Sponge Fauna of the Eastern Canadian Arctic and Subarctic

by

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Abstract

Benthic marine habitats in Canada have been well-sampled since the annual groundfish survey commenced in 1970. However, trawl surveys cover only non-rocky sediments and many species collected are not identified to lower taxa, leaving large gaps in our understanding of benthic diversity. Sponges are a prime example. Sponges preferentially attach to hard substrates and therefore trawls do not sample the most sponge-rich habitats. Furthermore, the identification of sponge species requires extensive comparative taxonomy that cannot be performed on board a survey vessel. While almost 9000 sponge species are known globally, in Canadian trawl surveys only few characteristic species are identified, otherwise sponge catches are frequently narrowed only to the phylum level. Sponges provide important habitat for fish and other animals and as such play a valuable role in overall marine ecosystem functioning. Targeted sampling of sponges was carried out using a remotely operated vehicle (ROV), box cores and short Agassiz trawl tows. Skeleton morphology and DNA barcoding were used to develop a new view of sponge community structure and habitat types in the eastern Canadian Arctic and Subarctic. This work covers a wide geographic area from the North Labrador Sea to Northern Baffin Bay. Sponges were also collected and described for the first time from Frobisher Bay. In total, 61 distinct sponge species were identified, six of which were described as geographic range extensions, with one considered a potential species new to science. These results substantially increase the number of marine sponges known from eastern Canada. Many of these sponges are small, cryptic, or encrusting species that would be ignored in non-targeted sampling. This work is presented as a field guide of sponge species found in the study region in order to provide a baseline for future benthic work in the Arctic and this increased knowledge of the biodiversity of the region will help future conservation efforts in Canada. In view of the increased

anthropogenic influences anticipated for Arctic regions, further understanding of benthic biodiversity and ecosystem functioning is critical.

Acknowledgments

This thesis provided me the opportunity to become an explorer. The chance to discover the unknown is the hope when one pursues science, and this work has allowed me to experience nature in a way that few ever will, and for that I am humbled and incredibly grateful.

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Glossary of Terms

General terms

Amphi-Atlantic – Found on both sides of the Atlantic Ocean from east to west

Benthic – region just above the seafloor or benthos

Choanocyte – flagellated cell which creates the feeding current in sponges

Choanosome – the body region that contains the choanocyte chambers

Cortex – the outer body region of a sponge that differs from the choanosome.

Cryptic species - species which look morphologically similar

Cryptofauna – animals that are too small to see with the bare eye

EBSA – ecologically or biologically signific area

***In situ* -** in place

Megasclere – large spicule, visible to the naked eye

Microsclere – small spicule, only visible using a microscope

MPA – marine protected area

Osculum – opening through which water leaves the sponge

Ostium – incurrent opening of the sponge aquiferous system

Plumoreticulate – a plumose (feather-like) reticulation of spicules

ROV – remotely operated vehicle. A submersible ocean craft controlled via a tethered cable.

Spicule – skeletal structure in sponges formed of either calcium carbonate or silica

VME – vulnerable marine ecosystem

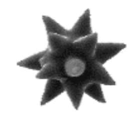
Spicule terms and forms used in this thesis

Ala – spatulate structures on the ends of chela — see ansiochela, isochela

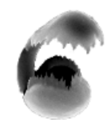
Anatriaene – a triaene with recurved clads pointing backwards

Anisochela – a chela with unequal ends

Aster – a star-shaped spicule



Bipocillum – modified anisochela with fused ala



Centrotylotic – a tyle or swelling in a central position of the spicule — see sigmaspire

Chela – a microsclere with a recurved shaft and ala at both ends — see anisochela, isochela

Clad – short ray of a triaene — see atriaene, protriaene, dichotriaene

Diact – a spicule with two rays that extend from a central point — see oxea

Dichotriaene – a triaene where the clads branch into distal rays

Forcep – a spicule which forms a U shape

Isochela – a chela with equal ends

Mycalostyle – a modified style with a narrowing near the rounded end of the spicule

Monact – a spicule consisting of a single ray — see style, tylostyle

Oxea – a spicule with two pointed ends

Oxyaster – an aster microsclere with a small central portion compared to the rays

Protriaene – a triaene with clads facing forwards

Raphide – A thin microsclere that looks like a very small oxea, can form bundles called trichodragmata

see oxea

Rhabd – long ray of a triaene

see anatriaene, protiaene, dichotriaene

Sigma – a C or S shaped microsclere with sharp points

Sigmaspire – a C or S shaped microsclere with spines along the shaft

Sphaerancora – a donut shaped spicule

Sterraster – an aster microsclere where the rays are fused and form rosettes

Strongylaster – an aster microsclere with blunt rays

Strongyle – a spicule with two rounded ends (acanthostyongyle shown)

Style – a megasclere with one round end and one pointed end

Tetractine – a calcareous spicule with four rays

Tornote – a spicule with conical ends

Toxa – a bow shaped spicule

Triactine – a calcareous spicule with three rays

Triaene – a spicule with four rays, one ray (the rhabd) is much longer than the others — see anatriaene, protieaene, dichotiraene

Tylostyle – a style with a swelling at the rounded end

Tylote – a diactinal megasclere with round or ovoid swellings on each end

Chapter 1. Introduction

1.1 Benthic marine biodiversity research in Eastern Canada

Canada has a rich history of ocean exploration, exploitation, and research. With the Oceans Act in 1997, Canada made a legal commitment to develop, conserve, and protect oceans sustainably. Stratified random trawl surveys in portions of the Northwest Atlantic Fisheries region have been occurring since the early 1970s, providing insight into the health and status of commercial fish stocks as well as the collection of non-commercial benthic invertebrates (McCallum & Walsh, 1997). These multi-species surveys, along with commercial catch and bycatch data are the primary means by which marine biodiversity in Canada is quantified, with an emphasis on commercial fish stocks. Scientific interpretation of this fisheries data has been the mainstay for imparting advice to fisheries managers and lawmakers on the identification and protection of biologically important areas (Fuller *et al.*, 2008; Kenchington *et al.*, 2010; Kenchington, Link*, et al.*, 2011). This trawl data, in conjunction with fisheries catch and bycatch data, is used to create models that can help predict the presence and health of fish stocks and estimate the location of non-commercial vulnerable marine ecosystems (Kenchington, Link*, et al.*, 2011; Murillo *et al.*, 2012; Knudby *et al.*, 2013). Some trawl surveys and data compilations of overall biodiversity have been conducted independent of the Canadian government (Piepenburg *et al.*, 2010; Roy *et al.*, 2015), and these describe the composition of Canadian Arctic fauna at a phylum level. Patterns of biodiversity from the results of these large-scale surveys give further insight into benthic communities in Canadian waters.

More recently, biodiversity studies in eastern Canada have begun to use *in situ* video imagery using submersibles and towed cameras to better understand benthic habitat structure non-destructively and to further quantify community composition (Fuller *et al.*, 2008; Beazley *et al.*, 2013; Beazley & Kenchington, 2015). One of the first submersibles used in Canada was the three-person *Pisces IV,* which allowed scientists to better explore the Pacific, Arctic, and Atlantic oceans from 1973-1986 (Smith, 2010). Since 1995 ROPOS (Remotely Operated Platform for Ocean Science), a submersible operated by the Canadian Scientific Submersible Facility for scientific use has become one of the most capable submersibles for research and industry in the world. The use of advanced technologies such as submersibles (Chu & Leys, 2010; Neves *et al.*, 2015), high definition drop cameras (Filbee-Dexter, 2016) and imaging rigs such as CAMPOD (Beazley *et al.*, 2013) have led to the identification of Ecologically or Biologically Significant

Marine Areas (EBSA), Vulnerable Marine Ecosystems (VME), and the designation of Marine Protected Areas (MPA) in each of the three oceans bordering Canada.

These methods of discovery provide valuable information on the general composition of fauna in a given region; however, the physical collection of specimens and in-depth taxonomic research is required to fully understand the exact species present in a marine system. In a 2010 review Archambault *et al.* suggest that the confirmation of species identities of many marine taxa is constrained by a lack of taxonomic work in Canada. This is exemplified in several large-scale studies of biodiversity in the region where some animal groups are not identified more precisely than to the phylum level (Archambault *et al.*, 2010; Piepenburg *et al.*, 2010; Kenchington, Link*, et al.*, 2011; Roy *et al.*, 2015). As a result, there are no identification guides or taxon lists for groups such as Brachiopoda, Nemertea, Platyhelminthes or Porifera from the Canadian Arctic (Roy *et al.*, 2014). Globally however, guides for these lesser-known phyla do exist. For example, a photographic field guide for underwater metazoans of Antarctica (Brueggeman, 1998) describes large, colourful Nemertea, though only one species is represented. Brachiopods from New Zealand have been described as well (Bowen, 1968). Simply put – certain animals require more in-depth taxonomic attention and therefore an expert is needed. More recently however, broad multi-phyla guides are being produced as underwater imagery is becoming more commonplace. Particularly on the west coast of Canada as part of the Ocean Networks Canada NEPTUNE underwater research laboratory, a guide to animals seen during submersible dives was created to be an authoritative reference work for future research in the region (NEPTUNE, 2012). Guides which are used to identify animals across multiple phyla are primarily geared towards using clear field markers where animals are easily distinguishable. Often this type of identification cannot be carried out for deep-sea collections where sampling relies on trawls and grabs where *in situ* images are not always obtainable. Of particular relevance to my thesis work, it is not routine to identify sponges on-board, not only because sponge taxonomy is usually impossible from a photo or video or even the whole specimen without using a microscope, but also because there are very few sponge species described in the eastern Canadian Arctic and Subarctic to compare specimens to (Hooper & Van Soest, 2002; Kenchington, Link*, et al.*, 2011; Van Soest *et al.*, 2012; Roy *et al.*, 2014). Extending knowledge of the biodiversity of sponges living in Eastern Canada is therefore the focus of this thesis.

1.2 Why study sponge biodiversity

Although sponges have diverse growth forms, they have the same underlying biology. Sponges are sessile filter-feeding animals that draw water through their bodies to obtain food (bacteria and unicells) and oxygen, and to excrete wastes. This seemingly simple mode of life has considerable effects on the surrounding ecosystem. Sponges play key roles in the coupling of benthic and pelagic productivity (Dayton *et al.*, 1974; Kahn *et al.*, 2015). Sponges achieve this by removing large volumes of bacteria as well as particulate and dissolved organic carbon from the water column using a unidirectional flow of water through the sponge body created by flagellated cells called choanocytes (Reiswig, 1975; Yahel *et al.*, 2003; de Goeij *et al.*, 2008; Maldonado *et al.*, 2012; Kutti *et al.*, 2013; Kahn *et al.*, 2015). Adaptations in body form can allow different sponge species to take advantage of flow regimes to obtain sufficient food for growth and reproduction. Most interestingly, where particulate and dissolved organic carbon is limited, some sponges have lost the water pumping aquiferous system altogether and have developed a carnivorous feeding strategy (Vacelet & Boury-Esnault, 1995). Variations in sponge shape are therefore quite common, leading to an array of sponge growth forms – even within individual species (Van Soest *et al.*, 2000).

The complexity of large coral and sponge assemblages significantly increases habitat heterogeneity, broadens the number of available microhabitats, and thus elevates local species diversity in the shelf-slope border (Bett & Rice, 1992; Klitgaard, 1995; Klitgaard & Tendal, 2004; Buhl-Mortensen *et al.*, 2010). The availability of food on the benthos determines the availability of niches, and although little more than 10% of primary production sinks below 100 m depth (Turley *et al.*, 1995), corals and sponges nevertheless persist in these cold-deep environments. Suspension-feeding animals that extend their bodies above the benthos may be better able to obtain food which may be transported in the benthic boundary layer, which provides increased flow compared to flow near the water-sediment interface (Frederiksen *et al.*, 1992; Witte *et al.*, 1997; Buhl-Mortensen *et al.*, 2010). Through this extension of body forms above the seafloor, erect sponges and corals offer a means for other benthic fauna to exploit different resources that are not available on an unmodified benthos. Off the coast of Ireland *Pheronema carpenteri*, a hexactinellid sponge that can occur in dense aggregations on fine sediments of up to 1.53 individuals m^{-2} not only creates complex habitat while alive, but spicule mats left behind after individuals die can also provide important firm substrate on an otherwise soft-bottom seafloor (Hughes & Gage, 2004; Howell *et al.*, 2016).

Increasing the complexity of the benthos not only allows organisms to obtain more food, but it also provides shelter for many other seafloor organisms. Sponges can have very elaborate and diverse body forms, with many variations in shape and appearance occurring within taxonomic groups (Hooper & Van Soest, 2002). Sponges occur as thin crusts, fan-like and digitate forms which are presumed to take advantage of ambient currents, massive sponges which can occur in dense aggregations (Klitgaard, 1995; Klitgaard & Tendal, 2004), and some species can even form dense, multi-species reefs in different parts of the world (Krautter *et al.*, 2001; Leys *et al.*, 2004; Chu & Leys, 2010; Maldonado *et al.*, 2015). All of these growth forms can provide more complex habitat than bare substrate alone (Barthel, 1992; Bett & Rice, 1992). This increase in habitat complexity and biogenic substrate provided by sponges can create shelter for invertebrates, provide nursery habitat for juvenile fish, become a substrate for egg attachment, and in some cases the tissue can both provide habitat and act as a food source (Freese & Wing, 2003; Barthel & Gutt, 2004; Ryer *et al.*, 2004; Amsler *et al.*, 2009; Todt *et al.*, 2009; Larcombe & Russell, 2010; Kenchington *et al.*, 2013). Sponges are therefore important ecosystem engineers as they modify water quality and flow regimes and create important biogenic habitat for a myriad of benthic organisms.

1.3 State of sponge research in Canada

Globally there are nearly 9000 valid sponge species described with many more species likely to be discovered in the coming decades (Van Soest *et al.*, 2012). The World Porifera Database (WPD) is an online catalogue of all recent sponge names, literature, and distribution data based on published scientific work and records that have been submitted to or gathered by the editors (Van Soest *et al.*, 2018). Using this online resource as a guide, it becomes clear where the gaps in sponge knowledge occur on a global scale. Unfortunately, the WPD does not indicate a level of sampling effort, and so regions where a high number of sponge species are described may be an artifact of greater sponge collection and identification effort, rather than a true index of species richness globally based on differences in marine habitat (Van Soest *et al.*, 2012).

There are few reports of community structure of deep sea sponges in the Northwest Atlantic (Hogg *et al.*, 2010) and sponge species richness is several orders of magnitude lower compared to the Northeast Atlantic (Van Soest *et al.*, 2012). The number of sponge species described in Canadian waters is relatively low compared to more well-studied regions such as European waters, the Caribbean, the Mediterranean, Australia, Antarctica, Northern Africa, and Indonesia (Van Soest *et al.*, 2012) (Figure 1-1), where hundreds of species are described. Few expeditions in the NW Atlantic describe sponges as compared to European efforts (Hestetun *et al.*, 2017), and the relatively low number of sponge species known from Eastern Canada may therefore be a result of this lower effort (Van Soest *et al.*, 2012). Where dense sponge aggregations occur in Canada is not well known (Knudby *et al.*, 2013). Research trawls (Kenchington, Link*, et al.*, 2011; Murillo *et al.*, 2012), fisheries observer data (DFO, 2009), and *in situ* observations using ROV and SCUBA (Leys *et al.*, 2004; Chu & Leys, 2010) have provided information of sponge communities at local spatial scales, but few of these studies have touched on areas in the eastern Canadian Arctic. Models of species distributions have used the data from targeted studies to determine where large sponge aggregations, termed sponge grounds, are likely to occur; but these models focus only on large astrophorid sponges like *Geodia* and *Stelletta* (Knudby *et al.,* 2013). Sponge grounds are defined as aggregations of large sponges that form structural habitat (Hogg *et al.*, 2010). Sponge grounds have similarly been called sponge gardens, fields, and beds, though the exact species associed with each term vary between publications (Hogg *et al.*, 2010; Maldonado *et al.*, 2015). Reports of sponges collected in multispecies trawls are limited in taxonomic scope, where the majority of sponges are simply assigned wet weights at a phylum level (Kenchington, Link*, et al.*, 2011; Roy *et al.*, 2015). This provides a useful index of areas where sponge catches are high but provides limited information on species composition in particular habitats. Interestingly, large astrophorid sponge aggregations in the NE Atlantic dominated by *Geodia* species are also home to up to 50 different sponge species (Klitgaard & Tendal, 2004). This suggests that similar sponge ground habitats in the NW Atlantic dominated by the same large sponge species could also be home to several more species that have yet to be identified. Further east, in Newfoundland waters along the Grand Banks and the Flemish Cap, where fishing effort in Eastern Canada is high, some trawled specimens have been identified to species (Fuller, 2011; Murillo *et al.*, 2012). Trawl surveys can allow the quantification of massive sponge biomass and provide some taxonomic depth to the identification of sponges that are collected. However, it should be noted that many species of sponge have small growth forms and have fragile bodies which are likely to disintegrate when they come in contact with fishing gear and are thus difficult to identify (Knudby *et al.*, 2013;

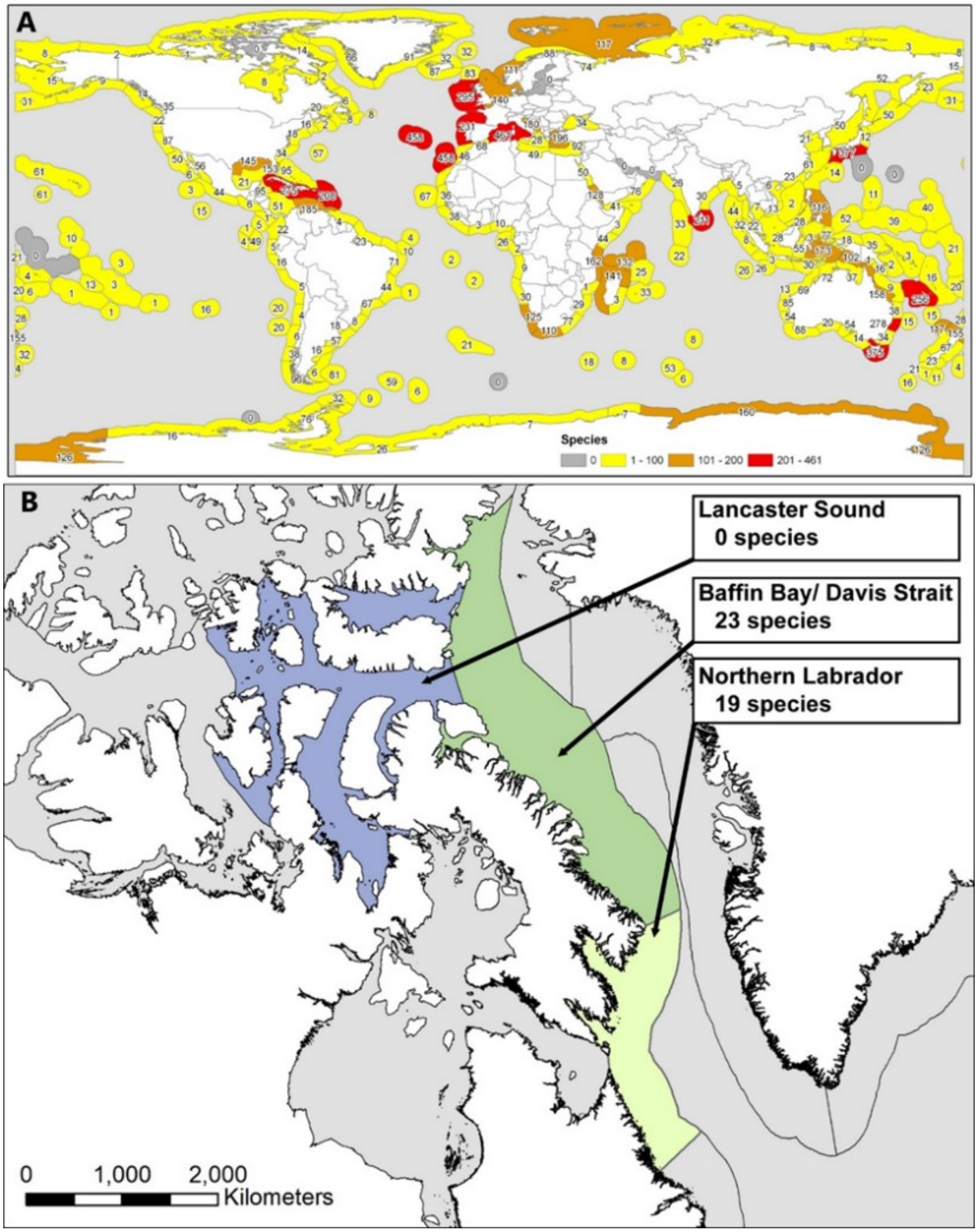


Figure 1-1. Global marine sponge biodiversity and published records of sponges in the study sites visited during this thesis work. (A) Number of sponge species recorded for each marine ecoregion reported in the World Porifera Database (WPD) in 2012 (modified from Van Soest et al. 2010). (B) The number of sponge species known in the three eastern Canadian marine ecoregions prior to this thesis. Species numbers are from the "valid" or "doubtful" distribution search function in the WPD, accessed Feb. 25, 2018.

Jørgensen *et al.*, 2016). Reliance on large survey trawls may therefore underrepresent the actual species composition in a region that can only be assessed using targeted *in situ* collections.

1.4 Sponges and fisheries management

Areas of high sponge abundance and biodiversity are of interest to fishers and managers to protect vulnerable habitat and to reduce unwanted bycatch. Since the 2006 United Nations General Assembly Resolution 61/105 (UNGA, 2006) which calls upon regional fisheries management organizations to implement measures to identify and protect species considered to form VMEs, the Canadian Government has been attempting to delineate where VME species occur and implement measures to protect these areas from fishing efforts (Kenchington *et al.*, 2015). The broadest attempt to recognize sponge concentrations in Eastern Canada was when Kenchington *et al.* (2010) identified areas of significant coral and sponge biomass along the eastern Canadian Arctic and the Hudson Bay Complex. Sponges were collected in 581 multi-species and shrimp survey trawls between 105-1484 m depth, though the trawl gear differed between surveys and locations (Kenchington *et al.*, 2010) (Figure 1-2). In the Eastern Arctic, which includes both the Northern Labrador Sea and Baffin Bay/Davis Strait marine ecoregions (Spalding *et al.*, 2007) which are biogeographic boundaries based on broad patterns of species and communities in the ocean, surveys revealed that that massive, ball-shaped *Geodia* species formed by far the majority of large sponge catches. There were also some branching specimens collected, although they were not identified to species. Marine ecoregions were defined from available taxonomic data in a global context, so it is unknown wether they represent functional boundaries in the eastern Canadian Arctic and Subarctic based on dispersal and isolation of sponge species. However, marine ecoregions are useful to compartmentalize species distributions in the region. they The largest sponge catches in the region from a single 15-minute Cosmos trawl tow were over 600 kg, indicating that massive sponges are quite abundant along the eastern Canadian shelf (Kenchington *et al.*, 2010). It should be noted however, that trawl surveys are not carried out in shallow, coastal regions, or in water deeper than 1500 m. The limitations in sampling area and gear type create a sampling bias in this type of large scale survey and leads to a disproportionate account of sponges that i) are large and resilient enough to be collected using a trawl, ii) occur on substrates that are deemed suitable for trawling, and iii) live in the depth ranges sampled. Despite this, several species of sponge from the waters surrounding Newfoundland are considered VME species. Sponges that form deep-sea sponge aggregations (*Geodia* spp., *Stelletta* spp*., Thenea muricata, etc.*), sponges that can form hard-bottom sponge gardens (*Mycale lingua, Polymastia* spp*., Axinella* sp*., Craniella cranium,* etc.), and glass sponges (*Asconema foliatum*) have all been reported from southern NW Atlantic areas (Kenchington *et al.,* 2015). It is possible that these species, or others creating similar vulnerable habit (though not yet considered a Vulnerable Marine Ecosystem (VME) species), may occur at higher latitudes but have not yet been identified. Although there is a concerted effort to identify areas of high sponge abundance, the protection of sponge-rich areas appears to focus on the conservation of commercial fish species rather than of the sponges themselves. Globally, only 20 species of sponge are listed as endangered (Bell *et al.*, 2015). Only one species, *Cliona patera,* is thought to have gone extinct but was subsequently found 30 years later (Bell *et al.*, 2015). Only recently has a Marine Protected Area (MPA) been established to specifically protect the glass sponge reefs of Hecate Strait and Queen Charlote Sound, the first MPA to specifically protect sponges (Grant *et al.*, 2018). No sponges have been considered at risk as part of the Species at Risk Act (SARA) or Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Until sponge species distributions are better understood in eastern Canada, it is unknown wether certain species have limited distirbutions and must be considered for special protection.

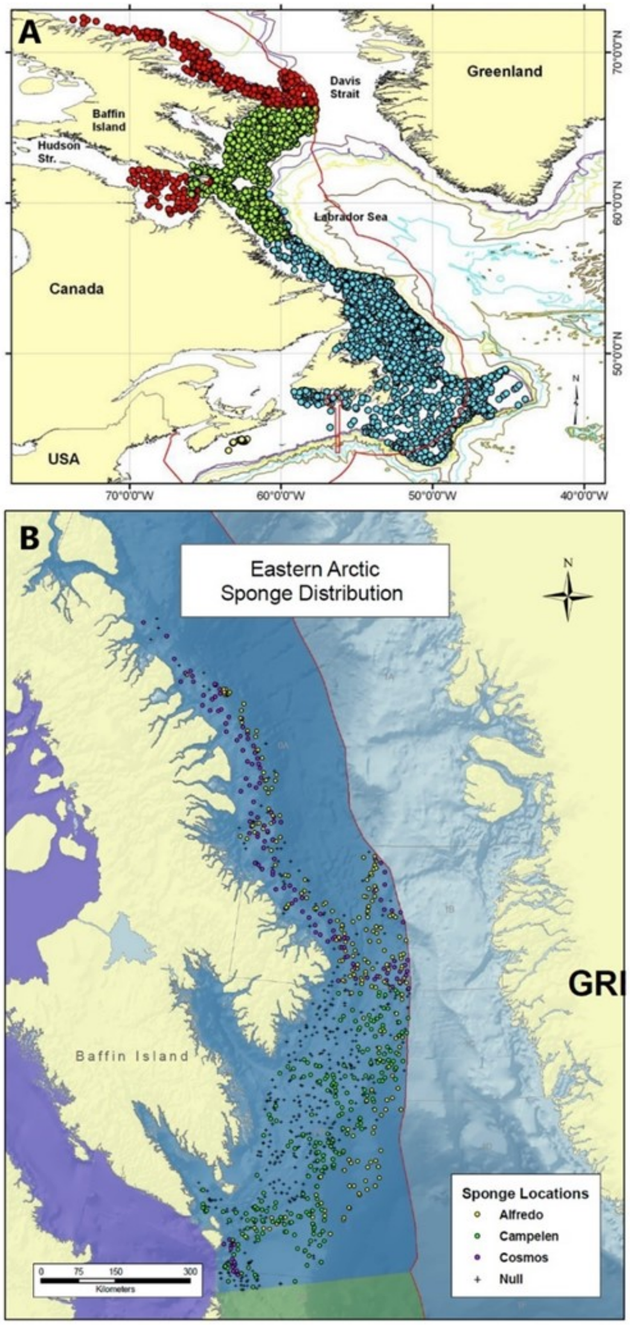


Figure 1-2. Sponge distributions known from trawl surveys in the eastern Canadian Arctic. (A) Trawl surveys carried out from 2005 to 2008; different colours represent different surveying institutions, DFO Newfoundland (blue), DFO central and Arctic (red) and NSRF/DFO (green). From The International Council for the Exploration of the Sea (ICES, 2009). (B) Distribution of sponges in the Eastern Arctic Biogeographic Zone by gear type. Sponge presence is indicated by circles and colours denote different trawl gears. From Kenchington et al. (2010).

