct-10	71.27	-67.85	1319
PAA2010009041240	*Mycale (Mycale) lingua*	22-Oct-10	75.10	-75.33	491
PAA2010009042241	*Mycale (Mycale) lingua*	22-Oct-10	75.31	-75.26	426
PAA2010009043242	*Mycale (Mycale) lingua*	22-Oct-10	75.47	-74.70	457
PAA2010009044243	*Mycale (Mycale) lingua*	22-Oct-10	75.53	-73.96	487
PAA2010009044244	*Mycale (Mycale) lingua*	22-Oct-10	75.53	-73.96	487
PAA2010009045245	*Mycale (Mycale) lingua*	23-Oct-10	75.33	-73.87	629
PAA2010009052517	*Mycale (Mycale) lingua*	24-Oct-10	71.66	-70.05	758
PAA2010009061247	*Mycale (Mycale) lingua*	25-Oct-10	70.68	-66.81	677
PAA2010009067248	*Mycale (Mycale) lingua*	26-Oct-10	70.09	-65.69	467
PAA2010009067483	*Mycale (Mycale) lingua*	26-Oct-10	70.09	-65.69	467
PAA2010009068488	*Mycale (Mycale) lingua*	26-Oct-10	69.95	-65.43	552
PAA2010009076249	*Mycale (Mycale) lingua*	27-Oct-10	68.88	-65.46	540
PAA2010009100493	*Mycale (Mycale) lingua*	30-Oct-10	67.45	-61.49	663
PAA2010009103319	*Mycale (Mycale) lingua*	31-Oct-10	67.13	-61.15	439
PAA2010009105250	*Mycale (Mycale) lingua*	31-Oct-10	66.84	-60.50	565
PAA2010009107251	*Mycale (Mycale) lingua*	31-Oct-10	66.69	-60.56	540
PAA2010009107252	*Mycale (Mycale) lingua*	31-Oct-10	66.69	-60.56	540
PAA2010009107253	*Mycale (Mycale) lingua*	31-Oct-10	66.69	-60.56	540
PAA2010009111254	*Mycale (Mycale) lingua*	1-Nov-10	66.50	-59.66	781
PAA2010009158577	*Mycale (Mycale) lingua*	8-Nov-10	66.70	-58.03	670
PAA2010009162255	*Mycale (Mycale) lingua*	8-Nov-10	66.51	-58.83	717
PAA2010009168256	*Mycale (Mycale) lingua*	8-Nov-10	66.43	-57.70	561
PAA2011007005016	*Mycale (Mycale) lingua*	23-Sep-11	65.19	-57.72	672
PAA2011007031096	*Mycale (Mycale) lingua*	27-Sep-11	62.34	-60.87	769
PAA2011007037119	*Mycale (Mycale) lingua*	28-Sep-11	61.76	-63.18	485

Lab_Mission_Set_ColNo	Lab_ID	Trawl_Start_Date	Trawl_Start_Latitude	Trawl_Start_Longitude	Trawl_Depth_m
PAA2011007044594	*Mycale (Mycale) lingua*	30-Sep-11	61.47	-66.69	239
PAA2011007045133	*Mycale (Mycale) lingua*	30-Sep-11	61.60	-66.23	246
PAA2011007047141	*Mycale (Mycale) lingua*	30-Sep-11	61.57	-67.12	229
PAA2011007058144	*Mycale (Mycale) lingua*	2-Oct-11	61.69	-67.94	253
PAA2011007060146	*Mycale (Mycale) lingua*	2-Oct-11	61.86	-68.19	239
PAA2011007062152	*Mycale (Mycale) lingua*	2-Oct-11	61.98	-68.51	226
PAA2011007063155	*Mycale (Mycale) lingua*	2-Oct-11	61.64	-68.39	273
PAA2011007069162	*Mycale (Mycale) lingua*	4-Oct-11	61.75	-69.40	307
PAA2011007071165	*Mycale (Mycale) lingua*	4-Oct-11	61.93	-69.02	279
PAA2011007079171	*Mycale (Mycale) lingua*	5-Oct-11	60.98	-69.22	173