1.5 Sponge taxonomy

1.5.1 Morphology-based identifications

Sponges are difficult or nearly impossible to identify from *in situ* observations or from photos (Hooper & Van Soest, 2002; Leys *et al.*, 2004). The Systema Porifera (Hooper & Van Soest, 2002) the foremost guide to the classification of sponges globally, states that defining sponge taxa in morphological terms is problematic, due to many losses, transformations, and additions of characters that are often critical for the diagnosis of many species. This underscores the need for lab-based taxonomic identification that cannot easily be completed on-board research vessels. Sponge taxonomy can be further complicated by the morphologically plastic nature of individuals and populations which differ depending on environmental conditions (Hooper, 2000). The size, shape, colour, texture, and surface ornamentation (presence of pores, digitation, spicules protruding from the surface, incorporation of sand particles, etc.) are useful morphological characters that can be used to describe a sponge specimen (Hooper, 2000). Often a synthesis of taxonomic tools is required to narrow sponges to lower classifications. Relying on only a single identifying character is not always fruitful, as traits like shape and colour may vary even within a species. Texture, though not a common taxonomic feature of many animals, is an interesting and often very informative character for sponge taxonomy because it can give insight into the underlying skeleton and water canal system within the sponge (Hooper, 2000). However, sponge spicule morphology and their arrangement in the body are the primary means for classification (Cárdenas, 2010) (Figure 1-3). Spicules form the inorganic skeleton of sponges and are composed of either calcium carbonate or silica and give rigidity to and strengthen sponge tissues (Koehl, 1982; Hooper & Van Soest, 2002). Isolation of spicules and assessment of spicule organization using thin cross sections of sponge tissue are the main methods of determining taxonomic placement of a specimen, and several means of tissue digestion and section preparation are used (Reiswig & Browman, 1987; Boury-Esnault *et al.*, 2002). The use of spicule complements can help researchers to narrow the identity of a specimen to lower taxonomic levels. Certain spicule types are diagnostic for different orders, families, genera, and species of sponges. Most sponges can be coarsely assigned to family or higher taxonomic groups based on a quick visual inspection of spicule forms, i.e. if a sponge has chelae-type microscleres (small spicules with curved shafts and recurved spatulate structures on the distal portions) it is most likely in the order Poecilosclerida; or if the sponge has microscleres that are star-shaped aster and megascleres that are large triaenes in which one ray of the four-rayed spicule is much longer than the others, the sponge is most likely in the order Tetractinellida (Boury-Esnault & Rützler, 1997; Hooper & Van Soest, 2002). However, the order Poecilosclerida contains more than 2,200 species, and the order Tetractinellida has more than 1,060 (Morrow & Cardenas, 2015). Therefore, precise classifications and measurements of spicules using a range of microscope methods are required to narrow specimens to species.

1.5.2 Molecular taxonomy

Sponge taxonomy is undergoing major revisions with the advent of molecular phylogenetic studies. Early branching metazoans are assessed both broadly across phyla as well as in lower family, genus, and species level contexts. Former classifications of sponges grouped taxa based on morphological/cytological or embryological characters (Levi, 1953; Borchiellini *et al.*, 2004), but the most recent molecular data does not support many of these former classifications based on traits like oviparity/viviparity or spicule morphology alone (Morrow & Cardenas, 2015). Loss of spicule types in some groups is common, and this can lead to misleading phylogenetic placement based on morphology. Sponges are currently grouped into four classes, Hexactinellida, Homoscleromorpha, Demospongiae, and Calcarea. With the widespread use of rapid sequencing and standard molecular markers such as 18S, 28S, COI, as well as whole mitochondrial genomes, sponge systematics has been modernized and new classifications are being presented for higher and lower taxa at an increasing rate (Morrow & Cardenas, 2015). Demospongiae has seen the greatest amount of flux, as it is the largest sponge taxon containing over 7000 species. Most recently the Demospongiae has been revised to contain a total of 22 distinct orders as a means to resolve any known polyphyletic groups (Morrow & Cardenas, 2015). New practices in sponge taxonomy such as the use of standard barcode fragments for phylogenetic placement have allowed the creation of databases that can facilitate the identification of specimens through rapid sequencing (Vargas *et al.*, 2012; Vargas *et al.*, 2015). It has been suggested that if there is a reliable candidate species database available for a particular geographic region, then DNA barcoding can be effectively used to sort and classify new collections from that region (Vargas *et al.*, 2015). Traditional taxonomy is time consuming, therefore the use of barcodes to identify taxa may be beneficial in instances when new collections contain many species that are already listed in the databases. In largely undersampled areas such as the Canadian Arctic however, the creation of useful taxonomic guides and initial descriptions of sponge fauna are required (Archambault *et al.*, 2010) before in-depth diagnositc studies of fauna in the area can be attempted. Databases of DNA barcodes of diverse regional sponge communities will be an asset moving forward, especially as the process of obtaining viable sequence data is becoming more and more accessible

Figure 1-3. The simplified sponge taxonomy workflow and an example of the morphology-based identification method of *Haliclona (Reniera)* sp. *1*. (A) A schematic of the sponge identification protocol using an integrative approach: both morphology-based and molecular methods are often required to narrow sponges to species. Sponges must be collected (B), then external morphological features are noted (shape, texture, colour, etc.) and the sponge is given a sample number (C). The specimen is then preserved for both spicule morphology-based as well as molecular identifications. The arrangement of spicules within the sponge body (skeleton) can be visualized using a thick section (D). The isolated spicules can be identified to type and measured through tissue digestion and microscopy (E).

1.6 Thesis objectives

The objectives of my thesis were to collect and describe the marine sponge fauna of the eastern Canadian Arctic. Through two field seasons aboard the *CCGS Amundsen*, 162 sponge specimens were collected from 37 sites ranging from the North Labrador Sea to Nares Strait. An integrative taxonomic approach was used to identify specimens to the lowest taxonomic level possible. The results of my work increase our knowledge of the sponge fauna of Eastern Canada and have created the first comprehensive inventory of sponge species in the region.

1.7 Overview and structure of chapters

This thesis is composed of four chapters including this introductory chapter. Chapter Two describes the fauna of Frobisher Bay, Baffin Island. Chapter Three is a functional field guide to sponges that were collected along the eastern Canadian shelf using targeted sampling methods. Chapter Four describes general conclusions.

Chapter Two. Frobisher Bay is an ideal place to begin to understand the sponge fauna of the eastern Canadian Arctic and Subarctic. Although bays and fjords are not sampled in current Canadian government fisheries surveys, the benthos of Frobisher has a rich history of biological and geological research. The sponge fauna of Frobisher Bay are described for the first time here. In this chapter, I discuss the 24 distinct sponge species that were identified from the bay, six of which are new geographic range extensions for the whole eastern Canadian Arctic.

Chapter Three. The number of sponge species described from the eastern Canadian Arctic is low compared to other regions globally. Using a targeted approach to sponge collections that focused in sites surveyed by ROV, 61 distinct sponge species were identified and compiled into a guide of sponges of the region. The guide contains photos of each sponge species, with a description of the body form, surface texture, consistency, and spicule measurements. DNA vouchers for select sponges are also included. This chapter is the first comprehensive guide to sponges for the region.

In Chapter Four, the findings from two years of sponge collections are reflected upon to give insight into the benthic communities in eastern Canada, and implications for future work in the region are discussed.

Chapter 2. Sponge fauna of Frobisher Bay, Baffin Island, Canada with geographic range extensions of six species.

2.1 Introduction

The biodiversity and distribution of sponge species in the eastern Canadian Arctic is largely unknown. Most studies that have been conducted in the region only identify sponges to phylum (Piepenburg *et al.*, 2010; Kenchington, Link*, et al.*, 2011; Roy *et al.*, 2014, 2015), or focus only on sponges in select groups (Hestetun *et al.*, 2017; Plotkin *et al.*, 2017; Tompkins *et al.*, 2017). Sponge catch by weight from trawl surveys in Baffin Bay makes up 33% of the total benthic megafaunal biomass and significant concentrations of sponges have been reported from the North Labrador Sea and the nearby Baffin shelf (Kenchington *et al.*, 2010). Nevertheless, the Baffin Bay/Davis Strait marine ecoregion (Spalding *et al.*, 2007) still has fewer than two thirds the diversity known from neighbouring Greenland waters, and species richness is an order of magnitude lower than that described in the NE Atlantic (Van Soest *et al.*, 2012). There is currently a single field identification guide for the entire Northwest Atlantic Fisheries region (NAFO area, Kenchington *et al.* 2015), however the problem is less in the availability of field guides than the difficulty of identifying sponges on board survey vessels or from *in situ* images. The above guide is the primary tool for classifying seabed habitats to prevent sponge bycatch, and although it describes 33 sponges, most are only identified to genus (Kenchington *et al.*, 2015).

The marine sponge biodiversity known from eastern Canada contrasts with the diversity known globally. There are currently 8,901 valid sponge species listed in the World Porifera Database (Van Soest *et al.*, 2018), although an equal number is thought to exist but are yet to be described (Van Soest *et al.*, 2012). Regional hotspots of sponge biodiversity, where hundreds of species are described, occur in Europe, northern Africa, the Caribbean, and Australia. These localized areas of high diversity are believed to reflect the amount of research effort in the region rather than actual biodiversity (Van Soest *et al.*, 2012). Areas where sponge species richness is high have a history of shallow water collections, most of which occur through dredging or through use of SCUBA (Boury-Esnault, 1971; Wiedenmayer, 1977; Pansini, 1987; Ackers *et al.*, 1992; Perez *et al.*, 2004; Picton & Goodwin, 2007) High sponge species richness and biomass are also reported from some deep-sea areas such as Antarctica (Sara *et al.*, 1992; McClintock *et al.*, 2005; Hogg *et al.*, 2010; Janussen & Downey, 2014; Kersken *et al.*, 2016), the Gulf of Alaska (Lehnert & Stone, 2016), and the NE Pacific (Austin *et al.*, 2015). In comparison to Antarctic work, which has described more than 400 sponge species in the Southern Ocean (Sara *et al.*, 1992; Downey *et al.*, 2012; Janussen & Downey, 2014), fewer than 20 species are described from the Northern Labrador ecoregion, and only 24 species are known from Baffin Bay/Davis Strait (Van Soest *et al.*, 2012; Van Soest *et al.*, 2018)

Due to the remote nature of the eastern Canadian Arctic and because of variable sea ice cover which is at a maximum in March and a minimum in September (Dey, 1980; Johannessen *et al.*, 1999), inshore and deep-water collections of benthic organisms are difficult. Since the 1970s, the Canadian Department of Fisheries and Oceans (DFO) and Greenland Institute of Natural Resources have conducted trawls to assess benthic species composition in the region. However, sponge biomass from these trawls is only quantified to the phylum level (Kenchington, Link*, et al.*, 2011) and so the species composition of sponges in the region remains largely unknown (Archambault *et al.*, 2010). However recent reports of select sponge taxa, notably Cladorizidae (Hestetun *et al.*, 2017), Coelosphaeridae (Tompkins *et al.*, 2017), Astrophorina (Cardenas & Rapp, 2012; Cárdenas *et al.*, 2013) and Polymastiidae (Plotkin *et al.*, 2017) indicate that several species which occur in Davis Strait tend to have wide distributions across the boreal Atlantic and Arctic seas. This amphi-Atlantic distribution of several species suggests that many more species described as having NE Atlantic and high Arctic distributions may also occur in the NW Atlantic.

One reason little is known about the benthic fauna of many inland habitats in the Canadian Arctic is that current multispecies trawl surveys carried out by DFO do not enter fjords and bays (Kenchington, Link*, et al.*, 2011). However, Frobisher Bay has a unique history of benthic exploration, and the seafloor has been extensively mapped (Mate *et al.*, 2015; Todd *et al.*, 2016). Surveys conducted within the bay by the Fisheries Research Board of Canada describe communities dominated by polychaete annelids, echinoderms, molluscs, and amphipods and few decapod crustaceans (Grainger, 1954, 1955; Squires, 1962). Despite this extensive work, there are no sponge species reported from Frobisher Bay. Two specimens thought to be sponges were reported in the bay previously (Wacasey *et al.*, 1980), but were not narrowed to any specific taxon. Given the large size of Frobisher Bay and its relative ease of access via the city of Iqaluit, we targeted this bay for a survey of the sponge and other benthic fauna as a part of the ArcticNet HiBIO (Hidden Biodiversity and Vulnerability of Hard-Bottom and Surrounding Environments in the Canadian Arctic) research program. Sites in Frobisher Bay were surveyed opportunistically in areas of geological interest, in particular on slope failures in the inner bay to understand the effect of disturbance events on seabed fauna within the bay. Here we report a diversity of sponge species from the bay with six range extensions of species known from the northeastern Atlantic.

2.2 Methods

2.2.1 Study area

Frobisher Bay lies on the southeast corner of Baffin Island, Nunavut, Canada, which opens into the North Labrador Sea/Davis Strait (Figure 2-1). The bay is approximately 230 km long by 20-40 km wide and varies in depth from the Calanus shelf in the northeast, which is consistently flat and soft bottomed at less than 50 m, to the southwest trough that reaches well over 600 m depth (Dunbar, 1958). The substrate throughout the bay varies in localized distributions of sediment types and ranges from heterogeneous bedrock outcrops to boulders, gravel, fine sand, and mud. The benthos of Frobisher Bay has been studied since the mid 20th century primarily as part of the *Calanus* expeditions from 1947-1955. The site of a submersible deployment in the bay was selected to assess the faunal differences across a slope failure scar off the coast of Hill Island. Using a CTD rosette, the bottom temperature and salinity at 115 m depth near the ROV site were found to be 0.59°C and ~32.57 PSU.

2.2.2 Collections and Systematics

Specimens were collected during research cruises aboard the CCGS *Amundsen* (October 25, 2015, July 15-17, 2016 and July 14-16, 2017). Video imagery was collected in 2015 with a Sub-Atlantic SuperMohawk remotely operated submersible (ROV) equipped with SubC Imaging 1Cam Alpha HD Colour Zoom camera and two sampling arms at a site in the inner bay near Hill Island (63° 38.3549’ N, 68° 37.5238′ W). Still images were captured of each specimen collected by the ROV. Sampling in 2016 and 2017 used an Agassiz trawl (1.5 m opening, 40 mm net mesh size, with a 5 mm cod end liner towed for 3 minutes at 1.5 knots) and a box core (BX 650 MK III 50 cm x 50 cm, maximum penetration depth 60 cm).

Sponge specimens were photographed on board with a scale for size reference, either preserved in 95% ethanol or frozen and transported to the University of Alberta. Collection information is available in the Polar Data Catalogue (https://www.polardata.ca/ CCIN: 12754). Sponge spicules were isolated from 1 cm^2 pieces that included outer and inner regions of the sponge body, called the cortex and choanosome respectively. Pieces of sponge were placed in undiluted household bleach overnight to remove tissue, rinsed 4 times in distilled water allowing spicules to settle for 15 minutes between rinses, and cleaned in two washes of 95% ethanol. Cleaned spicules were dried on glass slides, mounted in DPX mounting medium (Sigma-Aldrich, St. Louis, MO) and imaged with a Zeiss Axioskop2 Plus compound microscope and an Olympus

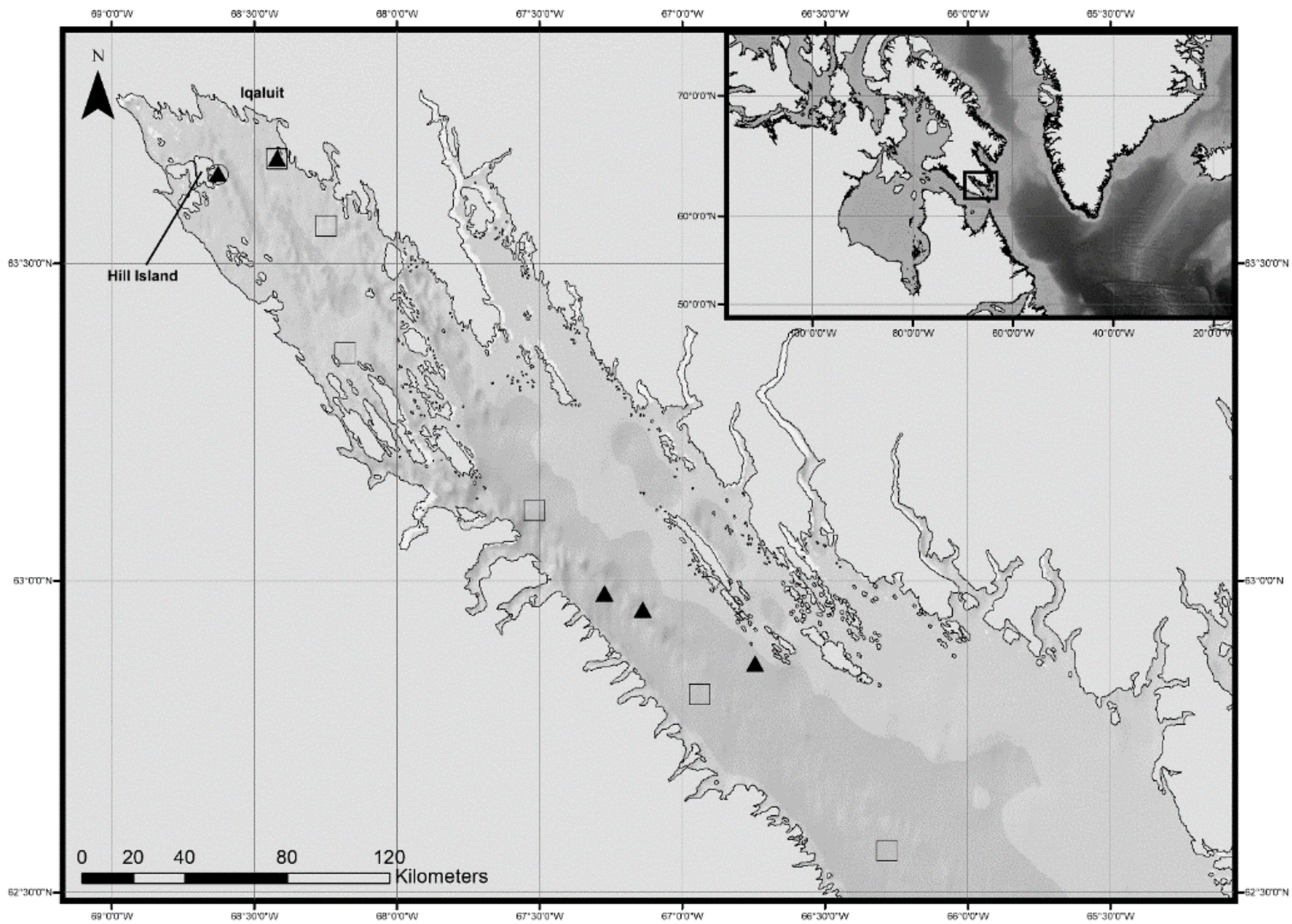


Figure 2-1. Collection locations in Frobisher Bay using different sampling methods. Black triangles, Agassiz Trawl; Open Squares, Box Core; Open Circles, Remote Operated Vehicle. Inset, location of bay noted by black squares. Bottom topography is shown by shading.

SZX12 stereomicroscope with a QImaging QiCam or Retiga 2000R camera using EMPIX Northern Eclipse v8. Thick sections were made using a razor blade, cleared in toluene for at least 24 hours, and mounted in DPX or Canada Balsam (Sigma-Aldrich, St. Louis, USA). For scanning electron microscopy (SEM), cleaned spicules were placed on metal stubs, coated with a gold/palladium mix and viewed with a Phillips XL30 SEM, Zeiss Sigma 300 VP, or Hitachi TM3000. Spicule measurements (N=30, unless otherwise noted) were made with ImageJ 1.51n and are reported as mean and range. Voucher specimens are deposited at the Canadian Museum of Nature (CMN) Ottawa, Canada. Specimens are numbered in this thesis by CMN catalogue numbers. The World Porifera Database was used as the taxonomic authority and for reference of known species distributions (Van Soest *et al.*, 2018).

2.2.3 Isolation of DNA and sequencing of 28S rDNA and CO1

Total DNA was extracted using the DNeasy Blood and Tissue kit (Qiagen, Valencia, CA) following the manufacturer's instructions, using approximately 0.5 cm^2 of sponge tissue to account for spicule weight. Spicules were allowed to settle in the post-lysis mixture for 10 minutes before the mixture was applied to the spin column to prevent clogging the column. DNA purity was assessed on a NanoDrop ND-1000.

The 5' end region of COI was amplified using M13F/M13R-tailed dgLCO1490: 5' – (GTA AAA CGA CGG CCA GTG) GGT CAA CAA ATC ATA AAG AYA TYG G and dgHCO2198: 5' – (GGA AAC AGC TAT GAC CAT G) TAA ACT TCA GGG TGA CCA AAR AAY CA degenerate Folmer fragment primers (Meyer, 2003). Amplification of 28S rDNA was performed using three pairs of primers designed by Christine Morrow (Folmer *et al.*, 1994; Morrow *et al.*, 2012): Por28S-15F/878R for region D1-D2, Por28S-830F/1520R for region D3-D5, and Por28S-1490F/2170R for region D6-D8. For COI and 28S amplifications, reactions used Platinum High-Fidelity Taq Polymerase (Invitrogen, Carlsbad, CA) and were run on an Eppendorf Mastercycler Ep Gradient using a standard protocol of 94.0° for 5 min; (95.0° for 30 s; 48.0° for 30 s; 72.0°for 30 s) × 40 cycles; 72.0° for 10 min. The amplification of 28S produced better results at an annealing temperature of 50°. PCR products were visualized on 2% agarose gels and purified using the MinElute PCR purification kit (Qiagen, Valencia, CA). Tailed primers were used to improve sequencing, using only the M13F/R tail primer in the final sequencing mixture. The sequencing reaction was run on an Applied Biosystems 3730 Genetic Analyzer at the Molecular Biology Service Unit (MSBU) at the University of Alberta. Contigs were assembled in BioEdit version 7.2 and manually checked for sequencing errors. The consensus sequences of the contigs were trimmed to remove primer residuals. Consensus sequences were aligned in MEGA (v.7.02) and species affinities were confirmed by BLAST nucleotide search (Altschul et al., 1990). Sequence alignments (Appendix 1) were made using T-Coffee Simple MSA alignment tool (ClustalW alignment) (Notredame *et al.*, 2000), and shaded using BoxShade 3.2 (written by K. Hofmann and M. Baron, SIB Swiss Institute of Bioinformatics, 2008).

2.3 Results

2.3.1 ROV transect and specimen collections

The single ROV dive in the inner bay near Hill Island (63°38'18" N, 68°37'50" W) covered a 1.2 km transect that crossed an submarine slope failure scar (Deering *et al.*, 2015), along depths ranging from 59-146 m along the dive. The seafloor along the ROV transect varied from sandy areas (Figure 2-2A-E) to bedrock outcrops (Figure 2-2F-G). Sponges were found living among fields of crinoids (Figure 2-2A-B), near solitary tunicates (Figure 2-2C-D), and most strikingly in dense aggregations of *Iophon* cf. *nigricans.* (Figure 2-2E). Kelp was often seen along the transect but was not attached to the substrate and so was presumed to come from a nearby kelp forest (Miles & Edinger, 2016).

Trawls and box cores in the bay collected many invertebrate specimens from multiple phyla. Sponges were collected in six Agassiz trawl tows and eight box core deployments in the inner and outer bay (Table 2-1). Two specimens were collected by ROV in 2015, fragments of *Iophon* cf. *nigricans* and a large specimen of *Tetilla sibirica*. The ROV transect passed over a submarine landslide area, but sponges appeared to be more abundant and were collected in a high slope area away from the landslide. Over the three-year sampling program in the eastern Canadian Arctic, 42 sponge specimens were collected from Frobisher Bay. These specimens represent 24 sponge taxa (Table 2-2), with six species-level range extensions.

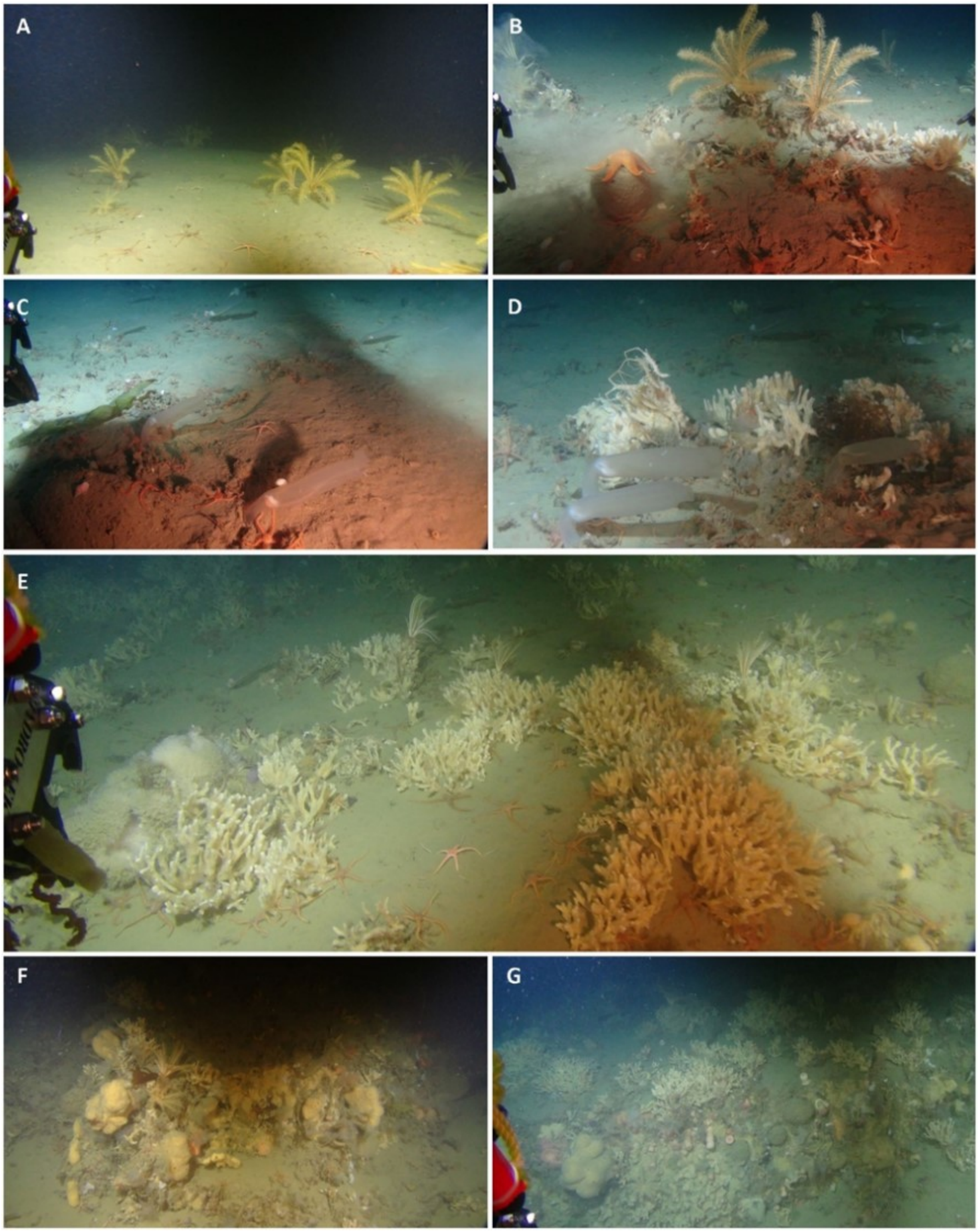


Figure 2-2. Examples of the diversity of sponges, associated animals, and of substrate types in Frobisher Bay recorded during an ROV dive near Hill Island. A. Crinoids and ophiuroids perch on a sandy bottom. B. The sponge *Tetilla sibirica* with seastar, crinoids, and other sponges attached. C. Solitary tunicates and loose kelp (green). D. Tunicates, the sponge *Iophon* cf. *nigricans* with another sponge *Arcturus baffini* attached. E. A garden of *I.* cf. *nigricans* . F, G. Sponges growing on bedrock outcrops.

Table 2-1. Sites of ROV, box core (BC), and Agassiz trawl (AT) operations in Frobisher Bay from 2015 to 2017. Bottom temperature and salinity are presented for sites where CTD casts were deployed.

Site	Date	Depth (m)	Latitude (N)	Longitude (W)	Bottom Temp.(°C)	Bottom Salinity (PSU)
Frobisher Bay Dive 48 (ROV)	2015-10-25	65	63° 38.322	68° 37.714	-0.59	32.57
FB6-1 (BC)	2016-07-15	459	63° 06.670	67° 31.100	-1.78	32.50
Bell 1 (BC)		208	63° 32.760	68° 28.510		
Bell 2 (BC)		204	63° 30.110	68° 30.070		
Bell 3 (BC)		187	63° 34.920	68° 31.260		
Bell 4 (BC)		186	63° 34.980	68° 31.330		
FB3 (BC)		150	63° 34.120	68° 30.470		
FB4 (BC, AT)	2016-07-16	118	63° 33.525	68° 14.967	-1.25	32.25
Bell 5 (BC)		104	63° 38.563	68° 37.158		
Bell 6 (BC)		117	63° 38.490	68° 36.920		
FB1-1 (BC)		135	63° 38.436	68° 37.253		
FB 2-2 (BC)		63	63° 40.506	68° 25.834	-1.35	32.20
FB2-1 (BC)		80	63° 39.817	68° 25.342		
FB7-1 (BC, AT)	2016-07-17	472	62° 58.672	67° 16.931	-1.75	33.20
FB8 (BC)		610	62° 55.39	67° 05.389	-1.75	32.00
OF-S-25 (OF B2) (BC, AT)	2017-07-14	442	62° 59.963	67° 19.992	-0.99	32.00
OF-B6 (BC, AT)		493	62° 44.775	66° 41.590	-0.95	33.25
FB 2-2 5G (BC, AT)	2017-07-15	82	63° 39.784	68° 25.250		
FB 2-2 5D (BC)		29	63° 40.474	68° 25.345		
Bell 12 (BC)		141	63° 41.263	68° 37.455		
A16 (BC, AT)		141	63° 38.390	68° 37.642	-1.25	32.18
Bell 11 (BC)		119	63° 21.591	68° 10.924	-1.25	31.00
OF-S-22 (BC, AT)	2017-07-16	289	62° 52.088	66° 44.740		
OF - B9 (BC)		377	62° 34.014	66° 16.942		
OF -B14 (BC)		411	62° 23.183	66° 01.312	-0.90.	33.25

Table 2-2. Inventory of the sponge fauna of Frobisher Bay collected on the *CCGS Amundsen* 2015-2017.

Taxon	Taxonomic Authority	Site	Latitude (N)	Longitude (W)	Catalogue number
Class Demospongiae					
Tentorium semisuberites	(Schmidt, 1870)	OF-B9	62° 34.014	66° 16.942	CMNI 2018-0195
Iophon piceum	(Vosmaer, 1882)	OF-S-25 (OF B2)	62° 49.126	66° 56.354	CMNI 2018-0177
Hymedesmia sp.	Bowerbank, 1864	OF-S-22	62° 52.088	66° 44.740	CMNI 2018-0193
Halichondira sp.	Fleming, 1828	OF-S-22	62° 52.088	66° 44.740	CMNI 2018-0191
Craniella cf. *cranium*	(Müller, 1776)	OF-S-25 (OF B2)	62° 57.232	67° 08.360	CMNI 2018-0168, CMNI 2018-0170, CMNI 2018-0173, CMNI 2018-0175
Polymastia thielei	Koltun, 1964	OF-S-25 (OF B2)	62° 57.232	67° 08.360	CMNI 2018-0169
		OF - B9	62° 34.014	66° 16.942	CMNI 2018-0194
Cladorhiza oxeata	Lundbeck, 1905	OF-S-25 (OF B2)	62° 57.232	70° 08.360	CMNI 2018-0171
Forcepia (Forcepia) fabricans	(Schmidt, 1874)	OF-S-25 (OF B2)	62° 57.232	67° 08.360	CMNI 2018-0174
Haliclona (Reniera) sp.	Schmidt, 1862	OF-S-25 (OF B2)	62° 57.232	67° 08.360	CMNI 2018-0176
Lycopodina lycopodium	(Levinsen, 1887)	FB7-1	62° 58.792	67° 16.367	CMNI 2018-0060
Lycopodina cupressiformis	(Carter, 1874)	FB7-1	62° 58.792	67° 16.367	CMNI 2018-0061
Mycale lingua	(Bowerbank, 1866)	FB6-1	63° 06.67	67° 31.10	CMNI 2018-0053
		OF-S-25 (OF B2)	62° 57.232	67° 08.360	CMNI 2018-0167
Halichondria (Eumastia) sitiens	(Schmidt, 1870)	FB4	63° 33.430	68° 14.846	CMNI 2018-0055
		FB 2-2 5G	63° 39.852	68° 25.246	CMNI 2018-0179
		Bell 11	63° 21.591	68° 10.924	CMNI 2018-0188
Iophon cf. *nigricans*	(Bowerbank, 1858)	A16	63° 38.390	68° 37.642	CMNI 2018-0180
		Frobisher Bay 2015	63° 38.322	68° 37.714	CMNI 2018-0166
Lissodendoryx (Lissodendoryx) indistincta	(Fristedt, 1887)	A16	63° 38.390	68° 37.642	CMNI 2018-0182
		OF-S-22	62° 52.088	66° 44.740	CMNI 2018-0192

Table 2-2. Continued.

Taxon	Taxonomic Authority	Site	Latitude (N)	Longitude (W)	Catalogue number
Lissodendoryx sp.	Topsent, 1892	A16	63° 38.390	68° 37.642	CMNI 2018-0186
Tetilla sibirica	(Fristedt, 1887)	Frobisher Bay 2015	63° 38.5745	68° 36.5265	CMNI 2018-0165
		A16	63° 38.390	68° 37.642	CMNI 2018-0183
Polymastia grimaldii	(Topsent, 1913)	FB 2-2 5G	63° 39.802	68° 25.226	CMNI 2018-0178
Thenea sp.*1*	Gray, 1867	FB2-1	63°39.805	68°25.320	CMNI 2018-0058
Thenea sp. *2*	Gray, 1867	OF-S-25 (OF B2)	62° 57.232	67° 08.360	CMNI 2018-0172
Class Calcarea					
Sycon cf. *lambei*	Dendy & Row, 1913	FB4	63° 33.525	68° 14.967	CMNI 2018-0054
		FB4	62° 57.232	67° 08.360	CMNI 2018-0057
Sycon sp. *1*	Risso, 1827	A16	63° 38.390	68° 37.642	CMNI 2018-0185
Calcarea unknown		Bell 11	63° 21.591	68° 10.924	CMNI 2018-0187

Taxonomy

Phylum Porifera

Class Demospongiae

Subclass Heteroscleromorpha Cárdenas, Pérez & Boury-Esnault, 2012

Order Poecilosclerida Topsent, 1928

Family Acarnidae Dendy, 1922

Genus *Iophon* Gray, 1867

2.3.2 Iophon c.f. nigricans (Bowerbank, 1858)

(Figure 2-3,Table 2-3)

2.3.2.1 Material Examined

CMNI 2018-0180. Specimen in 95% ethanol and frozen, collected by Curtis Dinn with an Agassiz Trawl; 15 July 2017 141 m, depth, (63° 38.390’ N, 68° 37.642’ W). CMNI 2018-0166. Specimen in 95% ethanol, collected by Philippe Archambault by ROV hydraulic manipulator; 25 October 2015, 96 m depth, (63° 38.332’N, 68° 37.7139’W). All operations performed from the *CCGS Amundsen* in Frobisher Bay near Hill Island.

2.3.2.2 External appearance (Figure 2-3A, C).

The specimens have irregular finger-like growths that form large bushes 15-25cm in height. Dense aggregations of the bushes were seen to occur in patches several meters in diameter. The fingers do not appear to attach to a broad base, but rather branch off a small central narrow stalk. The oscula are not obvious and are raised along the surface of the fingers, mostly near the base where neighbouring fingers join. The oscula collapse upon collection. The sponge grows in soft sediment attached to polychaete tubes and small rocks. The colour is pale yellow, with lighter almost white tips *in situ*, but becomes dark brown/grey on contact with air and after preservation in ethanol. The body surface is irregular and furrowed, with white distal portions that appear denser than the underlying body. A transparent membrane covers the lower portions but collapses after collection. The consistency is firm, with a soft surface texture that crumbles easily after freezing or preservation.

2.3.2.3 Spicules. (Figure 2-3D-K)

CMNI 2018-0180 has two types of megascleres: acanthostyles which are often swollen at the head resembling a spined tylostyle, variably spined, often with long spines on the head –

rarely these spicules are thin and elongate 277 (245-308) x 9.7 (8-12) µm; and smooth ectosomal tylotes with swollen microspined heads that are 247(199-266) x 7.6(6-9) µm long. Microscleres are spurred anisochelae 19 (16.5-22) µm; and large bipocilles with reduced, single, equal-sized alae and elongated teeth. The bipocilles appear isochelae-like with long, smooth, arcuate shafts with a bend in the centre of the shaft and are 15.4 (12.5-19.5) µm long. CMNI 2018-0166 was collected at 96 m depth and conforms to CMNI 2018-0180 in spicule complement and browning of the sponge in air and with preservation, even though only small fragments of CMNI 2018-0166 were collected by ROV in 2015. Megascleres of CMNI 2018-0166 include acanthostyles 268 (232-295) x 7.6 (4-12) µm and tylotes 249 (219-277) x 6.7(4.5-9) µm. Microscleres are anisochelae 29(17.5-37) µm and bipocilles 18(13.5-21) µm.

2.3.2.4 Skeleton. (Figure 2-3 B)

Ectosomal tylotes are arranged tangentially at the surface and in bundles forming multispicular tracts which give a somewhat plumoreticulate appearance to the skeleton. Acanthostyles are arranged in the choanosome in a loosely isodictyal reticulation forming triangular or square meshes. Bipocilles and spurred anisochelae are scattered throughout the body.

2.3.2.5 Discussion.

The specimens are characterized by acanthostyles, tangentially arranged tylotes, palmate anisochelae with spurs, and bipocilles, all of which place the sponge in the genus *Iophon.* The WPD lists 38 species of *Iophon*, nine of which are found in the Atlantic. There are only two other species of *Iophon* known from the NW Atlantic: *I. dubium* Koltun, 1955 which has been recorded from the Arctic Ocean, Barents Sea and the western Greenland shelf, and *I. piceum* (Vosmaer, 1882)*,* which has been recorded from the Western Greenland shelf, Arctic Ocean, Barents Sea, Iceland and the White Sea. Atlantic *Iophon* species have bipocilles of a common form where one ala is round, and the other is more elongate and saucer shaped with more numerous teeth, except *I. dogieli* in which the bipocilles in the original description are more variable in shape. The specimens from Frobisher Bay are notable because the tissue turns brown when exposed to air, much like *I. nigricans* which turns black, and because the large bipocilles with equally sized single alae are distinctive. The specimens described above are distinguished from the Atlantic species in the following ways (Table 2-3):

I. dogieli Koltun, 1955 (Iceland): Megascleres are smooth styles (not acanthostyles) and smooth, short, and thick styles with a microspined head (not tylotes). These small styles appear to be inequiended tornotes in Koltun's description (150-240 x 10-18 µm). Bipocilles are a similar length (16-20 µm) and shape, however of the three bipocille variations in Koltun's description, the irregular three-lobed type with clover shaped ala was not found in these specimens. The anisochelae are also slightly smaller (16-29 µm) than in the Frobisher Bay specimens. Source: Koltun, 1955.

I. dubium (Hansen, 1885) (Arctic, Western Greenland): The bipocilles are much smaller (7-10 µm) and have unequal alae. This species does not turn dark in air. Source: Lundbeck, 1905.

I. frigidum Lundbeck, 1905 (Barents Sea): This sponge lacks bipocilles. Acanthostyles are longer (298-387 x 7.1-12.8 µm), tylotes are larger (250-320 x 5.5-8.5 µm), and anisochelae are larger (17-44 µm). Source: Lundbeck, 1905

I. hyndmani (Bowerbank, 1858) (Europe): This species has a second category of smaller entirely spined acanthostyles (80-175 x 8 µm) and the bipocilles are smaller and have unequal alae (7-10 µm). Source: Ackers *et al.*, 1985.

I. piceum (Vosmaer, 1882) (Arctic): The acanthostyles are much longer and thicker (239-450 x 15-36 µm) than in the Frobisher Bay specimens, tylotes are longer (218-311 x 5-10 µm) and the bipocilles are smaller and have unequal alae with fine teeth (8-14 µm). Source: Arndt, 1935 and Van Soest *et al.* 2000.

I. pommeraniae Thiele, 1903 (Norway): The acanthostyles are longer (360 x 11 µm) than in the Frobisher Bay specimens, tylotes are longer (310 x 7 µm), and the bipocilles are smaller and have unequal alae (10 µm). Source Thiele, 1903.

I. spinulentum (Bowerbank, 1866) (Europe): The acanthostyles are smaller (127-178 µm), and the bipocilles are much smaller and have unequal alae (8.5 µm). Tylote length was not given in the source: Bowerbank, 1866.

I. variopocillatum Alander, 1942 (North Sea): The acanthostyles are shorter (115-220 x 4-5 µm), the tylotes are shorter and thinner (170-200 x 2 µm), and there are two size categories of bipocilles with unequal alae (15-17 µm and 10-12 µm). Source: Alander, 1942.

The specimens collected from Frobisher Bay appear to be most similar to *I. nigricans* (Bowerbank, 1858) which has a NE Atlantic distribution. Records of this species are mostly concentrated in European waters, but it has also been recorded on the eastern Greenland shelf and was said to be collected in the Bay of Fundy (Trott, 2004), but this is unconfirmed in the WPD (Van Soest *et al.*, 2018). Megascleres are slightly shorter in *I. nigricans* compared to the Frobisher Bay specimens, where acanthostyles are 220-260 x 11 µm, and tylotes are 225-250 x 7 µm. *I. nigricans* also has two categories of anisochelae, 26-30 µm and 10 µm and very small bipocilles with unequal alae that are 7.5 µm in length (Ackers et al., 1992, Van Soest *et al.* 2000) (Table 2-3).

Recently, an unnamed species of *Iophon* was reported from the Bay of Fundy (Goodwin, 2017). This sponge has slightly shorter acanthostyles 193 (193-284) x 9.9(7.4-11.7) µm, shorter tylotes 187 (157-244) x 5.9 (3.4-10.4) µm, small bipocilles with unequal alae are 7.9 (6.5-8.7) µm in length and this sponge has one size category of anisochelae that are 18 (14-22) µm in length. This sponge was reported to turn black in air, similar to *I. nigricans.* Therefore, the Frobisher Bay specimens are similar to the Bay of Fundy specimens in that they only have one size category of anisochelae, though they are smaller in the Bay of Fundy specimen, but the two differ in the form of the bipocilles, where the Frobisher Bay specimens have much larger bipocilles with equal sized alae. It is not clear whether the fact that it turns brown rather than black in air is distinctive.

In summary, most North Atlantic species of *Iophon* have bipocilles of the common form with unequal alae, except for *I. dogieli*, but that species has thick styles and smaller styles/tornotes rather than acanthostyles and tylotes as found in the present specimens. *I. nigricans* appears most similar in body form and darkening upon death but has two size categories of anisochelae and very small bipocilles. Due to the similar growth form and habit of darkening upon death, the specimens from Frobisher Bay are considered here to be *Iophon* cf. *nigricans* but should be reviewed as a potential distinct species when more comparable specimens are obtained.

2.3.2.6 Remarks.

This sponge forms dense aggregations in inner Frobisher Bay. It grows among large stalked ascidians and other sponges, notably *Mycale lingua* which has a similar yellow colour. *Halichondria sitiens* was also collected at this site and has a similar growth form, but close examination of the sponge texture and skeleton easily distinguish the species. *Haliclona* *urceolus*, which has large terminal oscula that can superficially look like *Iophon* cf. *nigricans*, was also collected in trawls and box cores near the ROV site, but these sponges are distinctive upon collection and examination on-board. *Arcturus baffini* isopods as well as crinoids (*Heliometra sp*.) were often attached to the distal portions of individual branches of *Iophon* cf. *nigricans* and *Tetilla sibirica* sponges.

2.3.2.7 Genetic data.

28S sequences were obtained from the D3-D5 9 (GenBank accession MH394248) and D6-D8 (GenBank MH394251) regions. A single base pair difference in the D3-D5 region and the D6-D8 region was noted between these specimens and *I. nigricans* (GenBank accession KF018114), and a 13 bp difference from *I. hyndmani* (GenBank accession KF018107) (Appendix A1.1, A1.2). More comparative DNA work is required to determine if spicule differences in the specimens collected from Frobisher Bay are sufficiently different from *I. nigricans* to be considered a separate species.

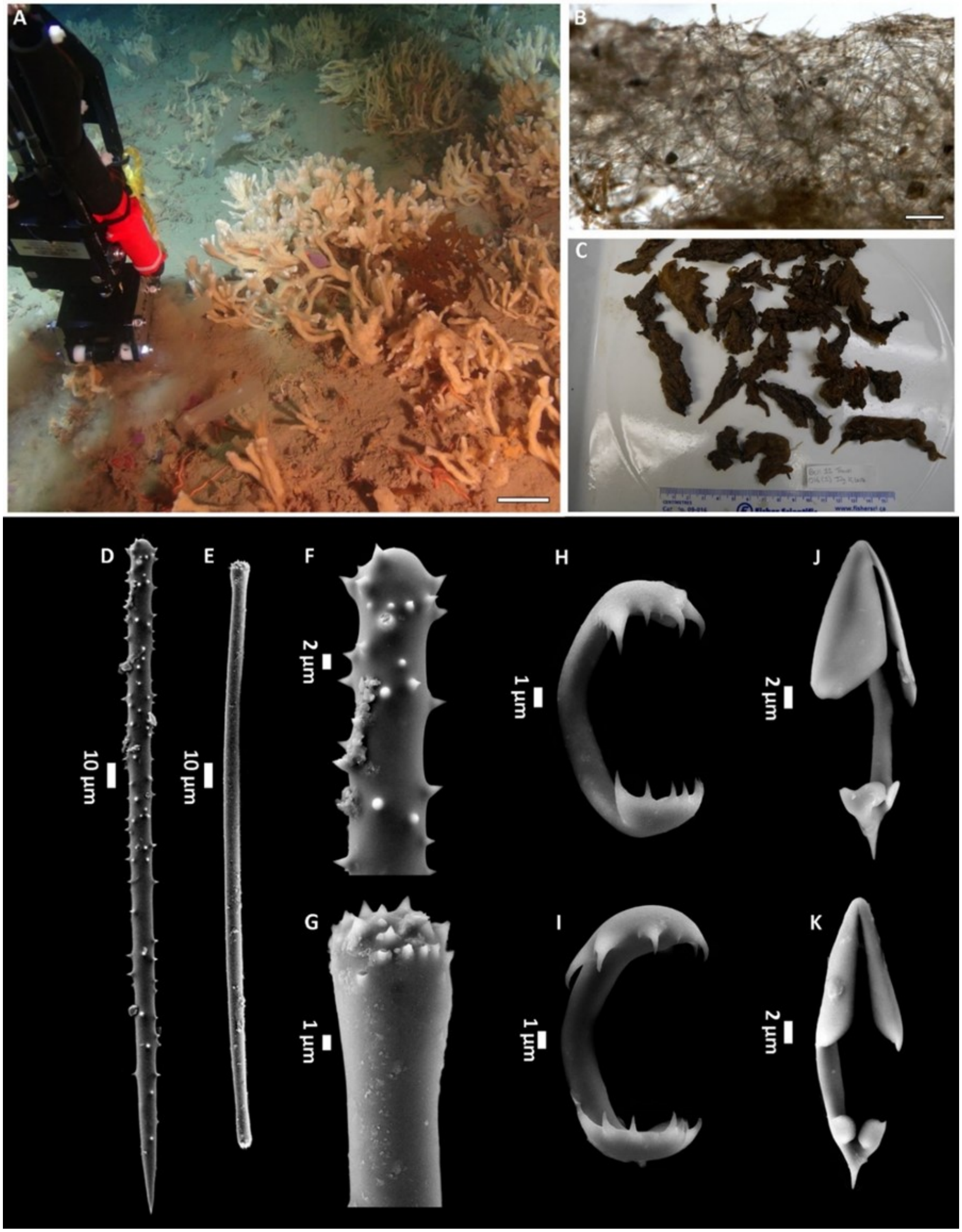


Figure 2-3. *Iophon* cf. *nigricans*.Collecting *I.* cf. *nigricans* with ROV manipulator arms. Scale bar is 6 cm. B. Skeleton showing tangential tylotes at surface, scale bar is 200 µm. C. Sponges after collection showing browning on contact with air. D. Acanthostyle. E. Tylote. F. Acanthostyle head. G. Tylote head. H. G. Bipocilles, J. K. Spurred anisochelae. .

Table 2-3. Spicule measurements (length and width ranges, µm) of Atlantic species of *Iophon* compared with *Iophon* cf. *nigricans*.

	Acanthostyles	Styles	Tylotes	Styles/Tornotes	Anisochelae	Bipocilles
I. cf. *nigricans* 2015 (CMNI 2018-0166)	**232-295 x 4-12**	**-**	**219-277 x 4.5-9**	**-**	**17.5-37**	**13.5-21**
I. cf. *nigricans. 2017* (CMNI 2018-0180)	**245-308 x 8-12**		**199-266 x 6-9**		**17-22**	**12.5-19.5**
I. nigricans, Bowerbank, 1858[i]	220-260 x 11	-	225-250 x 7	-	26-30 & 10	7.5
Iophon sp.[ii]	193-284 x 7.5-12	-	157-244 x 3.5-10	-	14-22	6.5-8.7
I. dogieli, Koltun, 1955	**-**	239-364 x 12-16	**-**	150-240 x 10-18	16-29	16-20
I. dubium, Hansen, 1885[iii]	208-274	-	190-250	-	17-31	7-10
I. frigidum, Lundbeck, 1905	298-387 x 7.1-12.8	-	250-320 x 5.5-8.5	-	17-44	none
I. hyndmani, Bowerbank, 1858[i]	200-250 x 8 & 80-175 x 8	-	135-250 x 8	-	13-20	9-15
I. piceum, Vosmaer, 1882[iv]	239-450 x 15-36	-	218-311 x 5-10	-	15-36	8-14
I. pommeraniae, Thiele, 1903	360 x 11	-	310 x 7		35	10
I. spinulentum, Bowerbank, 1866	127 -178	-	Length not given	-	17	8.5
I. variopocillatum, Alander, 1942	115-220 x 4-5	-	170-200 x 2	-	17-33	15-17 & 10-12

[i] Ackers *et al.,* 1992 and Van Soest *et al.,* 2000.
[ii] Goodwin, 2017.
[iii] Lundbeck, 1905.
[iv] Arndt, 1935 and Van Soest *et al*., 2000

2.3.3 Iophon piceum **Vosmaer, 1882**

(Figure 2-4, Table 2-4)

2.3.3.1 Material examined.

CMNI 2018-0177. Specimen in 95% ethanol, collected by Curtis Dinn with BX 650 MK III box core; July 14, 2017, 507m depth (62° 49.126’ N, 66°56.354’ W) operated from the *CCGS Amundsen*, Frobisher Bay, Canada.

2.3.3.2 Description.

Large fragments of a cup shaped specimen were collected. The whole specimen is anticipated to have been 10-20 cm in diameter, but the growth form was not obvious as the sponge was collected in pieces. The spongin fibres and spicules form a lattice. The sponge is rough to the touch, fragile and is dark black. The spicules consist of acanthostyles 320 (275-349) x 16 (12-19) µm; tylotes with spined heads 260 (237-278) x 12 (9-16) µm; spurred anisochelae 18.5 (13-32) µm; and bipocilles with unequal alae, both with fine teeth 11.8 (8.7-16.5) µm.

2.3.3.3 Discussion.

The spicule measurements agree with the original description by Vosmaer (1882) and subsequent descriptions by Lundbeck (1905) and Arndt (1935) (Table 2-4). Two slight variations in spicule size were noted in this specimen: tylote thickness in this specimen reaches a maximum of 16 µm whereas the thickest tylotes described by Lundbeck (1905) are 11 µm. The acanthostyles in this specimen do not exceed 350 µm, whereas Lundbeck states that acanthostyles can reach 450 µm. Vosmaer (1882) described this species as being of a “pitchy colour” (pp. 43) and having a cup-shape. Lundbeck (1905) describes the sponge as leaf shaped and erect with an attachment to the seafloor at the base. The overall spicule complement in the present specimen is very similar to Lundbeck’s (1905) description. The acanthostyles are “straight or, most frequently, curved in different degrees, often nearest to the head-end” (Lundbeck 1905, pp. 178), tylotes are fusiform with two ends that are not often equal with “one being a little thicker and with a roundish swelling, the other a little thinner with a more longish swelling” (pp.178). The bipocilles in the present specimen are rounded, with numerous fine teeth, similar to those described in Lundbeck (1905). However, Lundbeck (1905) also describes some bipocilles that attain “monstrous forms” (pp.179) where the alae split from the shaft, but these types of spicules were not seen in the present specimen. Despite minor variations in spicule size, the present specimen agrees with previous descriptions, especially in growth form and colour.

2.3.3.4 Remarks.

This is the first record of *I. piceum* in Canadian waters. Previous records show collections near SW Iceland and in the Barents Sea and White Sea (Lundbeck, 1905). The species was also collected from a depth of 719 m on the western Greenland shelf by Lundbeck (1905) during the Danish Ingolf-Expedition. Vosmaer also found this species at 350 m in the Barents Sea. This sponge was not seen in ROV video from the site near Hill Island, which supports reports that it is primarily a deep-water, rocky bottom species. In Frobisher Bay this species was only found in the deep water at the mouth of the bay and not in the sandy and shallow inner bay. The range of this species may extend east across Davis Strait, as the species is also found in Newfoundland waters (Kenchington *et al.,* 2015), though collection data is not readily available, nor is that data reported in the WPD.