PAA2011007080176	*Mycale (Mycale) lingua*	5-Oct-11	60.85	-68.91	129
PAA2011007080178	*Mycale (Mycale) lingua*	5-Oct-11	60.85	-68.91	129
PAA2011007086184	*Mycale (Mycale) lingua*	6-Oct-11	59.89	-68.54	184
PAA2011007086188	*Mycale (Mycale) lingua*	6-Oct-11	59.89	-68.54	184
PAA2011007088193	*Mycale (Mycale) lingua*	6-Oct-11	59.70	-68.80	130
PAA2011007088195	*Mycale (Mycale) lingua*	6-Oct-11	59.70	-68.80	130
PAA2011007088198	*Mycale (Mycale) lingua*	6-Oct-11	59.70	-68.80	130
PAA2011007095200	*Mycale (Mycale) lingua*	7-Oct-11	59.50	-66.38	240
PAA2011007097205	*Mycale (Mycale) lingua*	7-Oct-11	59.81	-65.84	342
PAA2011007099211	*Mycale (Mycale) lingua*	7-Oct-11	60.09	-65.96	243
PAA2011007114222	*Mycale (Mycale) lingua*	9-Oct-11	61.91	-63.64	534
PAA2011007115230	*Mycale (Mycale) lingua*	9-Oct-11	62.00	-63.06	463
PAA2011007115601	*Mycale (Mycale) lingua*	9-Oct-11	62.00	-63.06	463
PAA2011007126251	*Mycale (Mycale) lingua*	10-Oct-11	62.55	-61.37	583
PAA2011007133690	*Mycale (Mycale) lingua*	11-Oct-11	63.43	-60.22	699
PAA2011007141349	*Mycale (Mycale) lingua*	12-Oct-11	64.04	-59.46	538
PAA2011007145379	*Mycale (Mycale) lingua*	13-Oct-11	64.79	-59.14	478
PAA2011007146384	*Mycale (Mycale) lingua*	13-Oct-11	64.99	-59.36	448
PAA2011007147390	*Mycale (Mycale) lingua*	13-Oct-11	65.26	-59.19	451

Lab_Mission_Set_ColNo	Lab_ID	Trawl_Start_Date	Trawl_Start_Latitude	Trawl_Start_Longitude	Trawl_Depth_m
PAA2011007149578	*Mycale (Mycale) lingua*	14-Oct-11	65.67	-59.05	480
PAA2011007149582	*Mycale (Mycale) lingua*	14-Oct-11	65.67	-59.05	480
PAA2011007150404	*Mycale (Mycale) lingua*	14-Oct-11	65.75	-58.59	512
PAA2011007152409	*Mycale (Mycale) lingua*	14-Oct-11	65.42	-58.43	507
PAA2011007152574	*Mycale (Mycale) lingua*	14-Oct-11	65.42	-58.43	507
PAA2011007154435	*Mycale (Mycale) lingua*	14-Oct-11	65.15	-58.59	496
PAA2011007154436	*Mycale (Mycale) lingua*	14-Oct-11	65.15	-58.59	496
PAA2011007155451	*Mycale (Mycale) lingua*	14-Oct-11	65.40	-59.54	474
PAA2011007157626	*Mycale (Mycale) lingua*	14-Oct-11	65.59	-59.86	503
PAA2011007163485	*Mycale (Mycale) lingua*	15-Oct-11	66.01	-58.54	516
PAA2012007003341	*Mycale (Mycale) lingua*	29-Sep-12	72.25	-72.64	540
PAA2012007011010	*Mycale (Mycale) lingua*	30-Sep-12	72.64	-75.02	553
PAA2012007057044	*Mycale (Mycale) lingua*	8-Oct-12	74.42	-74.40	641
PAA2012007078357	*Mycale (Mycale) lingua*	10-Oct-12	73.55	-70.48	1435
PAA2012007095072	*Mycale (Mycale) lingua*	13-Oct-12	71.76	-70.97	537
PAA2012007104370	*Mycale (Mycale) lingua*	14-Oct-12	70.68	-66.81	678
PAA2012007111099	*Mycale (Mycale) lingua*	15-Oct-12	70.09	-65.69	474