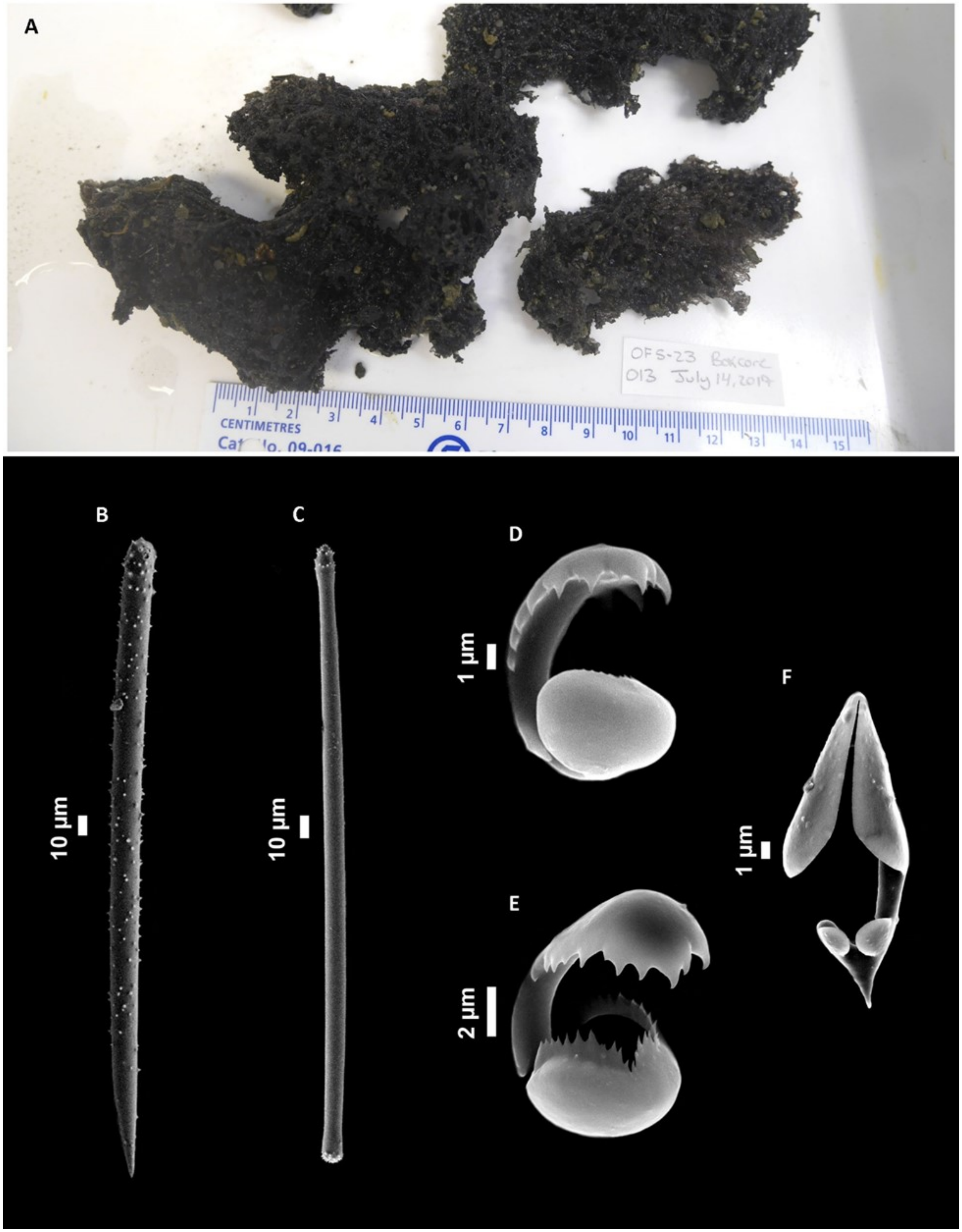


Figure 2-4. *Iophon piceum*. A, Specimen collected. B. Acanthostyle. C. Tylote. D,E. Bipocilles. F. Spurred anisochelae.

Table 2-4. Spicule measurements (length and width ranges, µm) of *Iophon piceum* (Vosmaer, 1882) from the original description and in Lundbeck (1905), (Arndt, 1935) and of *I piceum* in the present manuscript.

	Vosmaer, 1882	Lundbeck, 1905	Arndt, 1935 (supplemented with Van Soest *et al*. (2000))	This study (CMNI 2018-0177)
Acanthostyles	316 x 16	260-450 x 10-20	239-450 x 15-36	320 (275-349) x 16 (12-19)
Tylotes	280 x 9	238-298 x 5-11	218-311 x 5-10	260 (237-278) x 12 (9-16)
Anisochelae	21-31.6	16-36	15-36	18.5 (13-32)
Bipocilles	12.7	8-14	8-14	11.8 (8.7-16.5)

Family Mycalidae, Lundbeck, 1905

Genus *Mycale* Gray, 1867

Subgenus *Mycale* Gray, 1867

2.3.4 Mycale (Mycale) lingua Bowerbank, 1866

(Figure 2-5; Table 2-5)

2.3.4.1 Material examined.

CMNI 2018-0053. Spcimen in 95% ethanol. Collected by Curtis Dinn with BX 650 MK III box core July 15, 2016, 459m depth (63° 06.67' N, 67°31.10' W). CMNI 2018-0071. Specimen in 95% ethanol. Collected by ROV hydraulic manipulator July 19, 2016, 631 m depth (61° 26.417' N, 60° 39.8484' W). CMNI 2018-0152. Specimen in 95% ethanol. Collected by Curtis Dinn by ROV hydraulic manipulator July 25, 2016, depth 876 m (67° 58.0424' N, 59° 29.0396' W). CMNI 2018-0167. Specimen in 95% ethanol. Collected by Agassiz Trawl July 14, 2017, 402 m depth (62° 57.232' N, 67° 08.360' W). CMNI 2018-0196. Specimen in 95% ethanol. Collected by Agassiz trawl July 25, 2017, 333 m depth (76° 19.020' N, 75° 46.225' W). All operations performed from the *CCGS Amundsen* in Frobisher Bay and Davis Strait, Canada.

2.3.4.2 Description.

Specimens are bright yellow in colour with a characteristic fibrous root and soft, furrowed distal portion. (Figure 2-5). Spicules consist of styles/mycalostyles 514 (400-590) x 16 (12-20) µm; sigmas 20(14.5-26) µm, anisochelae I 73(52-88) µm; anisochelae II are 37.5(28.5-50) µm; and raphides which were rare and did not form conspicuous trichodragmas in the Frobisher Bay specimens 43 (30-53) µm n=16. Interestingly, some modified anisochelae were present where the alae were not fully developed (Figure 2-5G, H). These spicules occurred in both size categories, but only in the Frobisher Bay specimens.

2.3.4.3 Discussion.

The spicule sizes of this specimen correspond to descriptions of *M. lingua* by Ackers *et al.* (1992). Descriptions by Boury-Esnault *et al.* (1994) and Van Soest *et al.* (2014) are also similar except that a third category of small anisochelae described in these publications is not present in this specimen (Table 2-5). Trichodragmas are not common, but often 2-3 raphides are seen attached to one another. *In situ* photos of specimens agree with descriptions by Ackers (1992) which describe a sulcate, furrowed surface that resembles the “tongue of a sheep” (p. 111)

2.3.4.4 Remarks.

This is the first record of *Mycale lingua* in Frobisher Bay. The species was collected once from Baffin Bay/Davis Strait by Lundbeck (1905) (70° 24’ N, 63° 35’W, 497 m depth) and further south on the Southern Grand Banks (46° 4’ 40” N, 49° 2’ 30” W, 1267 m depth) by Topsent (1892). From collections with the *CCGS Amundsen* in 2016 and 2017 it appears that *Mycale (Mycale) lingua* is widely distributed in the whole western Atlantic. The spicules of the Frobisher Bay specimens are slightly smaller than those of separate specimens collected at 631 m (61° 26.417 N, 60° 39.8784 W) and 876 m (67° 58.0382N, 59° 29.0396 W). The styles of these specimens are ~600 µm long and the anisochelae occur in two sizes (~87 µm and ~40 µm long), suggesting that spicule size in this species varies by depth, or that there are separate species which occur in different habitats. *Mycale lingua* specimens in eastern Canada may therefore differ from NE Atlantic specimens genetically, though a formal revision of the genus was not attempted here. However, Ackers (1992) states that the furrowed grooves on the surface of the sponge are highly characteristic, so despite slight spicule variations, both specimens are best assigned to *M. lingua*.

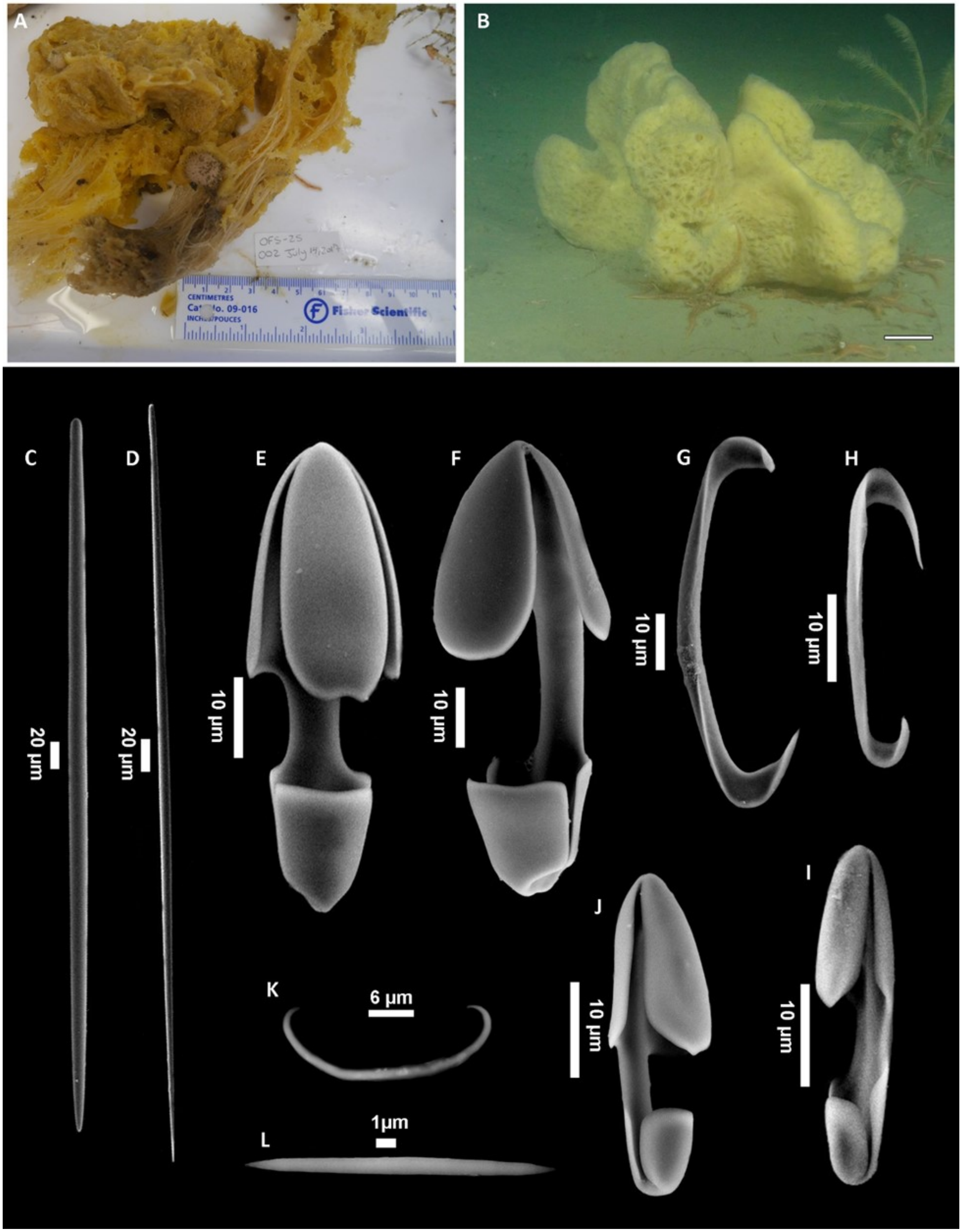


Figure 2-5. *Mycale lingua*. A. Specimen collected. B. Sponge *in situ*. Scale bar is 6 cm. C,D. Style/mycalostyles. E-G. Anisochelae I, G. H- J. Anisochelae II. K. Sigma. L. Raphide.

Table 2-5. Spicule measurements (length and width ranges, µm) of *Mycale lingua* (Bowerbank, 1866).

	Boury-Esnault et al., 1994	Van Soest et al. 2014	Ackers et al., 1992	Frobisher bay CMNI 2018-0053	Baffin Bay (Disko Fan) CMNI 2018-0152
Styles, sometimes mycalostyles or subtylostyles	557 (350-621) x 9.5 (8-17)	350-620 x 8-17	510 (530-1150) x 13-20	514 (400-591) x 16 (12-19.5)	596 (469-779)
Palmate anisochelae I	68 (60-77)	60-77	70	73 (52-87.5)	86 (77-97)
Palmate anisochelae II	34 (28-38)	24-38	35	37.5 (28.5-50)	40 (29.5-50)
Palmate anisochelae III	18 (16-20)	16-20	Not listed	None	None
Sigmata	19 (14-28)	14-28	16-32	19.8 (14.5-26)	19 (11.5-27) N=26
Raphides/trichodragmata	63 (50-74)	50-74	42-78	43 (30-53) N=16	60 (40-74.5)

Order Tetractinellida, Marshall 1876

Suborder Spirophorina, Bergquist & Hogg, 1969

Family Tetillidae, Sollas, 1886

Genus *Tetilla*, Schmidt, 1868

2.3.5 *Tetilla sibirica* Fristedt, 1887

(Figure 2-6; Table 2-6)

2.3.5.1 Material examined.

CMNI 2018-0165. Specimen in 95% ethanol, collected by Philippe Archambault by ROV hydraulic manipulator; 25 October 2015, 65m depth, (63° 38.5745'N, 68° 36.5265'W). CMNI 2018-0183. Specimen in 95% ethanol, collected by Curtis Dinn by Agassiz trawl; July 15, 2017, 141 m depth, (63° 38.390'N, 68° 37.642'W). All operations performed from the *CCGS Amundsen* in Frobisher Bay near Hill Island.

2.3.5.2 Description.

Two specimens of different sizes were collected in the inner bay near Hill Island. CMNI 2018-0165 is a large spherical sponge about 20 cm in diameter *in situ*, and the root is nearly 13 cm long after collection, and CMNI 2018-0183 is less spherical and more club shaped, about 2 cm in width, 3.5 cm in height with a root length of 2.5 cm. The surface of both specimens is hispid due to protruding spicules. The sponges are firm and incompressible, are covered in sediment *in situ,* and appear light brown or grey immediately after collection. (Figure 2-6B, D). The spicules from CMNI 2018-0183 consist of large oxeas 2811 (1784-4080) x 37 (28-54) µm; short oxeas are 1026 (754-1290) x 40 (26-52) µm; anatriaenes are 3030 (1992-4378) x 21 (9-35) µm; protriaenes, sometimes with one whip-like clad are 2219 (1150-3452) x 21 (6-29) µm, clads are 57 (29-83) µm, whip-like clads, when present are 91 (64-113) µm; sigmaspires are 17 (11-20) µm in length. (Figure 2-6E-K).

2.3.5.3 Genetic data.

28S rDNA sequences suggest this specimen groups with *Cinachyra* and *Antarctotetilla* specimens based on the D3-D5 (GenBank accession MH394249) domain sequence (Appendix A1.3). This species and the sympatric *C. polyura* appear to be closely related based 28S sequences, which suggests assignment to the genus *Tetilla* should be revisited.

2.3.5.4 Discussion.

The original description by Fristedt (1887) is of a firm sponge that is ovoid or subspherical with numerous roots (pp.436). Koltun (1966) gives the same description. Fristedt (1887) does not give a range of spicule lengths, and does not provide widths, yet the lengths reported largely agree with the measurements given by Koltun (1966) (Table 2-6). Fristedt (1887) does not describe a difference between protrienes with equal ended clads and those with a single whip-like clad. In CMNI 2018-0165 protrienes with clads of similar lengths were rare and these may not have been found by Fristedt at the time of the original description, therefore both regular protrienes and those with whip-like clads are treated as similar spicules here. Fristedt (1887) described the sigmaspires as smooth sigmas ("sigmoid bihamate spicules") in comparison to the "knotty" sigmaspires found in *Craniella polyura (T. polyura* in Fristedt, 1887 and Koltun, 1966) (pp.437). Koltun (1966) also described the sigmaspires as sigmas which appear smooth in his illustration (pp. 103), but they differ from the sigmas of *C. polyura* as they do not possess a centrotylotic swelling. The sigmaspires from these specimens are entirely spined with fine teeth, an aspect that is not always apparent from light micrographs. Micrographs of *C. Polyura* (described as *T. polyura,* Van Soest, 2016) show the centrotylotic swelling clearly, which the sigmaspires in these specimens lack.

2.3.5.5 Remarks.

This is the first record of the species in the North-West Atlantic. The World Porifera Database states that this species has a circumpolar high Arctic distribution, and is also found in the Barents Sea and coastal Northern Russia in the Laptev Sea. Koltun (1966) suggests that this species even occurs off the pacific coast of the Kuril Islands (pp. 99). This is a shallow water species. The specimens in this study were found at 65 m and 141 m, whereas Koltun (1966) found it at depths of 7-54 m in the Arctic and 127-414 m in the Pacific Ocean (pp 99). In Frobisher Bay, this sponge is quite common on sandy substrates at the site near Hill Island. In ROV video transects the sponge is seen growing amongst solitary tunicates, near the gardens formed by *Iophon* cf. *nigricans*, and in areas with few other sponges growing nearby. Both the large and small specimens have small tube worms attached to the base and embedded in the distal portions of the sponge. It is common to see echinoderms on the surface of the sponge. Brittle stars are often attached to the surface, and large crinoids are also commonly perched near the osculum (Figure 2-6 A, C).

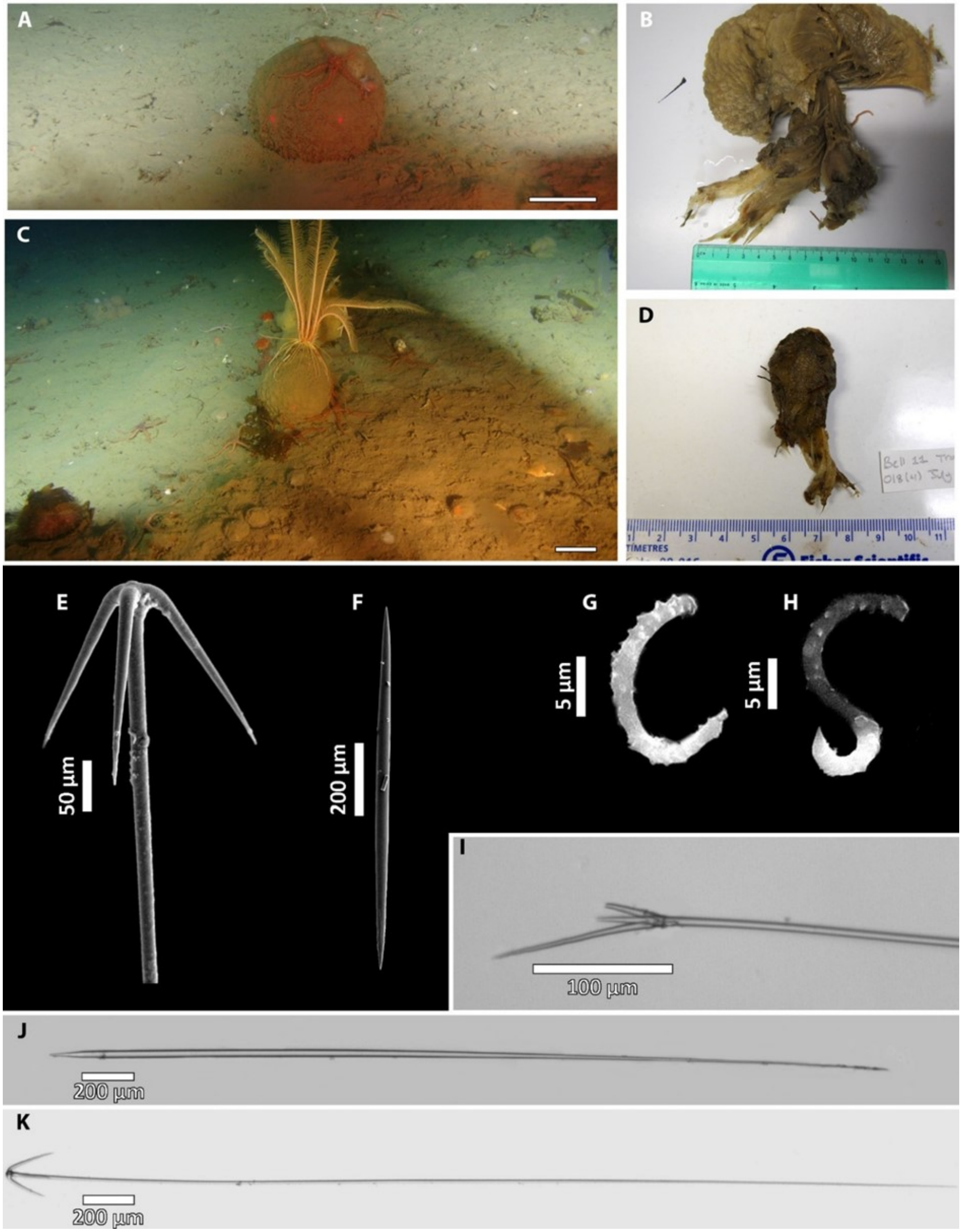


Figure 2-6. *Tetilla sibirica*. A, C. Sponge *in situ* with echinoderms attached. Scale bars are 6 cm. B. D. Specimen collected. E,K. Anatriaenes. F. Small oxea. G,H. Sigmaspires. I. Protriaene. J. Large Oxea.

Table 2-6. Spicule measurements (length and width ranges, µm) of *Tetilla sibirica* (Fristedt, 1887)

	Fristedt, 1887	Koltun, 1966	This study (CMNI 2018-0183)
Large oxeas	3500-5000	2000-6000 x 32-50	2811 (1784-4080) x 37 (28-54)
Small oxeas	800	440-1300 x 20-40	1026 (754-1290) x 40 (26-52)
Anatriaenes		Shafts 1700-4000 x 8-20, clads 70-270	3030 (1992-4378) x 21 (9-35)
Protraienes[i]	Shafts 300, clads 70, whip-like clad 140	Shafts 650-2000 x 2-4, clads 20-140	Shafts 2219 (1150-3452) x 21 (6-29) clads 57 (29-83), whip-like clads 91 (64-113)
Sigmaspires	30	12-30	17 (11-20)

[i] Koltun, 1966 describes regular protriaenes without a whip like clad to be 2000 – 3700 in length x 6-12 in width with clads of 70-150 µm. The protriene types in CMNI 2018-0183 were treated as one, as the shaft length did not appear different between the two types.

Genus *Craniella*, Schmidt, 1870

2.3.6 Craniella cf. *polyura* (Schmidt, 1870)

(Figure 2-7; Table 2-7)

2.3.6.1 Material examined.

CMNI 2018-0184. Specimen in 95% ethanol, collected by Curtis Dinn by Agassiz trawl; July 15, 2017, 141 m depth (63° 38.390’ N, 68° 37.642’ W) operated from the *CCGS Amundsen*, Frobisher Bay, Canada.

2.3.6.2 Description.

One specimen was collected in inner Frobisher Bay near Hill Island. The specimen is ovoid, 3 cm tall by 1.5 cm wide. The surface is optically smooth with small furrows, giving a somewhat dimpled appearance. A root section ~0.5 cm long is visible on the underside of the specimen, but this portion may have been damaged upon collection and so could be longer in life. The sponge is a light brown colour, lightening towards the root (Figure 2-7A). The sponge had a soft consistency when it was collected but became hard after preservation in ethanol. The spicules consist of large oxeas that are often thicker on one end 2206 (1610-3453) x 28 (15-41) µm, and short, very thin oxeas are 441 (251-1199) x 9 (4-17) µm long. There are also protriaenes that have a shaft length of 1905 (888-5879) x 16 (8-29) µm, with one whip-like clad 105 (36-183) µm long. Proteianes can have clads of equal lengths or have one long whip-like clad. Here the two protriaene variations are considered as one spicule type. Anatriaenes are uncommon compared to oxeas and protriaenes (only one was found fully intact with a length of 7017 µm); the shaft width is 14 (8-20) µm n=20, and the clads are 77 (57-94) µm; sigmaspires with a centrotylotic swelling are 13 (10-18) µm in length. (Figure 2-7B-F)

2.3.6.3 Genetic data.

28S rDNA sequences group this specimen with *Cinachyra* and *Antarctotetilla* specimens based on the D3-D5 (GenBank accession MH394250) domain sequence (Appendix A1.4). There are no nucleotide sequences published for this species. The Tetillidae are therefore in need of revision, as this species does not group with other *Craniella* species based on a preliminary analysis of the 28S sequences.

2.3.6.4 Discussion.

The spicule measurements of the present specimen are similar to those given by Koltun (1966). Anatriaenes were not common in this specimen, only one was found fully intact, but several anatriaene rhabdomes were seen. Koltun (1966) suggests that the anatrianes reach maximum length of over 10,000 µm, therefore it is difficult to find this spicule unbroken. Koltun (1966) also states that the anatriaenes may be absent, suggesting that this spicule is uncommon in this species. Compared with the sympatric *T. sibirica*, protriaenes of various sizes, most with one long whip-like clad are more common in this specimen, while anatriaenes are more common in *T. sibirica.* The key diagnostic spicules for this species are the sigmaspires with a centrotylotic swelling. This swelling occurs in both C and S shaped spicules and is quite apparent using light and scanning electron microscopy. The external appearance of this sponge fits Koltun's 1966 description, with the body "egg-shaped or spherical, up to 7 cm in height" pp. 96. The radially spiral skeleton and velvety surface described by Koltun (1966) is also apparent in this specimen.

2.3.6.5 Remarks.

The sponge corresponds to descriptions of *C. polyura* by Schmidt (1870) and Vosmaer (1885), and to a description of *Tetilla polyura* by Van Soest (2016). The centrotylotic swelling of the sigmaspires is distinctive and separates this species from the sympatric *Tetilla sibirica.* It is likely that both of these species belong to a common genus, and therefore the family requires revision. Koltun (1966) describes the distribution of this species to be the Barents Sea, the Kara Sea, the Laptev Sea, Greenland waters, Norway, the Azores, and Baffin Bay with a depth distribution ranging from 25-595 m. The collection locality in Baffin Bay was not listed in this publication and is not currently reflected in the WPD. Vosmaer (1885) stated that this sponge has a higher Arctic and coastal Russian distribution.

Figure 2-7. *Craniella* cf. *polyura*. A. Specimen collected. B, C. Sigmaspires showing centrotylotic swelling. D. Partial protriaene with whip-like clad. E. Large oxea with small oxea. F. Broken anatriaene.

Table 2-7. Spicule measurements (length and width ranges, µm) of *Craniella* cf. *polyura* (Schmidt, 1870)

	Koltun, 1966	Van Soest, 2016	This study (CMNI 2018-0184)
Large oxeas	1500-5000 x 10-35	4200 x 7	2206 (1610-3453) x 28 (15-41)
Small oxeas	340-1800	600-1080 x 12-19	441 (251-1199) x 9 (4-17)
Anatriaenes	10000 x 6-8 Clads 50-120	2100 x 8 Clads 28-81	7017µm (n=1) x 14 (8-20) n=20, Clads 77 (57-94)
Protraienes with one whip-like clad	1300-8700 x 3-5 Clads 19-70 and 70-200	960-1600 x 3-10 Clads 24-78, 88-225	1905 (888-5879) x 16 (8-29) Clads 105 (36-183)
Sigmaspires (with centrotylotic swelling)	13-20 up to 28	10-13	13 (10-18)
Raphides	n/a	215-345 x 1	n/a

Order Polymastiida, Morrow & Cárdenas, 2015

Family Polymastiidae, Gray, 1867

Genus *Polymastia*, Bowerbank, 1862

2.3.7 Polymastia thielei Koltun, 1964

(Figure 2-8; Table 2-8)

2.3.7.1 Material examined.

CMNI 2018-0121. Specimen in 95% ethanol, collected by Curtis Dinn by ROV hydraulic manipulator; July 22, 2016, 500 m depth (62° 59.194' N, 60° 37.7263' W). CMNI 2018-0125. Specimen in 95% ethanol, collected by Curtis Dinn by Agassiz trawl; July 22, 2016, 457 m depth (63° 00.251' N, 60° 38.573' W). CMNI 2018-0154. Specimen in 95% ethanol, collected by Curtis Dinn by Agassiz trawl; July 26, 2016, 1148 m depth (68° 15.59 N, 59° 49.38W), CMNI 2018-0169. Specimen in 95% ethanol, collected by Curtis Dinn by Agassiz trawl; July 14, 2017, 402 m depth (62° 57.232 N, 67° 08.360W), and CMNI 2018-0194. Specimen in 95% ethanol, collected by Curtis Dinn by BX 650 MK III box core; July 16, 2017, 377 m depth (62° 34.014 N, 66° 16.942 W). All operations performed from the *CCGS Amundsen* in Frobisher Bay and Davis Strait, Canada.