PAA2012007112108	*Mycale (Mycale) lingua*	15-Oct-12	69.53	-65.17	838
PAA2012007119118	*Mycale (Mycale) lingua*	16-Oct-12	68.88	-65.38	509
PAA2012007152366	*Mycale (Mycale) lingua*	21-Oct-12	67.03	-60.98	487
PAA2012007154164	*Mycale (Mycale) lingua*	21-Oct-12	67.00	-60.32	707
PAA2012007160203	*Mycale (Mycale) lingua*	22-Oct-12	66.47	-60.14	522
PAA2012007162214	*Mycale (Mycale) lingua*	22-Oct-12	66.56	-59.80	695
PAA2012007190380	*Mycale (Mycale) lingua*	26-Oct-12	67.30	-59.76	1315
PAA2012007201368	*Mycale (Mycale) lingua*	27-Oct-12	66.55	-58.01	635
PAA2013008011037	*Mycale (Mycale) lingua*	23-Sep-13	65.66	-58.14	537
PAA2013008016048	*Mycale (Mycale) lingua*	24-Sep-13	66.11	-58.42	585
PAA2013008018065	*Mycale (Mycale) lingua*	24-Sep-13	65.58	-58.68	505
PAA2013008022080	*Mycale (Mycale) lingua*	25-Sep-13	65.46	-59.12	457

Lab_Mission_Set_ColNo	Lab_ID	Trawl_Start_Date	Trawl_Start_Latitude	Trawl_Start_Longitude	Trawl_Depth_m
PAA2013008023088	*Mycale (Mycale) lingua*	25-Sep-13	65.75	-59.10	502
PAA2013008046170	*Mycale (Mycale) lingua*	27-Sep-13	62.88	-61.29	407
PAA2013008059214	*Mycale (Mycale) lingua*	29-Sep-13	61.64	-63.72	457
PAA2013008070216	*Mycale (Mycale) lingua*	1-Oct-13	59.90	-66.92	118
PAA2013008077218	*Mycale (Mycale) lingua*	1-Oct-13	60.27	-65.57	255
PAA2013008080220	*Mycale (Mycale) lingua*	2-Oct-13	59.66	-65.94	261
PAA2013008089222	*Mycale (Mycale) lingua*	3-Oct-13	60.01	-68.78	142
PAA2013008091384	*Mycale (Mycale) lingua*	3-Oct-13	60.40	-68.76	158
PAA2013008092394	*Mycale (Mycale) lingua*	3-Oct-13	60.58	-68.45	266
PAA2013008100229	*Mycale (Mycale) lingua*	4-Oct-13	61.93	-69.95	309
PAA2013008102230	*Mycale (Mycale) lingua*	5-Oct-13	62.47	-69.93	166
PAA2013008103232	*Mycale (Mycale) lingua*	5-Oct-13	62.05	-69.37	275
PAA2013008109234	*Mycale (Mycale) lingua*	5-Oct-13	62.12	-68.96	230
PAA2013008109237	*Mycale (Mycale) lingua*	5-Oct-13	62.12	-68.96	230
PAA2013008120239	*Mycale (Mycale) lingua*	6-Oct-13	61.66	-68.00	260
PAA2013008122241	*Mycale (Mycale) lingua*	7-Oct-13	61.81	-67.45	172
PAA2013008128252	*Mycale (Mycale) lingua*	8-Oct-13	61.58	-66.09	244
PAA2013008128254	*Mycale (Mycale) lingua*	8-Oct-13	61.58	-66.09	244
PAA2013008128364	*Mycale (Mycale) lingua*	8-Oct-13	61.58	-66.09	244
PAA2013008129260	*Mycale (Mycale) lingua*	8-Oct-13	61.52	-66.53	218
PAA2013008133277	*Mycale (Mycale) lingua*	9-Oct-13	61.36	-66.06	242
PAA2013008156349	*Mycale (Mycale) lingua*	14-Oct-13	63.41	-58.94	825
PAA2014007029067	*Mycale (Mycale) lingua*	27-Sep-14	71.90	-70.75	1425