2.3.7.2 Description.

Two specimens were collected on the SE Baffin shelf, one in a deep-water site in Davis Strait, and two in outer Frobisher Bay. The specimens range from 2-7 cm in diameter, with the specimens from Frobisher Bay being the largest (Figure 2-8A-C). The sponges were found attached to rocks and large pebbles. The sponges are pale beige with a velvety surface. The number of papillae vary from three to approximately thirty and are scattered around the entire surface of the sponge. The texture is firm and rubbery. In cross section the cortex is cream-coloured, while the choanosome is dark brown. Spicule dimensions are similar in all specimens (measurements based on CMNI 2018-0121, CMNI 2018-0154, CMNI 2018-0169, CMNI 2018-0194). The principal styles are 964 (712-1181) µm x 22 (16-28) µm N=120, intermediately sized tylostyles are 546 (409-750) µm x 15 (8.5-21.5) µm N=120, and small, often curved tylostyles are 250 (160-312) µm x 12 (5.5-22) µm, N=120 (Table 2-8).

2.3.7.3 Genetic data.

CO1 sequences were obtained from one sponge from outer Frobisher Bay (GenBank accession (MH394254). The present specimen matches *Polymastia thielei* (GenBank accession LN606469) based on a 474bp sequence (Appendix A1.5).

2.3.7.4 Discussion.

The specimen characters agree with the original description by Koltun (1964), and subsequent descriptions by Plotkin (Plotkin, 2004; Plotkin *et al.*, 2017). The presence of three size categories of styles/tylostyles as well as the genetic data strongly suggest this specimen is *P. thielei.* The principal styles are smaller than the maximum length reported by Plotkin (2017). This is likely a result of the small size of the specimens collected here (2-7 cm), compared to Plotkin's (2017) specimens which were up to 25 cm in diameter. Koltun (1966) describes the sponge as "lump-like, spherical or cushion shaped, up to 7.5 cm in diameter" with a smooth surface (p.126).

2.3.7.5 Remarks.

This is the first record of *P. thielei* north of the Grand Banks in Canada. The sponge appears to be common in most habitats in coastal Eastern Canada and is often seen in ROV video transects from multiple sites in the Canadian Arctic. However, other sympatric *Polymastia* species were collected in Davis Strait and Baffin Bay, therefore identifications from video transects may not be reliable. From video taken in 2017, sponges which appear to be *P. thelei* were seen as far north as Pond Inlet, although no specimens were collected during the dives, so the exact identity cannot be confirmed. The depth range in which the current specimens are found agrees well with that described previously (Plotkin *et al.*, 2017). It is therefore suggested that this sponge has a whole North Atlantic distribution and extends northward into Baffin Bay.

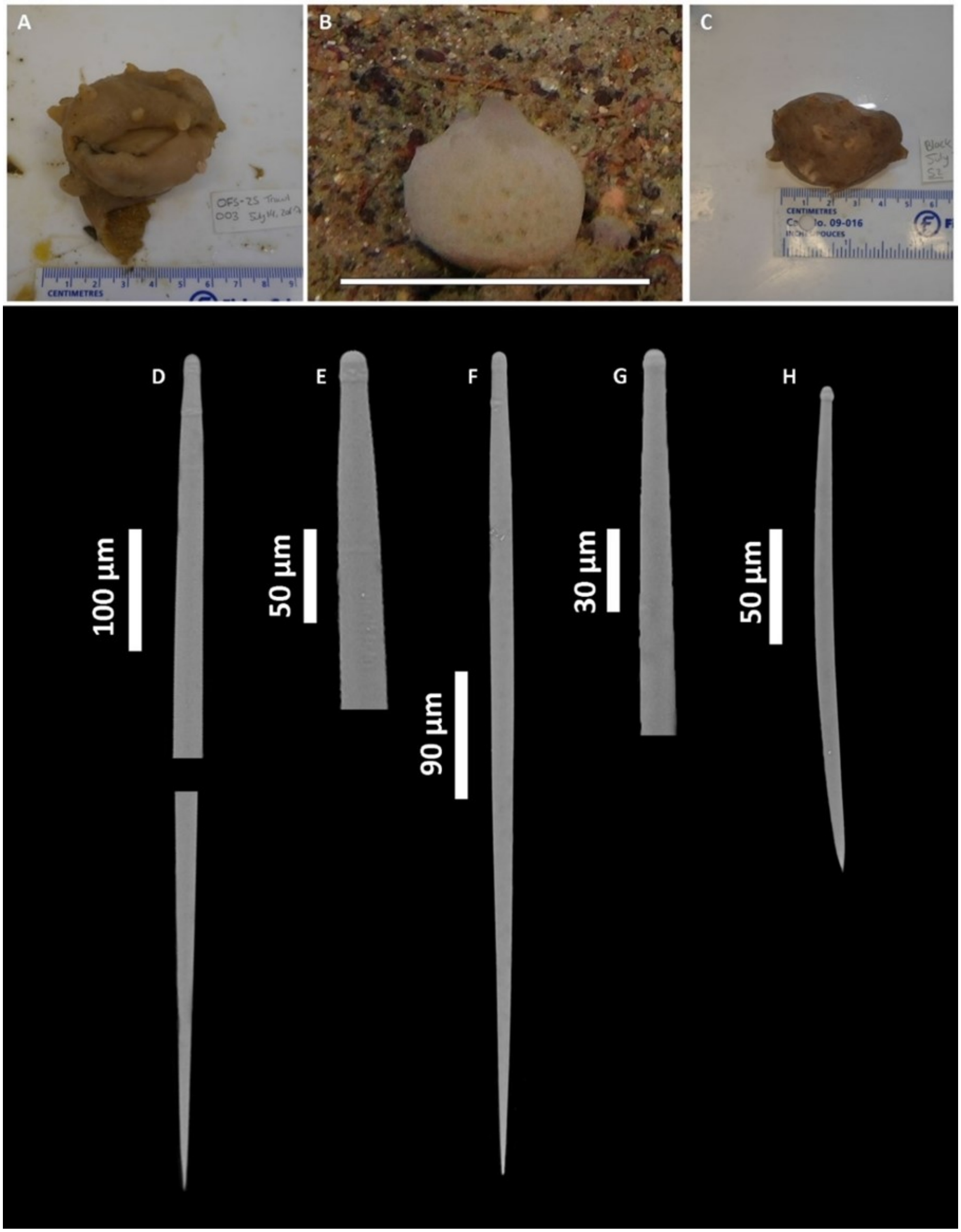


Figure 2-8. *Polymastia thielei*. A. Specimen collected from Frobisher Bay. B. Specimen *in situ* on the SE Baffin shelf. Scale bar is 6 cm. C. Specimen collected from Greenland shelf. D. Large tylostyle. E. Head of large tylostyle. F. Intermediate tylostyle. G. Head of intermediate tylostyle. H. Small tylostyle

Table 2-8. Spicule measurements (length and width ranges, µm) of *Polymastia thielei* Koltun 1964

	Plotkin et al., 2017	Koltun, 1966	This study (CMNI 2018-0169 only)
Primary styles	1277 (693–1705) x 18.4 (12.5–25.1)	700-1700 x 12-25	964 (740-1100) x 23 (18-28)
Intermediate tylostyles	539 (445–648) x 11.2 (10.5– 12.3)	450-650 x 10-12	552 (435 – 750) x 16 (11.8-21.5)
Small tylostyles	297 (219–363) x 6.8 (4.1–9.3)	220-360 x 4-9	221 (160-270) x 11 (7.7 – 15)

2.4 Discussion

Over three years of opportunistic sponge sampling in Frobisher Bay, 42 specimens were collected representing 24 unique sponge taxa. Five of the species identified are new geographic records for the region. Before this study, only 19 species of sponges were known from the entire Northern Labrador marine ecoregion (Spalding *et al.*, 2007; Van Soest *et al.*, 2018), which includes most of the North Labrador Sea and the southern Baffin Island shelf. Only three of those 19 species were collected in the present study; *Lycopodina lycopodium, Forcepia (Forcepia) fabricans,* and *Lissodendoryx (Lissodendoryx) indistincta.* Another species *Lissodendoryx* sp*.,* also reported by Tompkins *et al.* (2017) was also collected in the course of our work, but is not listed in the WPD. This work therefore increases the number of sponge species known in the region from 19 to 31, with an additional nine specimens that were only identified to genus.

2.4.1 Dense sponge gardens from inner Frobisher Bay

Iophon cf. *nigricans* was seen in ROV video from the inner bay at depths ranging from 72-146 m. This is the third species of *Iophon* recorded from the NW Atlantic: *I. dubium* is recorded from the Western Greenland shelf, and *I. piceum* is well known from the Grand Banks (Kenchington *et al.*, 2015) and the Western Greenland shelf (Lundbeck, 1905). Despite the differences in spicule morphology, 28S sequences from the D3-D5 and D6-D8 regions do not indicate that this specimen is different from *I. nigricans.* However, the D1-D2 region is more variable and are more likely to show species-level differences (Borchiellini *et al.*, 2000), but this region did not amplify in these specimens. Further DNA work is required to determine if there is any substantive difference between the specimens. The bipocille spicules from the Frobisher Bay specimens are the most strikingly different, in that they are almost twice the size as those described in *I. nigricans.* They also have a markedly different form because the alae are equal, and the shaft is arcuate. The Frobisher Bay specimens also lack the smaller size category of anisochelae found in the *I. nigricans* specimens previously described from Europe (Ackers *et al.*, 1992). Both these sponges show a peculiar dark colouration after collection however, where *I. nigricans* turns black, the Frobisher Bay specimens become brown. The *Iophon* cf. *nigricans* from Frobisher Bay are also notable as they form expansive sponge gardens near Hill Island. Throughout the ROV transect, this sponge was also the species encountered most often across all taxa (Miles & Edinger, 2016). *Iophon* cf. *nigricans* was not encountered in collections or seen in

ROV video from neighbouring Davis Strait and further north in Baffin Bay where the bottom on the shelf break is rocky. This suggests that this species likely has a sublittoral distribution on soft sediments. Since current trawl survey operations in eastern Canada do not occur in fjords and bays along the eastern Canadian coast (Kenchington, Link*,* *et al.*, 2011), it is unknown whether its distribution extends northward along Baffin Island, or further inland into the Hudson Bay complex. *Iophon* sp. described from the Bay of Fundy (Goodwin, 2017) also casts doubt on the assignment of this species. The specimens from the Bay of Fundy lack a second size category of anisochelae, much like the specimens collected in Frobisher Bay, but the bipocilles of the sponges from the Bay of Fundy are more similar to those of European *I. nigricans* than those found in *I.* cf. *nigricans* from Frobisher Bay. From the ROV video is was noted that other invertebrates and fish live amongst the elaborate branches of *Iophon* cf. *nigricans*, suggesting that this sponge also likely provides habitat for multiple other benthic species as it creates a complex three-dimensional structure (Bett & Rice, 1992).

2.4.2 Amphi-Atlantic species distributions and eastern Canadian sponge biodiversity

The six geographic range extensions in the present study show that sponges in the boreal Atlantic and higher Arctic can have distributions that extend throughout the whole North Atlantic Ocean. This is not an uncommon occurrence across marine taxa, where 13% of opisthobranch gastropods (Carmona *et al.*, 2011) and 11% of shallow-water azooxanthellate scleractinian corals (Cairns, 2000) in the Atlantic are regarded as amphi-Atlantic and occur on both North American and Northeast Atlantic coasts. Recent rDNA analyses of deep-sea bivalves of the subfamily Bathymodiolinae have also confirmed morphological identifications of transatlantic species, with the same species complexes occurring across the equatorial belt on separate continental margins (Olu-Le Roy *et al.*, 2007). Recent work on sponges echo this pattern where several species are common to both the NW and NE Atlantic (Cardenas & Rapp, 2012, 2015; Cárdenas & Moore, 2017; Hestetun *et al.*, 2017; Plotkin *et al.*, 2017; Tompkins *et al.*, 2017). These species may have first spread during the Plio-Pleistocene when trans-Atlantic currents were strong (Carmona *et al.*, 2011), or much more recently as a result of transport by increased marine traffic (Lavoie *et al.*, 1999; Keller *et al.*, 2011). It is unlikely that long distance displacement of sponge larvae occurs, especially in larval brooding species such as *Iophon*, which release fully formed swimming larvae that typically settle shortly after release (Burton, 1933; Maldonado, 2006). Patterns of surface water flow through the Canadian archipelago follow a general south easterly direction (McLaughlin *et al.*, 2004; Archambault *et al.*, 2010), so pan-Arctic connectivity may occur through the Beaufort Gyre, athough this requires further studies on population genetics and models of species distribution patterns in the region.

In this study, nine species were identified only to the genus level because no comprehensive resource describing sponge species exists for the Eastern Arctic and Subarctic, and these species are taxonomically ambiguous. Difficult taxonomy of groups such as calcareous sponges leads to uncertainty of true taxonomic identity. Further comparative work is required to narrow *Halichondria* sp. and the two *Thenea* specimens to the species level. *Hymedesmia sp*. considered here may very likely belong to the closely related genus *Phorbas*, as spicule types in these two genera are similar, but their arrangement in the body determines the taxonomic placement. Due to the irregularity of the sponge surface, skeletal preparations were quite difficult and therefore the specimen was tentatively placed in the genus *Hymedesmia*. Since these species could not be narrowed to the species level, it is unknown whether they represent new geographic range extensions, or if they are potentially new species.

Although the number of species described in the eastern Canadian Arctic has increased from this work, the sponge biodiversity in the region is still an order of magnitude lower than well-studied sites at similar latitudes globally. Unfortunately, a species accumulation curve could not be created due to the limited number of samples collected and the use of different sampling methods. Local field guides for other regions describe many species: for example 290 species of sponge are known from central California to southern Alaska (Austin, 1985; Austin *et al.*, 2015); 134 species are known from Rathlin Island, Northern Ireland alone (Picton & Goodwin, 2007); and 400 species are described from Antarctica (Janussen & Downey, 2014). Although many fewer marine sponge species have been described in Eastern Canada, their biomass is substantial. DFO trawls and bycatch records from fishers show that large sponge assemblages occur along the eastern Canadian shelf (Kenchington *et al.*, 2010; Kenchington, Link*, et al.*, 2011). Smaller trawls for scientific surveys in the Baffin Bay region also show that sponges are the dominant benthic fauna on hard bottoms (Roy *et al.*, 2015). Species identifications of sponges collected in DFO and Greenland Institute of Natural Resources fisheries trawls have revealed several new species records for the region (Tompkins *et al.*, 2017; Baker *et al.*, 2018), and this work is leading towards a better understanding of benthic community structure along the eastern Canadian shelf. Future work in near-shore habitats in conjunction with deep-water benthic monitoring will likely reveal similar sponge biodiversity in the NW Atlantic compared to other high latitude sites.

2.4.3 Future sampling in the eastern Canadian Arctic

Limited available ship time and sampling difficulty due to harsh ice and weather conditions are likely to contribute to the paucity of described species in the North Labrador Sea. Frobisher Bay has been studied more than other regions of the northeast Canadian shelf because it is close to Iqaluit, the capital city of the territory of Nunavut and the bay is usually only partially ice covered from June to November (Environment Canada Climatic Ice Atlas 1981-2010), and thus vessel-based marine science research is possible in the summer months. Long-term benthic faunal monitoring in the bay is feasible through comparative studies of benthic grab and trawl samples from the mid 20th Century (Grainger, 1954, 1955; Wacasey *et al.*, 1979, 1980; Cusson *et al.*, 2007; Aitken *et al.*, 2016). Although this is the first inventory of sponge species in Frobisher Bay, sponge catch from trawl surveys near the mouth of the bay are reported to be smaller than those further offshore near the shelf break (Kenchington, Link*, et al.*, 2011). Probabilistic models of *Geodia* spp. distributions also predict that large sponge aggregations are unlikely to occur in near-shore regions such as Frobisher Bay and Cumberland Sound (Knudby *et al.*, 2013). Despite this, ROV video near Hill Island shows that large sponge aggregations do occur in shallow water in Eastern Canada, in particular large aggregations of *Iophon* cf. *nigricans, Mycale lingua,* and *Tetilla sibirica*.

This work has shown that targeted sampling using box cores and short trawls complemented by video-based habitat exploration will be needed in the future to properly describe the benthic communities of Eastern Canada. Large-scale trawl surveys are useful if the goal is to assess biomass, but if the focus is on diversity, then more careful, focused sampling will allow living communities as well as species associations in areas of interest to be described. With an increased interest in protecting vulnerable marine ecosystems in Eastern Canada (Fuller *et al.*, 2008; Kenchington, Link*, et al.*, 2011), a better understanding of species-level interactions in the region should be a priority. From limited sampling in a single bay, it is clear that there is a hidden biodiversity of benthic organisms to be discovered in Canada.

Chapter 3. A field guide of sponges of the eastern Canadian Arctic and Subarctic.

3.1 Introduction

There is generally an inverse relationship between our knowledge of the diversity of marine species and the depth and remoteness of a region (Archambault *et al.*, 2010). The vast Canadian Arctic is extremely remote. The deep basins and extent of the continental shelf in the Arctic and Subarctic harbour a wide range of plankton, fish, mammal, and bird species which are important economic resources, particularly for inhabitants of northern regions (Darnis *et al.*, 2012), but the true biodiversity of the Canadian Arctic waters remains relatively unknown. Many benthic species are overlooked in biodiversity studies (Archambault *et al.*, 2010; Piepenburg *et al.*, 2010; Darnis *et al.*, 2012; Roy *et al.*, 2015) and sponges (phylum Porifera) in particular are poorly known in the Canadian North. The number of sponge species known from eastern Canadian waters is an order of magnitude lower than species known from similar latitudes globally (Ackers *et al.*, 1992; Sara *et al.*, 1992; Picton & Goodwin, 2007; Downey *et al.*, 2012; Van Soest *et al.*, 2012; Lehnert & Stone, 2016).

Canadian oceans contain approximately 7% of the world's 232 global marine ecoregions (Spalding *et al.*, 2007; Archambault *et al.*, 2010). Of the 17 marine ecoregions surrounding Canada, three occur in the eastern Canadian Arctic and Subarctic: Northern Labrador, Baffin Bay/Davis Strait and Lancaster Sound (Spalding *et al.*, 2007). These ecoregions represent a considerable portion of the Canadian continental shelf, thus knowledge of the marine fauna inhabiting the area is important for managing human activities in the north.

The goal of this chapter is to derive a better understanding of the biodiversity of sponges across the eastern Canadian Arctic and Subarctic and to create a useful field guide to sponge species in the region for future work. This chapter will be coupled with video analysis from ROV dives by Xinyue Zhang, an undergraduate student at the University of Alberta to form an in-depth view of sponge biodiversity in the study area. Analysis of ROV video provides information on the abundance, density, and diversity of sponge species described in this chapter, and also reveals species richness which was not collected or described here due to sampling contraints. Specimens were collected during research cruises aboard the Canadian Coast Guard Ship (*CCGS*) *Amundsen* in October 2015, July 2016 and July 2017. Collection sites were selected based on reported areas of high sponge abundance (Kenchington *et al.*, 2010; Kenchington, Link*, et al.*, 2011; Knudby *et al.*, 2013) and particular emphasis was given to deep, hard-bottom habitats where collection of benthic organisms is not possible using traditional sampling methods such as sediment grabs and cores.

3.2 Methods

Collections were made in three ways (Figure 3-1): using a Sub-Atlantic SuperMohawk remotely operated submersible (ROV) equipped with SubC Imaging 1Cam Alpha HD Colour Zoom camera and two sampling arms (Figure 3-1, Table 3-1); an Agassiz trawl (1.5 m opening, 40 mm net mesh size, with a 5 mm cod end liner towed for 3 minutes at 1.5 knots); and a box core (BX 650 MK III 50 cm x 50 cm, maximum penetration depth 60 cm) (Figure 3-2, Table 3-2). Sponges were photographed on-board using a Lumix GF7 camera using a ruler for scale. When sponges were collected by ROV, images of these sponges *in situ* were captured. Sponges were described based on field markers such as body form, size, colour, consistency, surface texture, and where possible the habitat and distribution as described in the World Porifera Database.

Bottom distance from ROV dives was calculated from ROV navigation records which report depth and position each second during the ROV deployment. The position data were imported as waypoints into ArcMap ver. 10.5 (ESRI Inc.) and trimmed to only include the time that the ROV was near the seafloor. These waypoints were converted into a line using the Points to Line tool in ArcMap, which gives an overestimation of the total ROV distance because this line measures the linear distance between waypoints. ROV distances were therefore estimated using a 10m PAEK (Polynomial Approximation with Exponential Kernel) linear smoother, which produces a realistic moving path between ROV points. This smoothed line was used to calculate the linear distance covered using the Calculate Geometry tool in ArcMap (Table 3-1). Smoothed ROV transects are shown for dives 50-61 in Figure 3-3 to Figure 3-6, with contour lines from multibeam data collected aboard the *CCGS Amundsen* during cruises in 2016 and 2017.

3.2.1 Sponge Taxonomy

Sponge specimens were either preserved in 95% ethanol or frozen and transported to the University of Alberta. Collection information is lodged in the Polar Data Catalogue (https://www.polardata.ca/ CCIN: 12754). Sponge spicules were isolated from 1 cm^2 pieces that included outer and inner regions of the sponge body, called the cortex and choanosome respectively (Figure 3-8). Pieces of sponge were placed in undiluted household bleach overnight to remove tissue, rinsed four times in distilled water allowing spicules to settle for 15 minutes between rinses, and cleaned in two washes of 95% ethanol. Cleaned spicules were dried on glass slides, mounted in DPX mounting medium (Sigma-Aldrich, St. Louis, MO) and imaged with a Zeiss Axioskop2 Plus compound microscope and an Olympus SZX12 stereomicroscope with a QImaging QiCam or Retiga 2000R camera using EMPIX Northern Eclipse v8 software. Thick sections 100-200µm thick which include the cortex or outer surface of the sponge were made using a razor blade. Sections were cleared in toluene for at least 24 hours and mounted in DPX or Canada Balsam (Sigma-Aldrich, St. Louis, USA). For scanning electron microscopy (SEM), cleaned spicules were placed on metal stubs with carbon tape, coated with a gold/palladium mix and viewed with a Phillips XL30 SEM, Zeiss Sigma 300 VP, or Hitachi TM3000. Spicule measurements (N=30, unless otherwise noted) were made with ImageJ 1.51n and are reported as mean and range. Voucher specimens are deposited at the Canadian Museum of Nature (CMN) Ottawa, Canada. The World Porifera Database was used as the taxonomic authority and for reference of species distributions (Van Soest *et al.*, 2018).

For some specimens COI and 28S were sequenced. Methodology for DNA extraction and amplification, as well as sponge sequences are provided in Appendix 3.

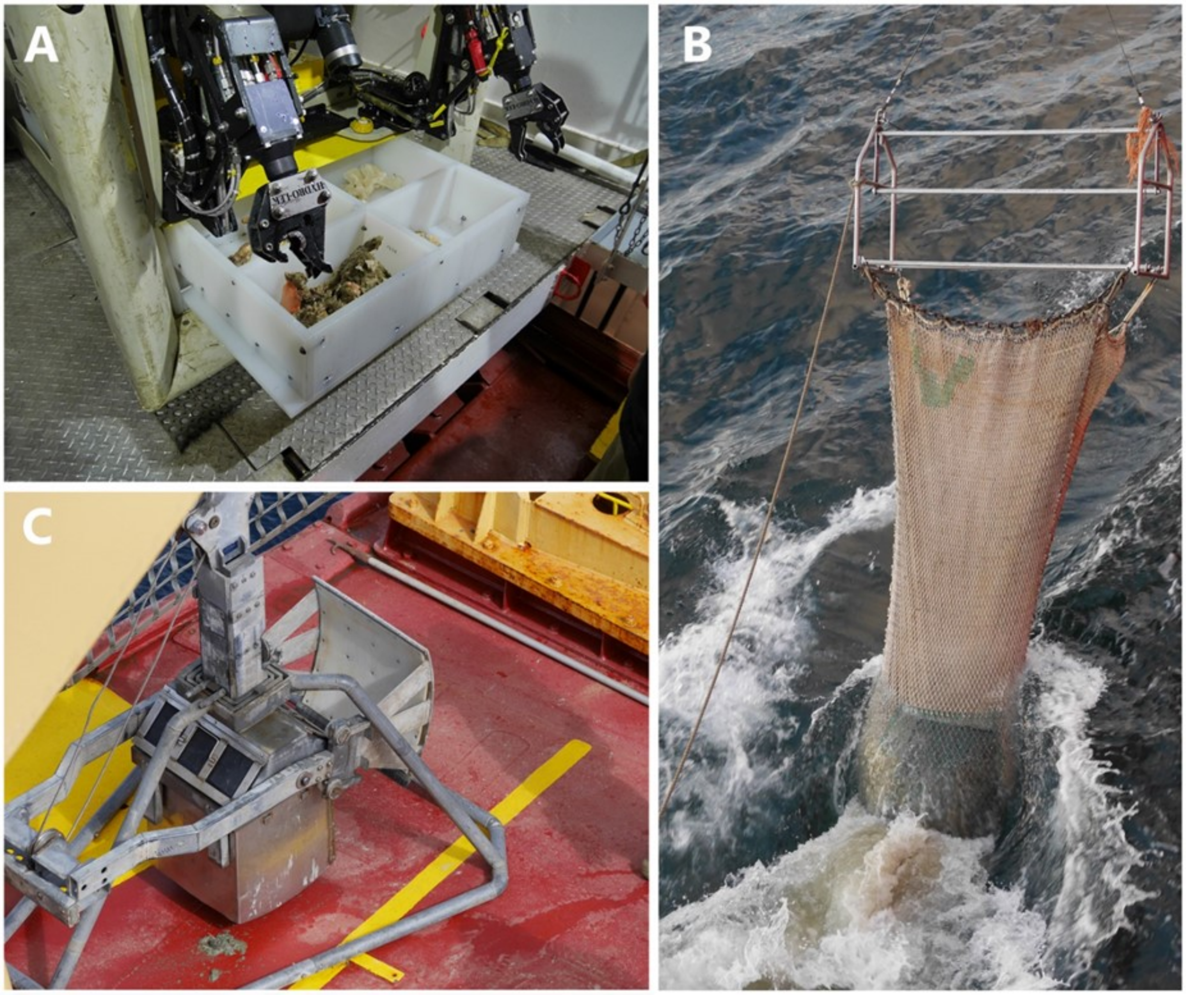


Figure 3-1. Collection methods used aboard the *CCGS Amundsen*. A. SuMO ROV showing hydraulic sampling arms and sampling skid. B. Agassiz Trawl. C. Box Core.