PAA2014007049076	*Mycale (Mycale) lingua*	30-Sep-14	70.07	-65.65	480
PAA2014007069108	*Mycale (Mycale) lingua*	3-Oct-14	67.06	-60.83	586
PAA2014007071121	*Mycale (Mycale) lingua*	4-Oct-14	66.70	-60.57	537
PAA2014007071124	*Mycale (Mycale) lingua*	4-Oct-14	66.70	-60.57	537
PAA2014007073126	*Mycale (Mycale) lingua*	4-Oct-14	66.55	-60.37	520
PAA2014007076133	*Mycale (Mycale) lingua*	4-Oct-14	66.22	-60.19	448

Lab_Mission_Set_ColNo	Lab_ID	Trawl_Start_Date	Trawl_Start_Latitude	Trawl_Start_Longitude	Trawl_Depth_m
PAA2014007078146	*Mycale (Mycale) lingua*	4-Oct-14	66.44	-59.84	685
PAA2014007117255	*Mycale (Mycale) lingua*	12-Oct-14	62.88	-58.62	1207
PAA2014007131295	*Mycale (Mycale) lingua*	14-Oct-14	62.05	-62.30	444
PAA2014007135314	*Mycale (Mycale) lingua*	15-Oct-14	61.98	-60.73	745
PAA2014007136322	*Mycale (Mycale) lingua*	15-Oct-14	62.20	-61.22	483
PAA2014007138335	*Mycale (Mycale) lingua*	15-Oct-14	62.56	-61.39	568
PAA2014007148378	*Mycale (Mycale) lingua*	17-Oct-14	64.02	-59.44	543
PAA2014007154416	*Mycale (Mycale) lingua*	17-Oct-14	65.14	-58.61	494
PAA2014007155426	*Mycale (Mycale) lingua*	17-Oct-14	65.32	-58.18	560
PAA2014007158517	*Mycale (Mycale) lingua*	18-Oct-14	66.33	-57.96	578
PAA2014007161461	*Mycale (Mycale) lingua*	18-Oct-14	66.53	-57.81	585
PAA2014007162470	*Mycale (Mycale) lingua*	18-Oct-14	66.70	-57.98	663
PAA2014007164485	*Mycale (Mycale) lingua*	19-Oct-14	65.79	-59.21	529
PAA2010009105320	*Mycale (Mycale) lingua*	31-Oct-10	66.84	-60.50	565
PAA2011007017046	*Mycale (Mycale)* cf. *toporoki*	25-Sep-11	63.00	-58.70	1078
PAA2011007060149	*Mycale (Mycale)* cf. *toporoki*	2-Oct-11	61.86	-68.19	239
PAA2012007037030	*Mycale (Mycale)* cf. *toporoki*	5-Oct-12	74.61	-77.83	442
PAA2013008020071	*Mycale (Mycale)* cf. *toporoki*	24-Sep-13	65.15	-58.76	475
PAA2014007164486	*Mycale (Mycale)* cf. *toporoki*	19-Oct-14	65.79	-59.21	529
PAA2010009061246	*Mycale (Mycale)* cf. *loveni*	25-Oct-10	70.68	-66.81	677
PAA2010009067237	*Mycale (Mycale)* cf. *loveni*	26-Oct-10	70.09	-65.69	467
PAA2012007037332	*Mycale (Mycale)* cf. *loveni*	5-Oct-12	74.61	-77.83	442
PAA2012007038033	*Mycale (Mycale)* cf. *loveni*	5-Oct-12	74.45	-78.43	663
PAA2010009031239	*Mycale (Rhaphidotheca) marshallhalli*	21-Oct-10	73.79	-70.51	1476
PAA2010009156508	*Mycale (Rhaphidotheca) marshallhalli*	7-Nov-10	66.85	-58.06	823
PAA2011007132303	*Mycale (Rhaphidotheca) marshallhalli*	11-Oct-11	63.25	-60.17	907
PAA2011007133314	*Mycale (Rhaphidotheca) marshallhalli*	11-Oct-11	63.43	-60.22	699
PAA2013008128247	*Isodictya* aff. *palmata*	8-Oct-13	61.58	-66.09	244