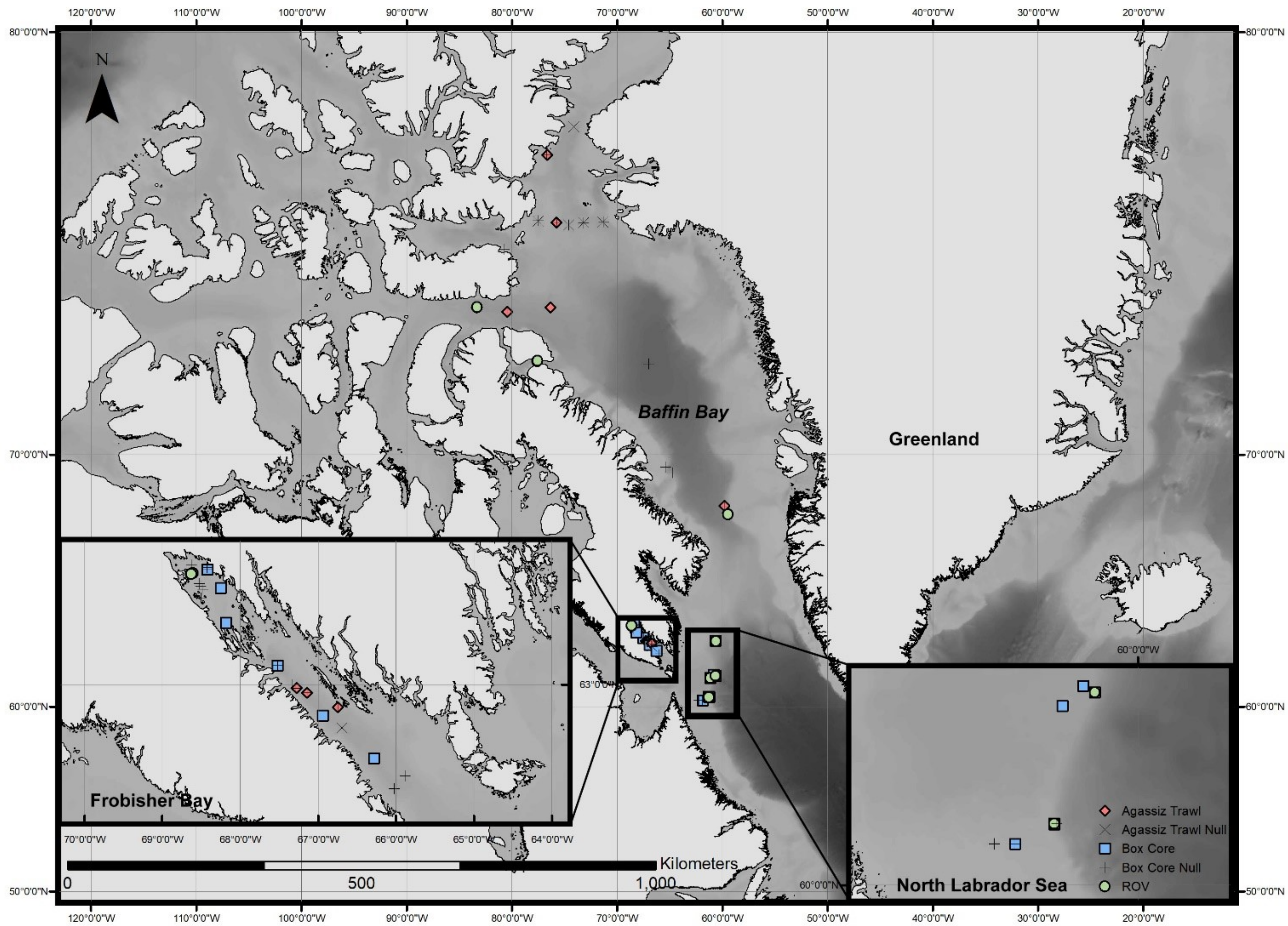


Figure 3-2. Study sites in the eastern Canadian Arctic and Subarctic. Insets show sites in Frobisher Bay and the North Labrador Sea. Circles represent sites where sponges were collected, and crosshairs represent areas sampled but no sponges were collected. Red, Agassiz trawl. Blue, box core. Green, ROV.

Table 3-1. Locations of ROV dives 2015-2017. Dives 49 and 56-58 were cancelled due to weather, and dive 60 was a repeat dive in the W Greenland shelf site and is not included.

Dive number and location	**Date**	**Start Latitude, Longitude**	**End Latitude, Longitude**	**Bottom Time**	**Distance Covered (m)**[i]	**Depth Range (m)**
48 – Inner Frobisher Bay	October 25, 2015	63.6392°, -68.6253°	63.6348°, -68.6303°	4:10	2,463	55-147
50 – NE Hatton Basin	July 19, 2016	61.3415°, -61.1571°	61.3401°, -61.1445°	1:48	4,541	523-574
51 – NE Hatton Basin *Primnoa* rich	July 19, 2016	61.4401°, -60.6645°	61.4402°, -60.6650°	0:59	787	592-632
52 – Saglek Bank	July 21, 2016	61.4672°, -61.2781°	60.4670°, -61.2763°	3:13	3,910	361-473
53 – SE Baffin shelf	July 22, 2016	62.9836°, -60.6287°	62.9869°, -60.6290°	0:26	575	495-499
54 – W Greenland shelf Disko Fan I	July 24, 2016	67.9688°, -59.5040°	67.9701°, -59.5044°	2:08	1,698	894-940
55 – W Greenland shelf Disko Fan II	July 25, 2016	67.9688°, -59.5032°	67.9675°, -59.4839°	2:35	1,588	853-934
59 – Pond Inlet	August 1, 2017	72.8274°, -77.6099°	72.8368°, -77.5940°	4:52	3,449	410-876
61 – Lancaster Sound	August 3, 2017	74.2778°, -83.3121°	74.2767°, -83.3500°	3:42	2,670	713-748

[i] The distance covered is based on a 10 m Polynomial Approximation with Exponential Kernel (PAEK) smoother.

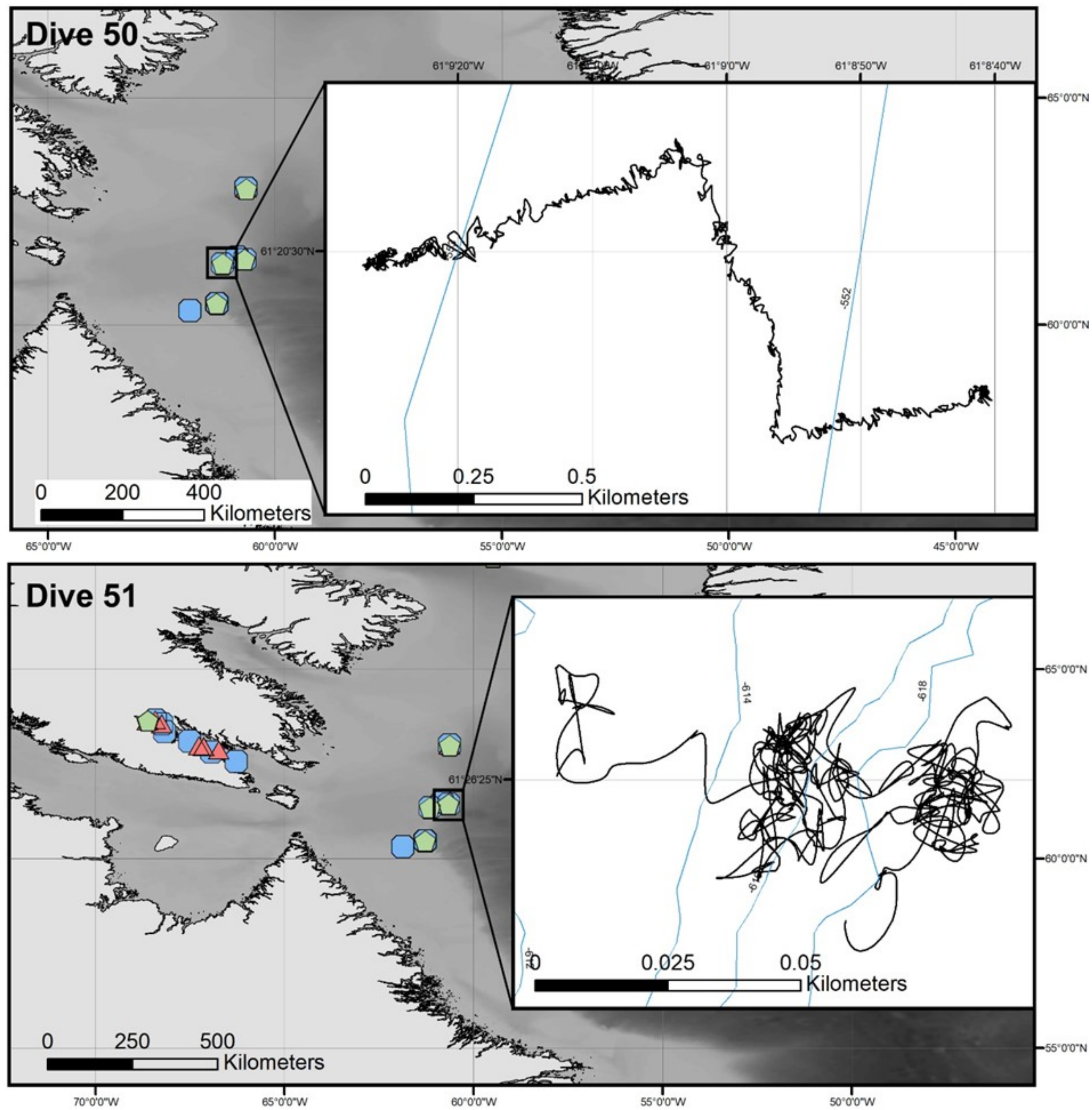


Figure 3-3. Transects of submersible (ROV) dives 50 (NE Hatton Basin) and 51 (NE Hatton Basin *Primnoa* rich) with ROV path shown in the inset.ROV path shown using a 10m PAEK linear smoother. Green pentagons, ROV. Blue squares, box cores. Pink triangles, Agassiz trawls.

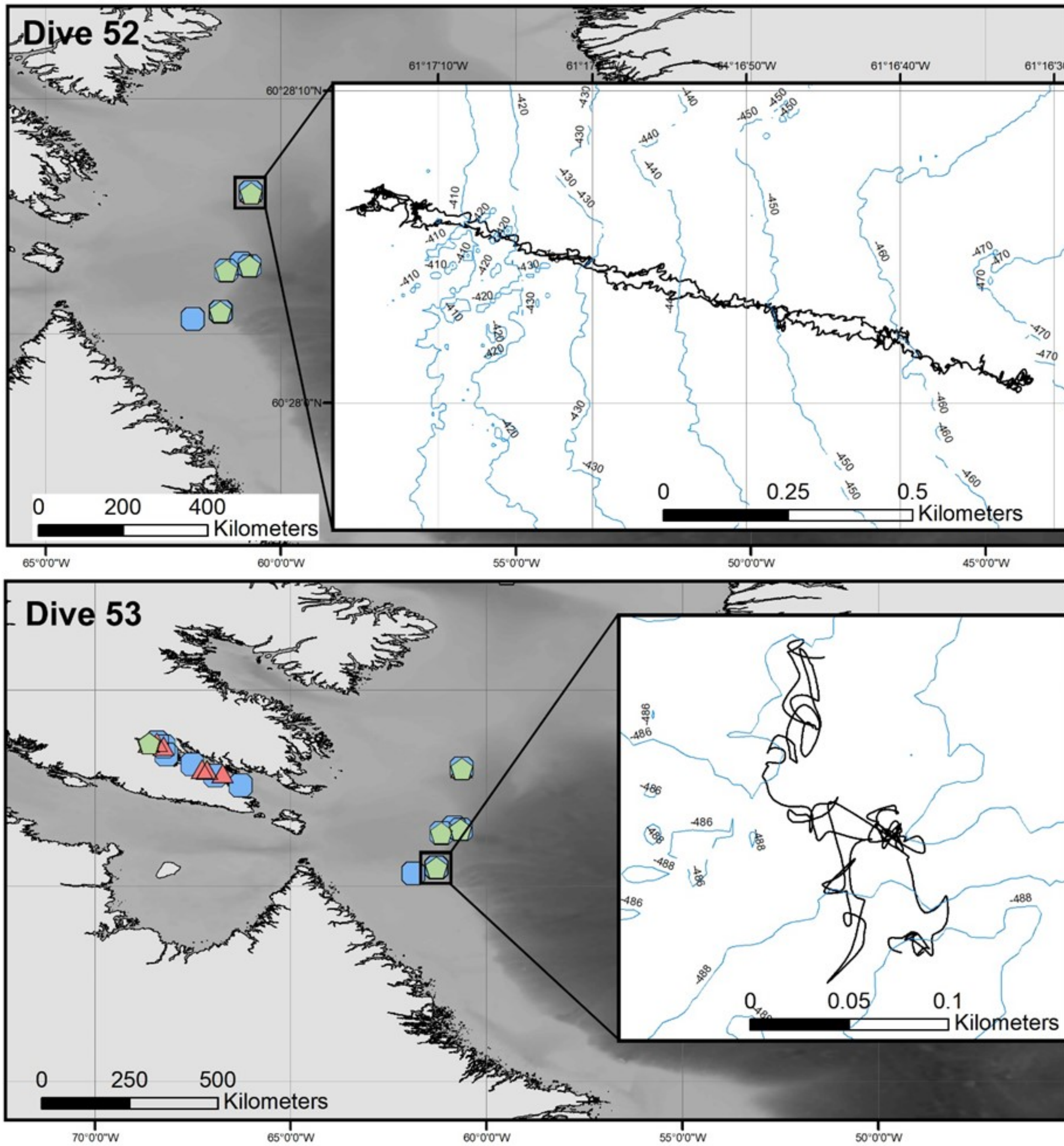


Figure 3-4. Transects of submersible (ROV) dives 52 (Saglek Bank) and 53 (SE Baffin shelf) with ROV path shown in the inset ROV path shown using a 10m PAEK linear smoother. Green pentagons, ROV. Blue squares, box cores. Pink triangles, Agassiz trawls.

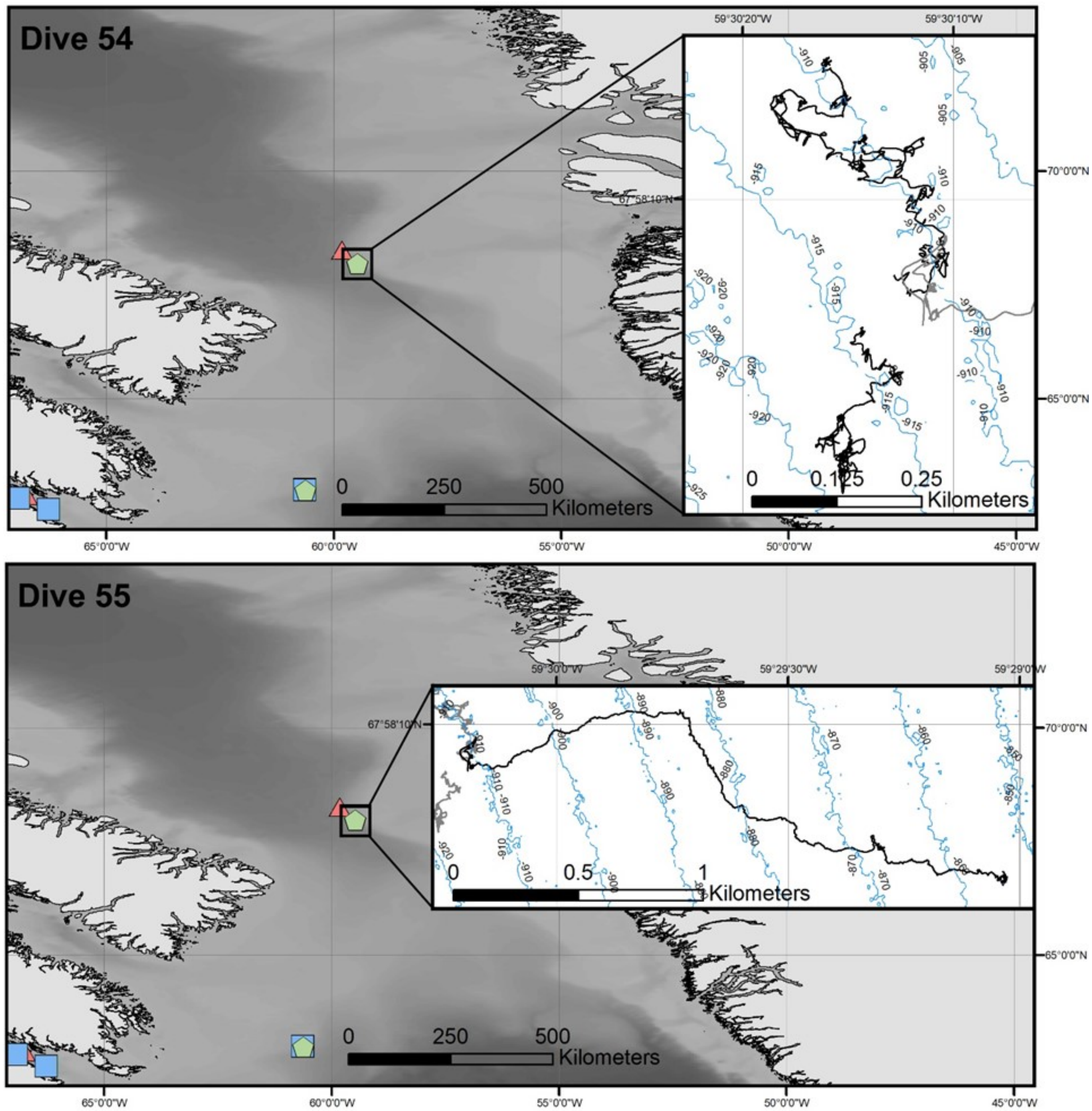


Figure 3-5. Transects of submersible (ROV) dives 54 (W Greenland shelf Disko Fan I) and 55 (W Greenland shelf Disko Fan I) with ROV path shown in the inset.ROV path shown using a 10m PAEK linear smoother. Green pentagons, ROV. Blue squares, box cores. Pink triangles, Agassiz trawls.

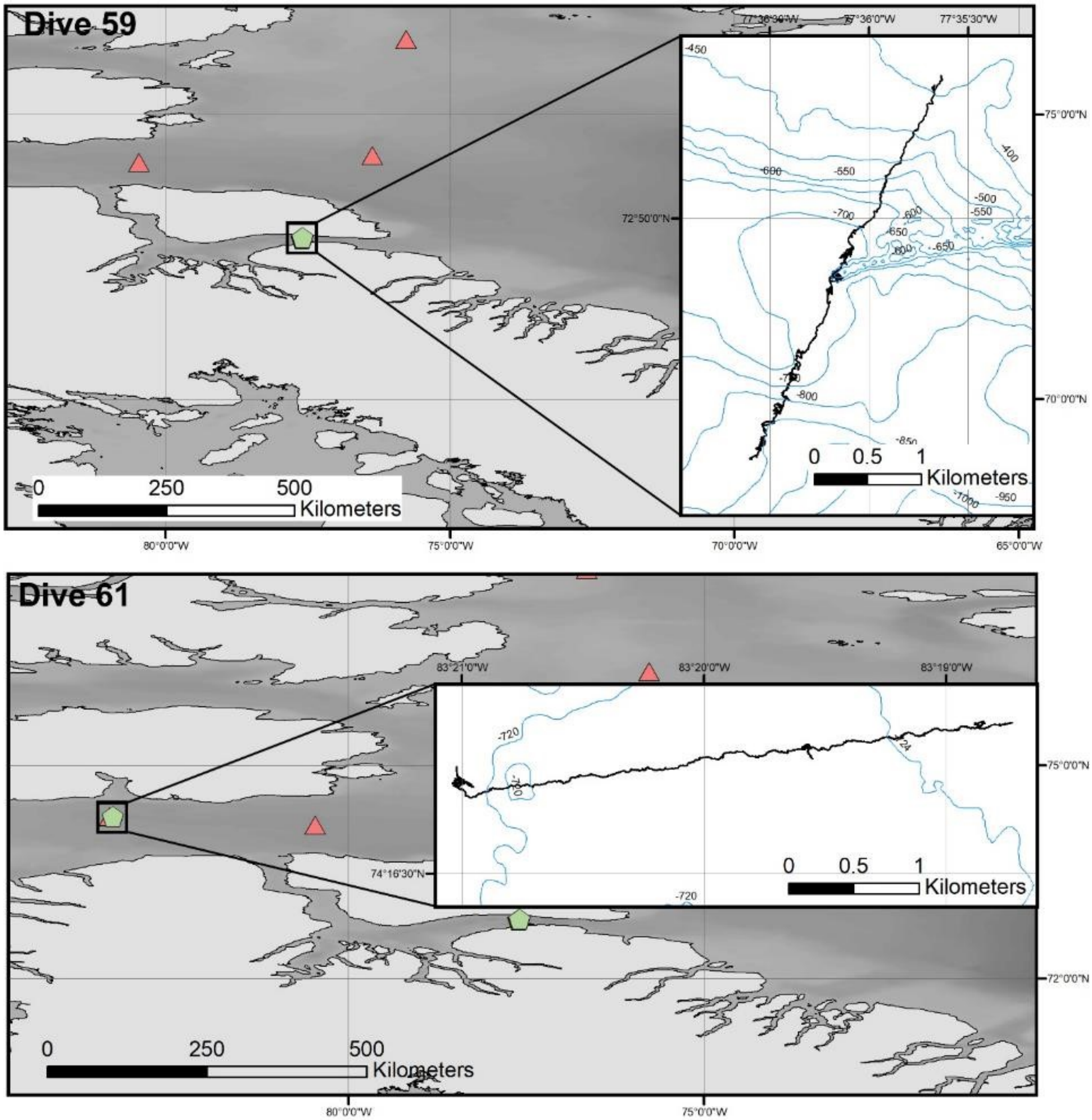


Figure 3-6. Transects of submersible (ROV) dives 59 (Pond Inlet) and 61 (Lancaster Sound) with ROV path shown in the inset. ROV path shown using a 10m PAEK linear smoother. Green pentagons, ROV. Blue squares, box cores. Pink triangles, Agassiz trawls.

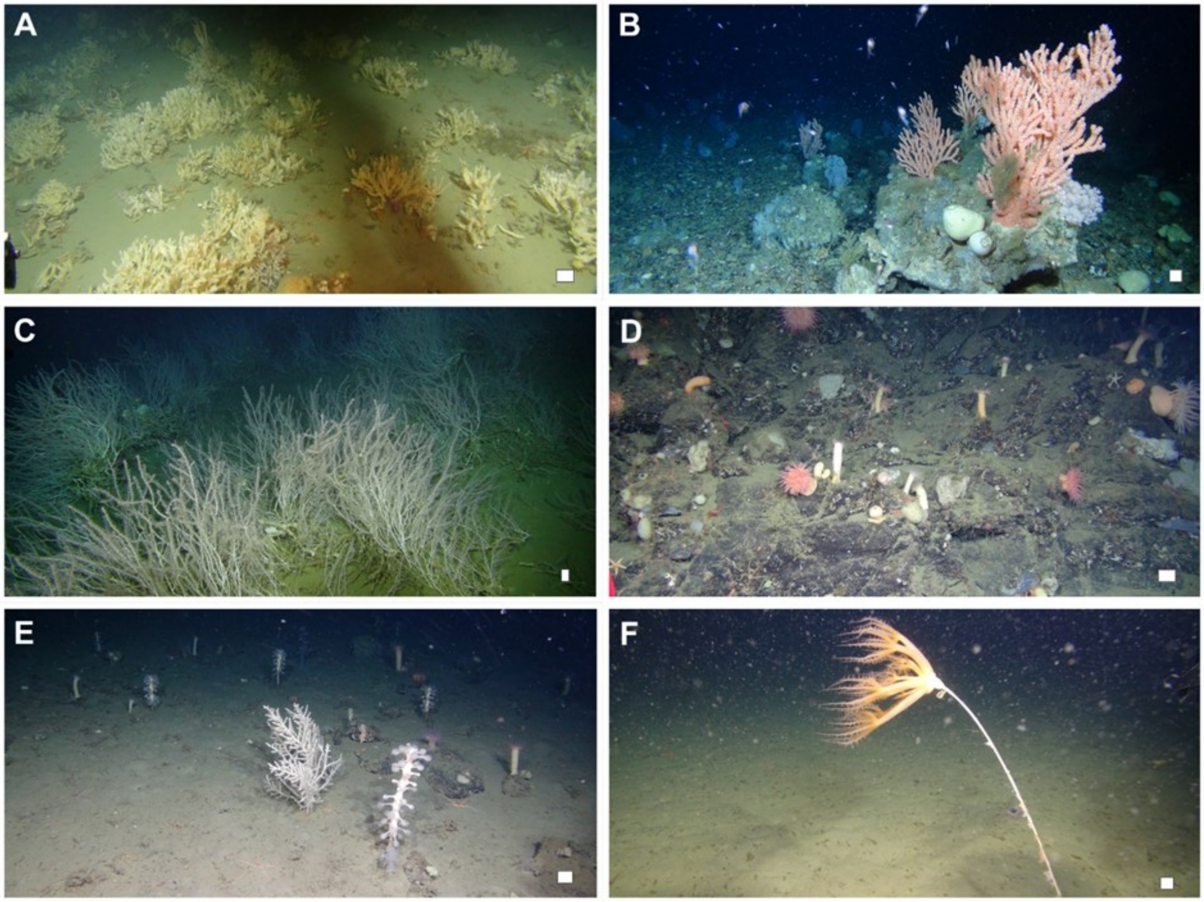


Figure 3-7. Characteristic seafloor types at dive sites. A. Soft sediment and *Iophon* sponge gardens of inner Frobisher Bay (Dive 48). B. Rocky substrate in the North Labrador Sea (Dive 52). C. Sandy/muddy bottom with dense *Keratoisis* coral forests on the Western Greenland shelf (Dives 45 & 55). D. Steep bedrock cliff of Pond Inlet (Dive 59). E. Sand flat in Pond Inlet (Dive 59). F. Sandy/muddy substrate with *Umbellula* sea pen (Dive 61). Scale bar is 6 cm.

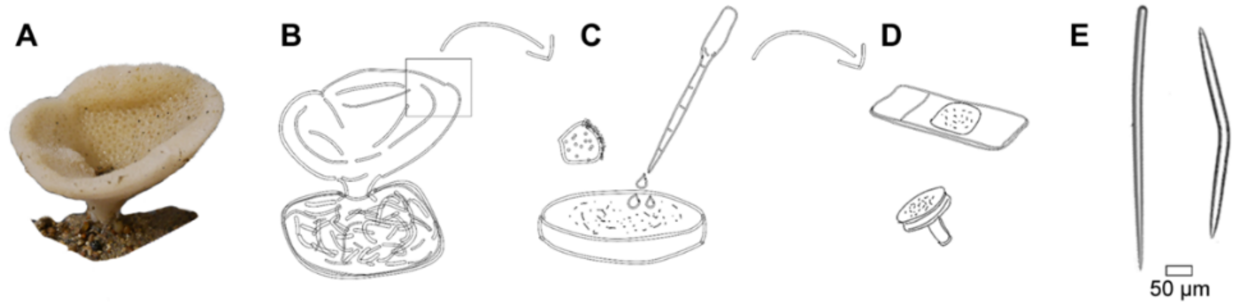


Figure 3-8. Workflow of sponge spicule isolation. A. A sponge is photographed either *in situ* or after collection on deck; it is then either preserved in 95% ethanol, or frozen. B. Portions of preserved specimens are cut from the specimen, taking care to select morphologically distinct regions, i.e. cortex, choanosome, papillae, and stalks, because spicules may be different in different portions of the sponge body. C. The sponge tissue is placed in bleach until the tissue is dissolved. Bleach is removed through rinses with distilled water and ethanol. D. Cleaned spicules are mounted on microscope slides or SEM stubs for viewing by light or electron microscopy. E. Spicules can be photographed, identified to type, and measured.

Table 3-2. Sites of ROV, box core (BC), and Agassiz trawl (AT) deployments from the *CCGS Amundsen* 2016-2017.

Date (y-m-d)	Site	Ecoregion[i]	Depth (m)	Latitude (N)	Longitude (W)
2015-10-25	Frobisher Bay Dive 48 (ROV)	NL	65	63.64291	-68.6088
	FB6-1 (BC)	NL	459	63.11117	-67.5183
	Bell 1 (BC)	NL	208	63.546	-68.4752
	Bell 2 (BC)	NL	204	68.50183	-68.5012
	Bell 3 (BC)	NL	187	63.582	-68.521
	Bell 4 (BC)	NL	186	63.583	-68.5222
	FB3 (BC)	NL	150	63.56867	-68.5078
2016-07-16	FB4 (BC, AT)	NL	118	63.55875	-68.2495
	Bell 5 (BC)	NL	104	63.64272	-68.6193
	Bell 6 (BC)	NL	117	63.6415	-68.6153
	FB1-1 (BC)	NL	135	63.6406	-68.6209
	FB 2-2 (BC)	NL	63	63.6751	-68.4306
	FB2-1 (BC)	NL	80	63.66362	-68.4224
2016-07-17	FB7-1 (BC, AT)	NL	472	62.97787	-67.2822
	FB8 (BC)	NL	610	62.92317	-67.0898
2016-07-18	NE Hatton Basin Dive 50 (BC, ROV)	NL	562	61.34173	-61.16
2016-07-19	NE Hatton Basin Primnoa Rich Dive 51 (BC, ROV)	NL	631.8	61.44024	-60.6646
2016-07-20	NE Saglek Bank Cold Seep (BC)	NL	277	60.3183	-62.1987
2016-07-21	Saglek Bank Primnoa Rich Dive 52 (BC, ROV)	NL	411.8	60.46844	-61.2874
2016-07-22	SE Baffin Shelf Dive 53 (BC, AT, ROV)	NL	499.6	62.98661	-60.6287
2016-07-24	Disko Fan Dive 54 (BC, ROV)	BB	934.6	67.96992	-59.5052
2016-07-25	Disko Fan Dive 55 (ROV)	BB	877.6	67.96749	-59.4847
	Black Coral Site (BC, AT)	BB	1051	68.26667	-59.8
2017-07-14	OF-S-25 (OF B2) (BC, AT)	NL	442	62.99938	-67.3332
	OF-B6 (BC, AT)	NL	493	62.74567	-66.7058
2017-07-15	FB 2-2 5G (BC, AT)	NL	82	63.66307	-68.4208

Table 3-2 Continued

Date (y-m-d)	Site	Ecoregion	Depth	Latitude (N)	Longitude (W)
	FB 2-2 5D (BC)	NL	29	63.67457	-68.4224
	Bell 12 (BC)	NL	141	63.68772	-68.6243
	A16 (BC, AT)	NL	141	63.63983	-68.6274
	Bell 11 (BC)	NL	119	63.35985	-68.1821
2017-07-16	OF-S-22 (BC, AT)	NL	289	62.86695	-66.7463
	OF - B9 (BC)	NL	377	62.5669	-66.2824
	OF -B14 (BC)	NL	411	62.38638	-66.0219
2017-07-19	Disko Fan 2017 (BC)	BB	873	67.96483	-59.4851
2017-07-20	Coring Stn. 8.1 (BC)	BB	1054	69.40728	-64.7322
2017-07-21	Stn. 176 (BC)	BB	367	69.59753	-65.4038
2017-07-22	BB 2 (BC)	BB	2373	72.75133	-67.0152
2017-07-24	Stn. 101 (BC, AT)	BB	378	76.35788	-77.5022
2017-07-25	Stn. 105 (BC, AT)	BB	331	76.31768	-75.7581
2017-07-26	Stn. 115 (BC, AT)	BB	668	76.33192	-71.2547
2017-07-27	Stn. 129 (BC, AT)	BB	545	78.32267	-74.0924
2017-07-28	Trinity Glacier TS 233 (BC, AT)	BB	396	77.75522	-76.6861
2017-07-29	Stn. 111 (BC, AT)	BB	593	76.3081	-73.2071
2017-07-30	Stn. 108 (BC, AT)	BB	448	76.25688	-74.6158
	Belcher Glacier (BC)	BB	623	75.70217	-80.752
2017-07-31	Stn. 323 9BC, AT)	LS	787	74.1566	-80.4679
2017-08-01	Pond Inlet Dive 59 (ROV)	BB	874.8	72.82782	-77.609
2017-08-03	Stn. 301 (BC, AT)	LS	715	74.27757	-83.3189
	Lancaster Sound Dive 61 (ROV)	LS	743	74.27781	-83.3123

[i] NL Northern Labrador, BB Baffin Bay/Davis Strait, LS Lancaster Sound

Table 3-3. Number of box core deployments and sponges collected by site.

Site	Number of box core deployments	Number of sponges collected	Catalogue number
FB6-1	3	1	CMNI 2018-0053
Bell 1	1	0	
Bell 2	1	0	
Bell 3	1	0	
Bell 4	1	0	
FB3	1	0	
FB4	1	1	CMNI 2018-0054
Bell 5	1	0	
Bell 6	1	0	
FB1-1	1	0	
FB 2-2	3	0	
FB2-1	3	2	CMNI 2018-0059, CMNI 2018-0060
FB7-1	1	0	
FB8	1	0	
NE Hatton Basin Dive 50	1	6	CMNI 2018-0062 - CMNI 2018-0066
NE Hatton Basin Primnoa Rich Dive 51	2	11	CMNI 2018-0072 - CMNI 2018-0082
NE Saglek Bank Cold Seep	6	10	CMNI 2018-0083 - CMNI 2018-0092
Saglek Bank Primnoa Rich Dive 52	4	24	CMNI 2018-0096 - CMNI 2018-0119
SE Baffin Shelf Dive 53	4	2	CMNI 2018-0123, CMNI 2018-0164
Disko Fan Dive 54	4	0	
Black Coral Site	1	0	
OF-S-25 (OF B2)	3	1	CMNI 2018-0177
OF-B6	1	0	CMNI 2018-0178
FB 2-2 5G	3	1	
FB 2-2 5D	3	0	
Bell 12	1	0	
A16	4	0	
Bell 11	1	4	CMNI 2018-0187 - CMNI 2018-0188
OF-S-22	1	0	
OF - B9	1	2	CMNI 2018-0194, CMNI 2018-0195
OF -B14	2	0	
Disko Fan 2017	6	0	

Table 3-3 Continued

Site	Number of box core deployments	Number of sponges collected	Catalogue number
Coring Stn. 8.1	1	0	
Stn. 176	1	0	
BB 2	1	0	
Stn. 101	1	0	
Stn. 105	1	0	
Stn. 115	1	0	
Stn. 129	1	0	
Trinity Glacier TS 233	1	0	
Stn. 111	1	0	
Stn. 108	2	0	
Belcher Glacier	1	0	
Stn. 323	1	0	
Stn. 301	4	0	

Table 3-4. Number of Agassiz trawl deployments and sponges collected by site.

Site	Number of Agassiz trawl deployments	Number of sponges collected	Catalogue number
FB4	1	3	CMNI 2018-0055 - CMNI 2018-0057
FB7-1	1	2	CMNI 2018-0060, CMNI 2018-0061
SE Baffin Shelf Dive 53	1	10	CMNI 2018-0124 - CMNI 2018-0128, CMNI 2018-0139 - CMNI 2018-0143
Black Coral Site	1	11	CMNI 2018-0153 - CMNI 2018-0163
OF-S-25 (OF B2)	1	12	CMNI 2018-0167 - CMNI 2018-0176
OF-B6	1	0	
FB 2-2 5G	1	1	CMNI 2018-0179
A16	1	7	CMNI 2018-0180 - CMNI 2018-0186
OF-S-22	1	6	CMNI 2018-0189 - CMNI 2018-0193
Stn. 101	1	0	
Stn. 105	1	3	CMNI 2018-0196, CMNI 2018-0197, CMNI 2018-0198
Stn. 115	1	0	
Stn. 129	1	0	
Trinity Glacier TS 233	1	1	CMNI 2018-0199
Stn. 111	1	0	
Stn. 108	1	0	
Stn. 323	1	1	CMNI 2018-0200
Stn. 301	1	2	CMNI 2018-0210, CMNI 2018-0211

Table 3-5. Sponges collected by ROV at each dive site.

Site	Number of sponges collected	Catalogue number
Frobisher Bay Dive 48	2	CMNI 2018-0165, CMNI 2018-0166
NE Hatton Basin Dive 50	0	
NE Hatton Basin Primnoa Rich Dive 51	5	CMNI 2018-0067 - CMNI 2018-0071
NE Saglek Bank Cold Seep	0	
Saglek Bank Primnoa Rich Dive 52	3	CMNI 2018-0093 - CMNI 2018-0095
SE Baffin Shelf Dive 53	3	CMNI 2018-0120 - CMNI 2018-0122
Disko Fan Dive 54	1	CMNI 2018-0134
Disko Fan Dive 55	18	CMNI 2018-0135 - CMNI 2018-0152
Pond Inlet Dive 59	9	CMNI 2018-0201 - CMNI 2018-0209
Lancaster Sound Dive 61	0	

3.3 Resources used for sponge identifications

The following list contains works that are indispensable for identifying sponges in the North Atlantic.

Hooper, J. & Van Soest, R. W. (2002) **Systema Porifera: A Guide to the Classification of Sponges**.

> This is a first stop resource when attempting to identify an unknown sponge based on spicule morphology.

Boury-Esnault, N. & Rützler, K. (1997) **Thesaurus of Sponge Morphology**.

> In order to understand the language of sponges, this illustrated guide is an asset for any aspiring sponge taxonomist.

Hooper, J. (2000) **Sponguide: Guide to Sponge Collection and Identification.**

> This guide describes how to identify a sponge, from laboratory methods to "mud-map" depictions of major sponge groups.

Ackers, R. G., Moss, D. & Picton, B. E. (1992) **Sponges of the British Isles ("Sponge V"): A Colour Guide and Working Document, 1992 Edition: Marine Conservation Society.**

> Many sponges found in the NE Atlantic are also found in Canadian Waters. This guide provides many useful descriptions and was the inspiration for this work.

Van Soest, R.W.M.; Picton, B.E.; Morrow, C. (2000). **Sponges of the North East Atlantic.** In: World Biodiversity Database CD-ROM Series, Windows/Mac version 1.0. (ETI, University of Amsterdam, Amsterdam), available from http://species-identification.org/species.php?species_group=sponges&id=104&menuentry=soorten.

> This website provides a key to sponge species of the NE Atlantic, as well as a glossary of sponge terminology. The rich multimedia portions of this source are incredibly useful when faced with an unknown sponge.

Van Soest, R.W.M; Boury-Esnault, N.; Hooper, J.N.A.; Rützler, K.; de Voogd, N.J.; Alvarez, B.; Hajdu, E.; Pisera, A.B.; Manconi, R.; Schönberg, C.; Klautau, M.; Picton, B.; Kelly, M.; Vacelet, J.; Dohrmann, M.; Díaz, M.-C.; Cárdenas, P.; Carballo, J. L.; Ríos, P.; Downey, R. (2018). **World Porifera database**. Accessed at http://www.marinespecies.org/porifera

> The ultimate source of sponge distributions, literature, and news on new sponge discoveries. This guide would not have been possible without the WPD.

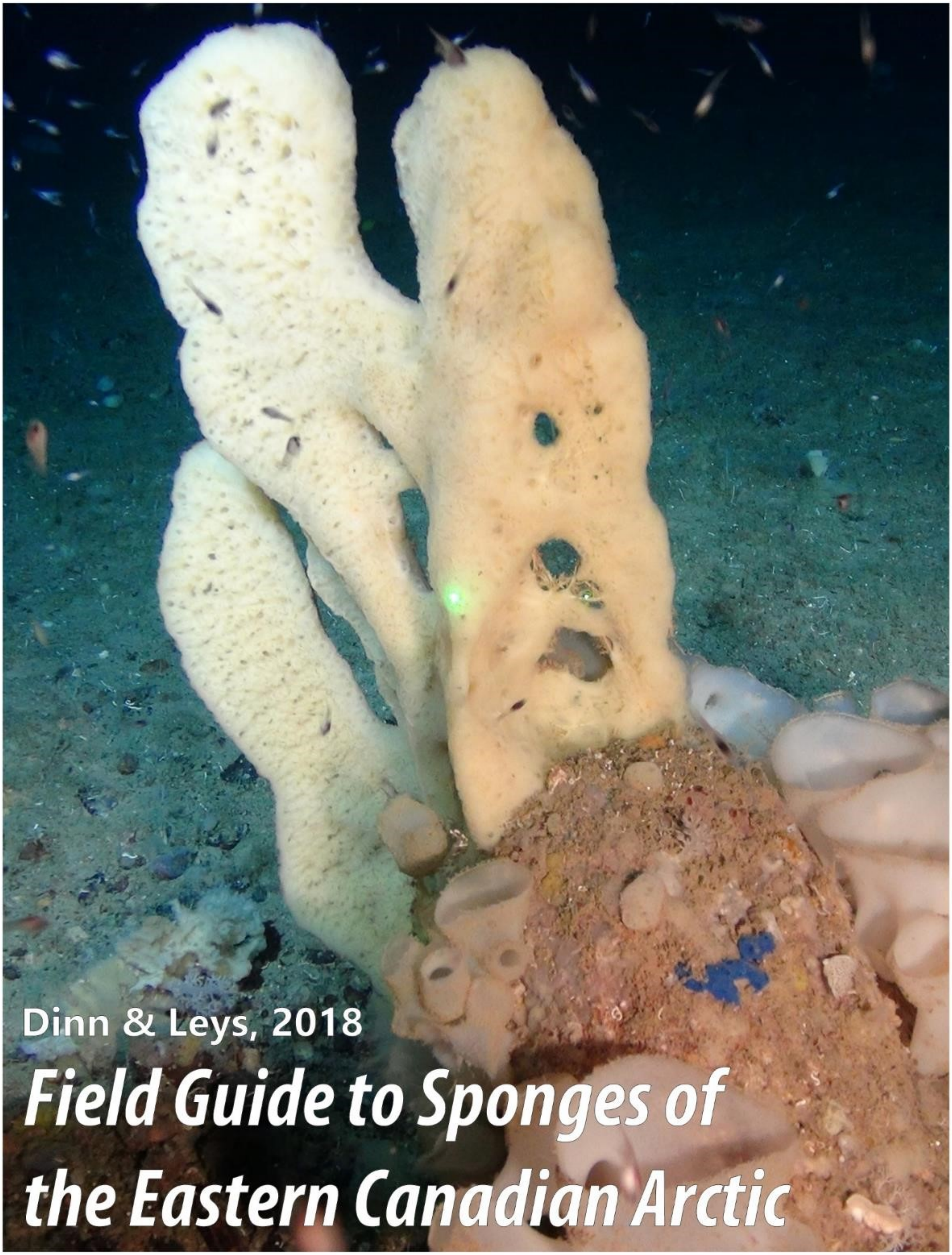
3.4 Sponge species described from collections in the Eastern Canadian Arctic on ship cruises in 2015-2017.

The study material includes 162 sponge specimens comprising 61 separate species, 19 of which could only be identified to the genus level. In the Northern Labrador marine ecoregion (which includes ROV dives 50, 51, 52, and 53), a total of 32 individual species were identified, and 14 additional sponges were identified to the genus level. In the Baffin Bay/Davis Strait marine ecoregion (which includes ROV dives 55 and 59), a total of 15 species were identified (six of which also occurred in Northern Labrador) and eight additional sponges were narrowed to genus (four of which also occurred in Northern Labrador). In the Lancaster Sound marine ecoregion, two species of sponge were collected, one of which was also collected in the Baffin Bay marine ecoregion. Forty-three specimens could not be identified, either because of spicule contamination, the specimen was too damaged, or the specimen was taxonomically ambiguous.

Since body form and spicule complements vary considerably within orders, it is difficult to define key characters to separate individual sponges. Therefore, instead of developing a dichotomous key, I have structured this guide by sponge order, with lower classifications listed alphabetically.

Table 3-6. Number of sponges collected in each marine ecoregion. Repeat taxa are shown in parentheses. (Collection dates, sampling method, depth, and specimen numbers are shown in Appendix 2)

Marine Ecoregion of the World (MEOW)	**Number of sponges collected**	**Number of sponge species identified**	**Number of sponge genera identified**
Northern Labrador	116	32	14
Baffin Bay/Davis Strait	43	15 (6)	8 (3)
Lancaster Sound	3	2 (1)	-
Total (excluding repeat taxa)	162	42	19


Dinn & Leys, 2018
Field Guide to Sponges of the Eastern Canadian Arctic

Sponge species collected as part of the ArcticNet HiBIO project 2015-2017

Class Demospongiae	
Subclass Heteroscleromorpha	
Order Axinellida	
Family Axinellidae	
Genus *Axinella*	*Axinella arctica* (Vosmaer, 1885)
Family Raspailiidae	
Subfamily Plocamioninae	
Genus *Janulum*	*Janulum spinispiculum* (Carter, 1876)
Order Biemnida	
Family Biemnidae	
Genus *Biemna*	*Biemna variantia* (Bowerbank, 1858)
Order Haplosclerida	
Family Chalinidae	
Genus *Haliclona*	*Haliclona (Flagellia) porosa* (Fristedt, 1887)
	Haliclona (Reniera) sp. *1* Schmidt, 1862
	Haliclona (Reniera) sp. *2* Schmidt, 1862
	Haliclona (Haliclona) urceolus (Rathke & Vahl, 1806)
Order Poecilosclerida	
Family Acarnidae	
Genus *Iophon*	*Iophon piceum* (Vosmaer, 1882)
	Iophon spp. (Gray, 1867)
Family Cladorhizidae	
Genus *Cladorhiza*	*Cladorhiza oxeata* Lundbeck, 1905
Genus *Lycopodina*	*Lycopodina lycopodium* (Levinsen, 1887)
	Lycopodina cupressiformis (Carter, 1874)
	Lycopodina sp. *1* Lundbeck, 1905
	Lycopodina sp. *2* Lundbeck, 1905
Genus *Chondrocladia*	*Chondrocladia (Chondrocladia) grandis* (Verrill, 1879)
Family Crellidae	
Genus *Crella*	*Crella (Yvesia) pyrula* (Carter, 1876)
Family Coelosphaeridae	
Genus *Lissodendoryx*	*Lissodendoryx (Lissodendoryx) complicata* (Hansen, 1885)
	Lissodendoryx (Lissodendoryx) indistincta (Fristedt, 1887)
	Lissodendoryx (Lissodendoryx) lundbecki Topsent, 1913
	Lissodendoryx sp. Topsent, 1892
Genus *Forcepia*	*Forcepia (Forcepia) fabricans* (Schmidt, 1874)

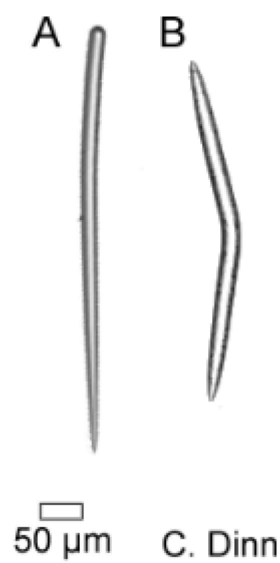
Family Hymedesmiidae		
	Genus *Hymedesmia*	*Hymedesmia (Hymedesmia) paupertas* (Bowerbank, 1866)
		Hymedesmia sp. Bowerbank, 1864
	Genus *Phorbas*	*Phorbas* sp. Duchassaing & Michelotti, 1864
		Phorbas microchelifer (Cabioch, 1968)
	Genus *Plocamionida*	*Plocamionida ambigua* (Bowerbank, 1866)
		Plocamionida sp. Topsent, 1927
Family Iotrchotidae		
	Genus *Iotroata*	*Iotroata affinis* (Lundbeck, 1905)
Family Microcionidae		
Subfamily Ophlitaspongiinae		
	Genus *Antho*	*Antho (Acarnia) signata* (Topsent, 1904)
Family Mycalidae		
	Genus *Mycale*	*Mycale (Anomomycale)* Topsent, 1924
		Mycale (Mycale) lingua (Bowerbank, 1866)
Family Myxillidae		
	Genus *Melonanchora*	*Melonanchora elliptica* Carter, 1874
Family Tedaniidae		
	Genus *Tedania*	*Tedania (Tedania) suctoria* (Schmidt, 1870)
Order Polymastiida		
Family Polymastiidae		
	Genus *Polymastia*	*Polymastia uberrima* (Schmidt, 1870)
		Polymastia thielei Koltun, 1964
		Polymastia grimaldii (Topsent, 1913)
		Polymastia andrica de Laubenfels, 1949
	Genus *Tentorium*	*Tentorium semisuberites* (Schmidt, 1870)
	Genus *Spinularia*	*Spinularia sarsii* (Ridley & Dendy, 1886)
	Genus *Quasillina*	*Quasillina brevis* (Bowerbank, 1861)
Order Suberitida		
Family Suberitidae		
	Genus *Plicatellopsis*	*Plicatellopsis* sp. Burton, 1932
	Genus *Pseudosuberites*	*Pseudosuberites* sp. Topsent, 1896
Family Halichondriidae		
	Genus *Halichondria*	*Halichondria (Eumastia) sitiens* (Schmidt, 1870)
		Halichondria (Halichondria) panicea (Pallas, 1766)
		Halichondria sp. Fleming, 1828
	Genus Hymenicidon	*Hymeniacidon* sp. Bowerbank, 1858

Order Tethyida	
Family Tethyidae	
Genus *Tethya*	*Tethya* cf. *norvegica* Bowerbank, 1872
Order Tetractinellida	
Suborder Astrophorina	
Family Geodiidae	
Subfamily Geodiinae	
Genus *Geodia*	*Geodia barretti* Bowerbank, 1858
	Geodia macandrewii Bowerbank, 1858
Family Theneidae	
Genus *Thenea*	*Thenea* cf. *muricata* (Bowerbank, 1858)
	Thenea sp. *1* Gray, 1867
	Thenea sp. *2* Gray, 1867
Family Tetillidae	
Genus *Tetilla*	*Tetilla sibirica* (Fristedt, 1887)
Genus *Craniella*	*Craniella* cf. *polyura* (Schmidt, 1870)
	Craniella cf. *cranium* (Müller, 1776)
	Craniella sp. Schmidt, 1870
Class Calcarea	
	Calcarea unknown
Subclass Calcaronea	
Order Leucosolenida	
Family Sycettidae	
Genus *Sycon*	*Sycon* cf. *lambei* Dendy & Row, 1913
	Sycon sp.*1* Risso, 1827
Class Hexactinellida	
Subclass Hexasterophora	
Order Lyssacinosida	
Family Rossellidae	
Subfamily Rossellinae	
Genus *Asconema*	*Asconema* spp. Kent, 1870

Axinella arctica (Vosmaer, 1885)

Top: on-board. Bottom: *in situ*

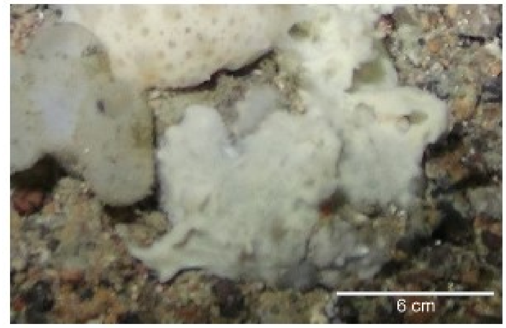
Sample	CMNI 2018-0094, CMNI 2018-0099, CMNI 2018-0146, CMNI 2018-0150
Family	AXINELLIDAE
Synonyms	*Axinella calyciformis* (Lamarck, 1814), *Phakellia arctica* Vosmaer, 1885, *Spongia calyciformis* Lamarck, 1814, *Spongia pocillum* Lamouroux, 1816 *Tragosia arctica* (Vosmaer, 1885), *Tragosia calyciformis* (Lamarck, 1814)
Collection Details	North Labrador Sea 60.468° N, -61.287° W, Depth 412 m 60.466° N, -61.278° W, Depth 452 m Greenland shelf 67.967° N, -59.484° W, Depth 877 m
Form	Cup-like or flabellate. Often an inverted, hollow cone with a solid stalk.
Size	5-25 cm in diameter.
Colour	Pale yellow or buff to white.
Consistency	Firm. Pieces will break off when bent more than 45°.
Surface	Surface of the inner portions has many pin-hole sized exhalent openings. The outside surface has inhalant openings which appear to be facing upward. Dense longitudinal ribs extend from the stalk to the distal portions on the outside surface.
Spicules	Megascleres are styles 470 (400-561) x 17.5 (12.8-24.5) µm, and oxeas 385 (330-443) x 18 (12.8-23.6) µm. No microscleres are present.
Habitat	Rocky bottoms.
Distribution (WPD)	Northern Norway and Finnmark, Barents Sea, North Sea, Celtic Seas, Southern Norway, European Waters.
Remarks	This sponge is similar in form to *Axinella infundibuliformis (Linnaeus, 1759)*, though it lacks trichodragmas. *A. infundibuliformis* was not found during *CCGS Amundsen* collections. Only the base potion of the specimen from the



Greenland shelf was collected, so outer morphology cannot be confirmed for deeper water specimens.

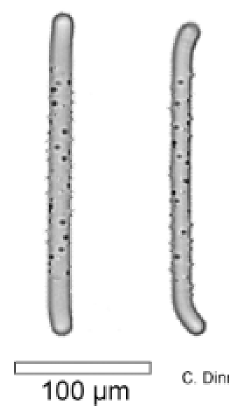
References	Stephens (1921), Vosmaer (1885)

Janulum spinispiculum (Carter, 1876)



Top: *in situ.* Bottom: on board.

Sample	CMNI 2018-0095
Family	RASPAILIIDAE
Synonyms	*Isodictya spinispiculum* Carter, 1876 *Lithoplocamia spinispiculum* (Carter, 1876) *Metschnikowia spinispiculum* (Carter, 1876)
Collection Details	North Labrador Sea (Saglek Bank) 60.468° N, -61.287° W, Depth 412 m
Form	Encrusting. Oscula protrude from crust on raised, nearly cylindrical portions.
Size	Irregular crust 15 cm wide. May grow much larger.
Colour	White *in situ,* buff to yellow upon collection.
Consistency	Firm. Very sticky mucous.
Surface	Soft, except for raised portions which are irregular.
Spicules	Strongyles with sharp spines on the central portion, but smooth at the extremities. The tips of the spicules are often bent.
Habitat	Rocky substrates. Seen encrusting pebbles and boulders.
Distribution (WPD)	South European shelf, Celtic Seas, Northern Norway and Finnmark, South and West Iceland, Western Mediterranean.
Remarks	Fits the description in Kelly *et al.,* 2015. Bone-white encrusting sponges with irregular borders in the North Labrador Sea are assumed to be *J. spinispiculum.* Appears to be very common in the region.
References	Kelly *et al.* (2015)

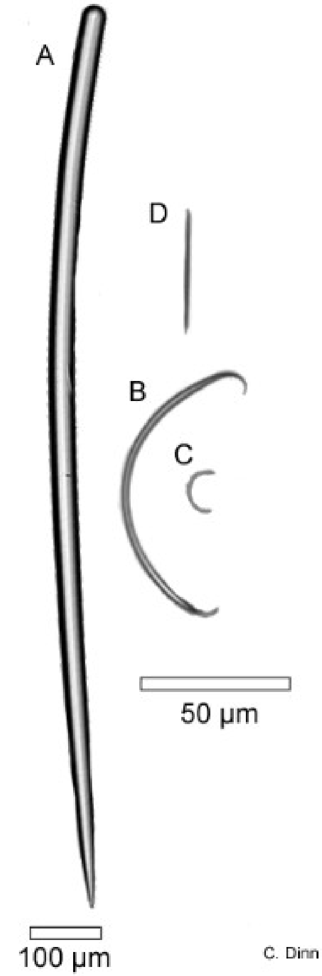


Biemna variantia (Bowerbank, 1858)

Top: on board whole. Bottom: on board in pieces.

Sample	CMNI 2018-0110, CMNI 2018-0115, CMNI 2018-0133
Family	BIEMNIDAE
Synonyms	*Asychis variantia* (Bowerbank, 1858) *Biemna capillifera* (Levinsen, 1887) *Biemna gemmulifera* (Breitfuss, 1912) *Biemna groenlandica* (Fristedt, 1887) *Biemna hamifera* (Lundbeck, 1902) *Biemna peachii* (Bowerbank, 1866) *Biemna variantia hamifera* (Lundbeck, 1902) *Desmacella capillifera* (Levinsen, 1887) *Desmacella groenlandica* Fristedt, 1887 *Desmacella hamifera* Lundbeck, 1902 *Desmacella peachii* (Bowerbank, 1866) *Desmacella peachii var. groenlandica* Fristedt, 1887 *Desmacella peachii var. stellifera* Fristedt, 1885 *Desmacella variantia* (Bowerbank, 1858) *Desmacidon korenii* Schmidt, 1875 *Desmacidon peachii* Bowerbank, 1866 *Gellius capillifer* Levinsen, 1887 *Gellius gemmuliferus* Breitfuss, 1912 *Halichondria variantia* Bowerbank, 1858 *Hymeniacidon varians* Bowerbank, 1882 *Hymeniacidon variantia* (Bowerbank, 1858) *Raphiodesma aculeatum* Topsent, 1888
Collection Details	North Labrador Sea (Saglek Bank) 60.468° N, -61.288° W, Depth 401 m North Labrador Sea (SE Baffin shelf) 63.004° N, -60.642° W, Depth 457 m
Form	Cushion shaped, encrusting.
Size	Variable – up to 15 cm in height and breadth.
Colour	Yellow, beige
Consistency	Friable, rough to the touch
Surface	Spicules project from the surface. Many large exhalent openings on outer surface.
Spicules	Megascleres are styles that can be slightly bent (A) 1128 (834-1397) x 30.8 (22.5-39) µm. Microscleres are sigmas (B) 90.5

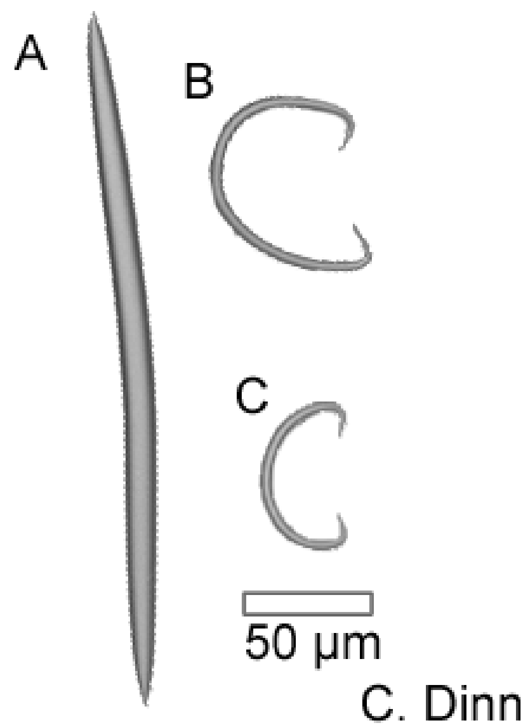
	(78.5-108) µm in length, small sigmas (C) ~18 µm in length N=2, and raphides (D) 55 (33-165) µm in length. Commata were not measured.
Habitat	Encrusting rocks.
Distribution (WPD)	Whole North Atlantic distribution
Remarks	Similar spicule measurements to those in Ackers (1992), though megascleres much smaller in that description (max. 700µm). Two small specimens were dome shaped with large spicule projections. Several synonymized species may indicate that several species are sharing the same taxon. Revision may be necessary.
References	Ackers *et al.* (1992)



Haliclona (Flagellia) porosa (Fristedt, 1887)

Shown whole.

Sample	CMNI 2018-0197
Family	CHALINIDAE
Synonyms	*Desmacella porosa* Fristedt, 1887 *Gellius porosus* (Fristedt, 1887) *Haliclona porosus* (Fristedt, 1887) *Hemigellius porosus* (Fristedt, 1887)
Collection Details	Northern Baffin Bay 76.317° N, -75.770° W, Depth 333 m
Form	Massive, cushion shaped.
Size	2 cm wide by 2 cm tall.
Colour	Buff to white, oscular portion are transparent.
Consistency	Soft.
Surface	The specimen appears to have a thin skin with noticeable openings under the surface. The oscula are large in relation to specimen size.
Spicules	Megascleres are slightly bent oxeas (A) 282 (250-314) x 13.5 (11.3-15.5) µm. Microscleres are flagellosigmas with long ending length (B) ~62 µm, short ending ~49 µm, width ~61 µm, and thickness ~5 µm N=7, and regular sigmas (C) ~61 µm N=1.
Habitat	Unknown.
Distribution (WPD)	Whole North Atlantic and Arctic
Remarks	Fits the description in Van Soest, 2017. Regular sigmas were less common than flagellosigmas, which is typical for the species.
References	Van Soest (2017)



Haliclona (Reniera) sp. 1 Schmidt, 1862

Sample CMNI 2018-0142

Family CHALINIDAE

Synonyms *Haliclona (Reniclona)* De Laubenfels, 1954
Kallypilidion de Laubenfels, 1954
Philotia Gray, 1867
Prianos Gray, 1867
Reniclona de Laubenfels, 1954
Reniera Schmidt, 1862
Toxadocia Laubenfels, 1936

Top: *in situ*. Bottom: pieces on board.

Collection Details Western Greenland shelf (Disko Fan)
67.967° N, -59.484° W, Depth 877 m

Form Flabellate. Very slight transverse ribbing along the plates is noticeable upon close examination.

Size Plates are about 5 cm in breadth.

Colour Bone white *in situ* with noticeable bright white spots. The sponge becomes off-white upon collection. After contact with air the sponge becomes bright pink. This pink colour remains after preservation in ethanol.

Consistency Soft and flexible.

Surface Smooth, covered in noticeable pin-hole apertures.

Skeleton Anisotropic reticulation forming a square-like lattice. This reticulation is mostly formed by unispicular tracts.

Spicules Short, stout oxeas 325 (288-378) x 18.3 (14-24) µm.

Habitat Was found growing on dead *Keratoisis* coral skeleton along with other sponges.

Distribution (WPD) Unknown.

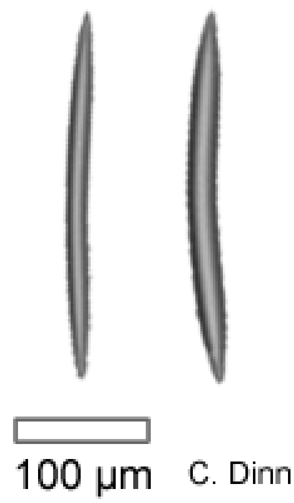
Remarks The peculiar pink colouration after death is distinctive. COI sequences were not of high read quality but suggest the specimen belongs to the genus *Haliclona.* Anisotropic reticulation of oxeas suggests subgenus *Haliclona (Reniera)*. It does not appear to fit any known species descriptions and was only found at this site.

References Ackers *et al.* (1992)

Haliclona (Reniera) sp. 2 Schmidt, 1862

Collected as a piece.

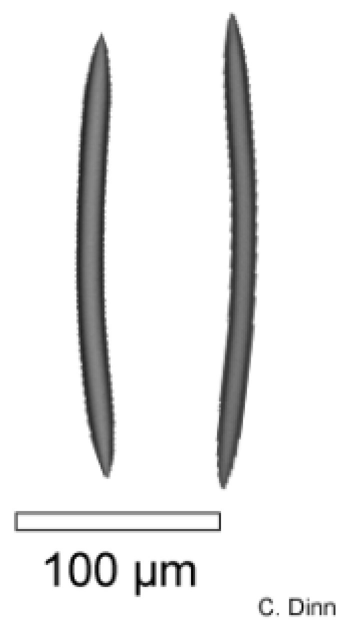
Sample	CMNI 2018-0176
Family	CHALINIDAE
Synonyms	*Haliclona (Reniclona)* De Laubenfels, 1954 *Kallypilidion* de Laubenfels, 1954 *Philotia* Gray, 1867 *Prianos* Gray, 1867 *Reniclona* de Laubenfels, 1954 *Reniera* Schmidt, 1862 *Toxadocia* Laubenfels, 1936
Collection Details	Frobisher Bay 62.953° N, -67.139° W, Depth 402 m
Form	Chimney shaped with an obvious terminal osculum. Tissue appears fibrous and stringy.
Size	4 cm in breadth, true height is unknown as specimen was damaged.
Colour	Yellow.
Consistency	Soft and fibrous.
Surface	Smooth.
Spicules	Oxeas that are short and sharply pointed 280 (243-307) x 23 (15.5-29) µm.
Habitat	Unknown.
Remarks	The spicules and skeleton suggest *Halicona (Reniera)*. COI sequence aligns most closely with *Haliclona (Reniera) cinerea* (Grant, 1826), however the spicules are much longer in this specimen. This specimen was also collected much deeper than is documented for *H. cinera.* Further work is needed to determine the species of this specimen.
References	Ackers *et al.* (1992)



Haliclona (Haliclona) urceolus (Rathke & Vahl, 1806)

Sample	CMNI 2018-0065, CMNI 2018-0139
Family	FAMILY
Synonyms	*Adocia urceolus* (Rathke & Vahl, 1806) *Chalina pulcherrima* Fristedt, 1885 *Haliclona (Haliclona) urceola* (Rathke & Vahl, 1806) *Haliclona clava* (Bowerbank, 1866) *Haliclona clavata* (Levinsen, 1887) *Haliclona pulcherrima* (Fristedt, 1885) *Haliclona urceolus* (Rathe & Vahl, 1806) *Isodictya clava* Bowerbank, 1866 *Polysiphonia mucronalis* Levinsen, 1893 *Reniera clavata* Levinsen, 1887 *Reniera simplex* Hansen, 1885 *Reniera urceolus* (Rathke & Vahl, 1806) *Siphonochalina pulcherrima* (Fristedt, 1885) *Spongia urceola* Rathke & Vahl, 1806 *Spongia urceolus* Rathke & Vahl, 1806
Collection Details	North Labrador Sea (NE Hatton Basin) 61.341° N, -61.1600° W, Depth 562 m western Greenland shelf 67.967° N, -59.484° W, Depth 877 m
Form	Tubular to chimney shaped. A thin flexible stalk attaches the sponge to the substrate.
Size	Less than 10 cm in length.
Colour	Grey to light yellow.
Consistency	Soft and flexible.
Surface	Smooth.
Spicules	North Labrador Sea specimen: Oxeas 235 (206-252) x 12 (10-15) µm Western Greenland shelf specimen: Oxeas 275 (240-308) x 18.4 (12-21) µm
Habitat	Unknown. Attached to hard substrate.
Distribution (WPD)	Whole North Atlantic (only once recorded on the western Greenland shelf)

Top: whole. Bottom: piece with shrimp inside.

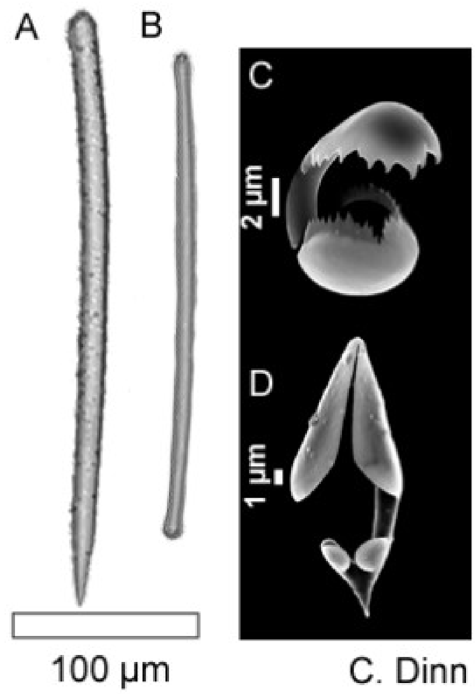


Remarks	Spicules and body form of North Labrador Sea specimen agree with the description in Ackers, 1992. The spicules of the western Greenland shelf specimen are just slightly longer than that in Ackers 1992. The Western Greenland specimen was much thinner and there was no obvious base, though this may have been damaged upon collection. However, there was no osculum on this sponge, and a single amphipod was completely enclosed in the specimen. These sponges may be separate species but are treated as one here.
References	Ackers *et al.* (1992)

Iophon piceum (Vosmaer, 1882)

Sample	CMNI 2018-0177
Family	ACARNIDAE
Synonyms	*Alebion piceum* Vosmaer, 1882 *Esperella picea* (Vosmaer, 1882) *Esperia pattersoni* sensu Fristedt, 1887 *Iophon piceus* (Vosmaer, 1882)
Collection Details	Frobisher Bay 62.819° N, -67.139° W, Depth 507 m
Form	Cup-shaped.
Size	10-20 cm in diameter.
Colour	Black.
Consistency	Firm, stringy.
Surface	Rough due to the lattice form of the spongin fibres.
Spicules	The spicules consist of acanthostyles (A) 320 (275-349) x 16 (12-19) µm, tylotes (B) with spined heads 260 (237-278) x 12 (9-16) µm, spurred anisochelae (C) 18.5 (13-32) µm, and bipocilles (D) with fine teeth 11.8 (8.7-16.5) µm.
Habitat	Unknown substrate in deeper water.
Distribution (WPD)	Arctic Ocean, Faroe Plateau, European Waters, Barents Sea, South and West Iceland, White Sea, West Greenland shelf.
Remarks	This is an easily identified species due to the colour and lattice-like growth form. The general body form is a cup-shape.
References	Lundbeck (1905), Vosmaer (1882)

Shown in pieces.



Iophon cf. *nigricans* (Bowerbank, 1858)

Sample CMNI 2018-0180, CMNI 2018-0166

Family ACARNIDAE

Synonyms *Alebion* Gray, 1867
Burtonella de Laubenfels, 1928
Dendoryx (Iophon) Gray, 1867
Hymedesanisochela Bakus, 1966
Ingallia Gray, 1867
Iophonopsis Dendy, 1924
Iophonota Laubenfels, 1936
Menyllus Gray, 1867
Myxilla (*Pocillon*) Topsent, 1891
Pocillon Topsent, 1891

Collection Details Frobisher Bay
63.640° N, -68.627° W, Depth 141 m
63.639° N, -68.629° W, Depth 95.5 m

Form Finger-like projections.

Size Forms very large bushes *in situ*, up to a metre wide. Individual finger-like projections can be up to 10 cm long.

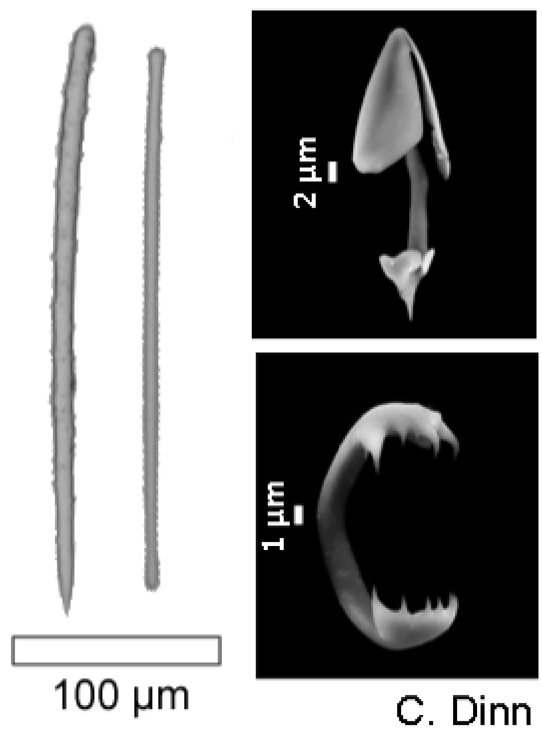
Colour Yellow to tan *in situ*, becomes dark brown on contact with air.

Consistency Firm.

Surface Soft. Furrowed texture. A transparent dermal membrane is seen covering the tissue *in situ*, but this collapses after collection.

Spicules There are two types of megascleres, acanthostyles which are often swollen at the head resembling a spined tylostyle, variably spined, often with long spines on the head, rarely these spicules are thin and elongate 277 (245-308) x 9.7 (8-12) µm, and smooth ectosomal tylotes with swollen microspined heads are 247(199-266) x 7.6(6-9) µm. Microscleres are spurred anisochelae 19 (16.5-22) µm, and large bipocilles with reduced, single, equal-sized alae and elongated teeth. Bipocilles are isochelae-like with long, smooth, arcuate shafts with a bend in the centre of the shaft 15.4 (12.5-19.5) µm.

Top: collected in pieces. Bottom: *in situ.*

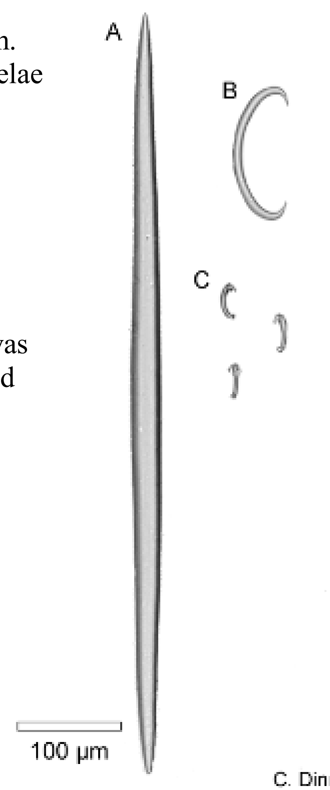


Habitat	Seen only in inner Frobisher Bay on sand or bedrock outcrops.
Distribution (WPD)	European waters
Remarks	This species is most similar to *Iophon nigricans* (Bowerbank 1858) in body form and darkening upon death, but it has much larger bipocilles that are not of the same form and lacks a small ~10 µm size category of anisochelae. The bipocilles are similar to those found in *I. dogieli* Koltun, 1955, but this species has styles rather than acanthostyles.
References	Bowerbank (1866), Koltun (1955)

Cladorhiza oxeata Lundbeck, 1905

Top: *in situ.* Bottom: on-board.

Sample	CMNI 2018-0171, CMNI 2018-0201
Family	CLADORHIZIDAE
Synonyms	*Exaxinata oxeata* (Lundbeck, 1905)
Collection Details	Frobisher Bay 62.953° N, -67.139° W, Depth 402 m Pond Inlet 72.827° N, 77.609° W, Depth 875 m
Form	Branching, erect. The main stem is thick with many side branches.
Size	Variable but often large, can be over 30 cm tall.
Colour	White to pinkish. The stem is darker than the branches.
Consistency	Hard. Stem is particularly hard and requires a very sharp razor blade to cut.
Surface	Filamentous along the branches.
Spicules	Megascleres are oxeas, rarely styles (A) 707 (617-765) x 29 (16-36) µm. Microscleres are sigmas (B) 131.5 (112-144) µm in length and anisochelae (C) 35.5 (30.5-41) µm in length.
Habitat	Soft sediments
Distribution (WPD)	Baffin Bay, Davis Strait, European Waters, Barents Sea, South and West Iceland.
Remarks	Easily identified by the presence of oxeas. Specimen from Pond Inlet was collected by ROV and had *Themisto abyssorum* amphipods attached and partially digested on the terminal branches. This specimen is like that described by Hestetun e*t al.* (2017) in not having sigmancistras.
References	Hestetun *et al.* (2017)



Lycopodina lycopodium (Levinsen, 1887)

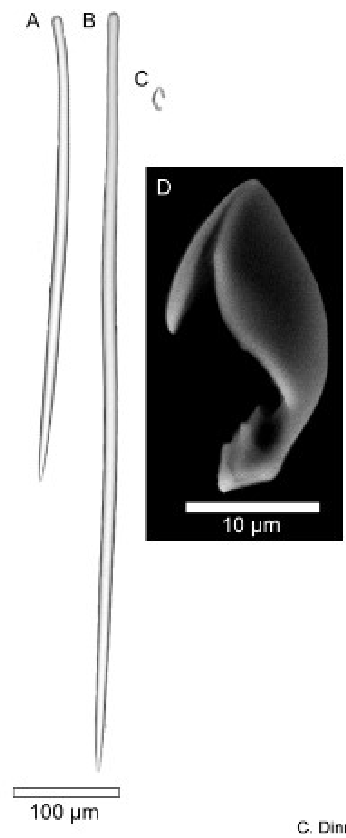
Shown whole.

Sample	CMNI 2018-0139
Family	CLADORHIZIDAE
Synonyms	Asbestopluma (*Asbestopluma*) *lycopodium* (Levinsen, 1887) *Asbestopluma* (*Lycopodina*) *lycopodium* (Levinsen, 1887) *Esperella cupressiformis* var. *lycopodium* Levinsen, 1887 *Esperella lycopodium* Levinsen, 1887
Collection Details	Frobisher Bay 62.979° N, -67.272° W, Depth 443 m
Form	Pinnate. Peduncle attaches to substrate.
Size	Minute, < 2 cm tall and 1 mm wide.
Colour	White
Consistency	Stiff.
Surface	Hispid.
Spicules	Megascleres are styles/mycalostyles that are highly variable in size 1093 (640.5-1443) x 15 (12-21) µm. Microscleres are palmate anisochelae 11.3 (9-13.5) µm long. See Hestetun *et al.,* 2017 for spicule images.
Habitat	Rocky bottoms, attached to a large rock.
Distribution (WPD)	Amphi-Atlantic, Northern Russian waters.
Remarks	Fits the description provided for this specimen by Hestutun *et al.* (2017). Although small styles were not seen in this specimen, those spicules may occur in a portion that was not examined due to the size of the specimen. Forceps spicules are absent but are noted as only being associated with spermatic cysts (Riesgo *et al.,* 2007), and spermatic cysts were not found in this specimen. Found with *L. cupressiformis,* though the external morphology is distinctive.
References	Hestetun *et al.* (2017), Riesgo *et al.* (2007).

Lycopodina cupressiformis (Carter, 1874)

Shown whole.

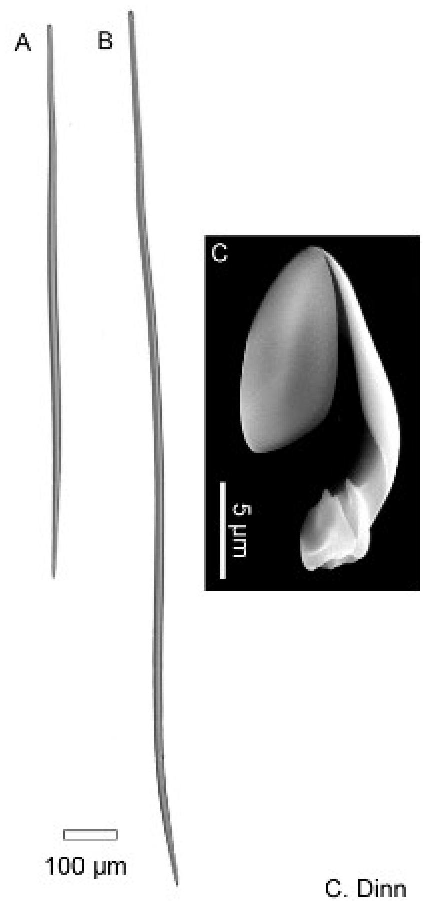
Sample	CMNI 2018-0061
Family	CLADORHIZIDAE
Synonyms	*Asbestopluma (Asbestopluma) cupressiformis* (Carter, 1874) *Asbestopluma (Lycopodina) cupressiformis* (Carter, 1874) *Cladorhiza cupressiformis* (Carter, 1874) *Esperella cupressiformis* (Carter, 1874) *Esperia cupressiformis* Carter, 1874
Collection Details	Frobisher Bay 62.979° N, -67.272° W, Depth 443 m
Form	Pedunculate with small knobby projections along the body.
Size	3 cm tall and about 3-4 mm wide.
Colour	Pinkish white.
Consistency	Soft and fleshy.
Surface	Smooth along the body and shaft.
Spicules	Megascleres are styles/mycalostyles that range in size, the smaller of which are (A) 413 (293-540) x 11 (7.8-15) µm, and the larger are (B) 689 (585-772) x 14 (11.3-17) µm. These were not split into two size categories by Hestetun (2017) but are rather described as being highly variable. Microscleres are palmate anisochelae (C, D) 22 (19-25) µm in length.
Habitat	Rocky bottoms, attached to a large rock.
Distribution (WPD)	Amphi-Atlantic and the Kara Sea/Northern Russia.
Remarks	Fits the description given in Hestutun *et al.* (2017). Forceps spicules are absent but are noted as only being associated with spermatic cysts (Riesgo *et al.,* 2007). Found with *L. lycopodium,* although the external morphology between these species are distinctive.
References	Hestetun *et al.* (2017), Riesgo *et al.* (2007).



Lycopodina sp. 1 Lundbeck, 1905

Sample	CMNI 2018-0157
Family	CLADORHIZIDAE
Synonyms	*Asbestopluma (Lycopodina)* Lundbeck, 1905
Collection Details	Baffin Bay 68.259° N, -59.823° W, Depth 1148 m
Form	Pinnate.
Size	Less than 10 cm long and 5 mm thick
Colour	Beige to brown.
Consistency	Bristly, somewhat stiff.
Surface	Moderately hispid
Spicules	Megascleres are mycalostyles I (A) 972 (719-1293) x 19 (12-25) µm, mycalostyles II are long and veriform (B) 1934 (1525-2322) x 21 (13-27) µm. Microscleres are palmate anisochelae 9C) 17 (11-21) µm. No forceps spicules were seen.
Habitat	Unknown.
Distribution (WPD)	Unknown.
Remarks	Since the mycalostyles were longer than 1500 µm, this species could be *L. tendali* (Hestetun, 2017), however small tylostyles and forceps spicules were not seen in this specimen. Therefore, the assignment to species is not certain.
References	Hestetun *et al.* (2017).

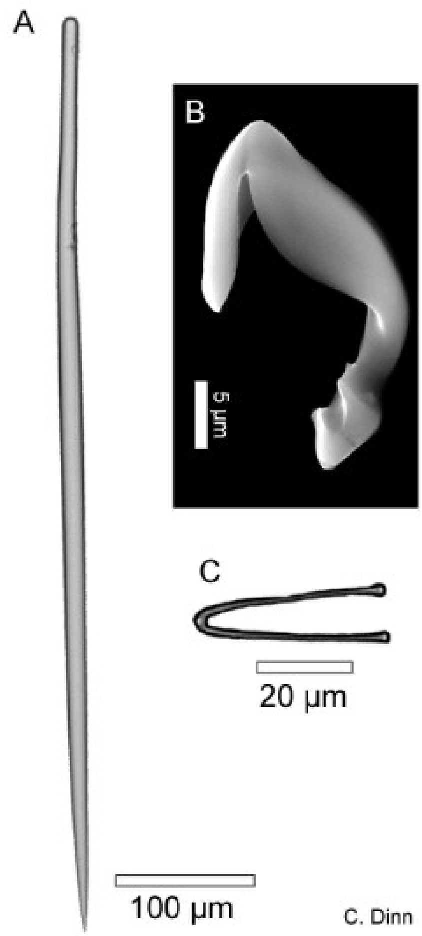
Shown whole.



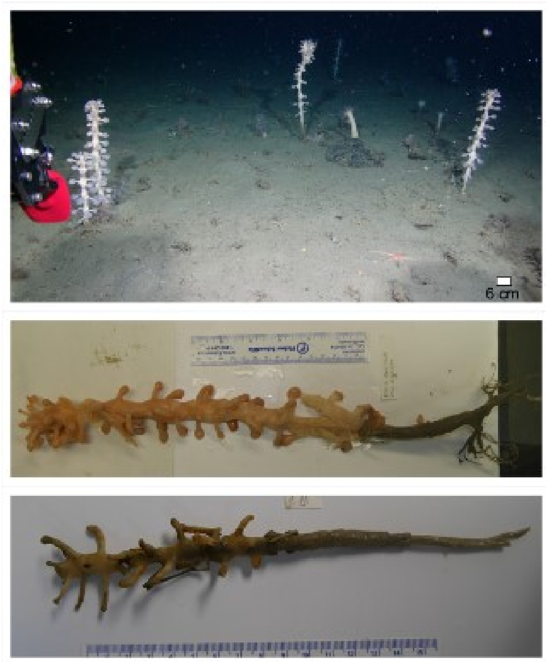
Lycopodina sp. 2 Lundbeck, 1905

Collected as a piece.

Sample	CMNI 2018-0161
Family	CLADORHIZIDAE
Synonyms	*Asbestopluma (Lycopodina)* Lundbeck, 1905
Collection Details	Baffin Bay 68.259° N, -59.823° W, Depth 1148 m
Form	Potentially pedunculate. Specimen was damaged.
Size	Approximately 10 cm long.
Colour	Beige to brown.
Consistency	Firm and stiff.
Surface	Silt covered and rough.
Spicules	Megascleres are mycalostyles with some modified to strongyles (A) 734 (643-810) x 17 (13-20) µm. Microscleres are palmate anisochelae (B) 25 (22-28) µm in length, and forceps (C) ~38 µm N=4.
Habitat	Unknown.
Distribution (WPD)	Unknown.
Remarks	Body form and spicules do not fit descriptions of other North Atlantic *Lycopodina* species. Since forceps spicules were found, this strongly suggests assignment to this genus.
References	(Hestetun *et al.*, 2017).



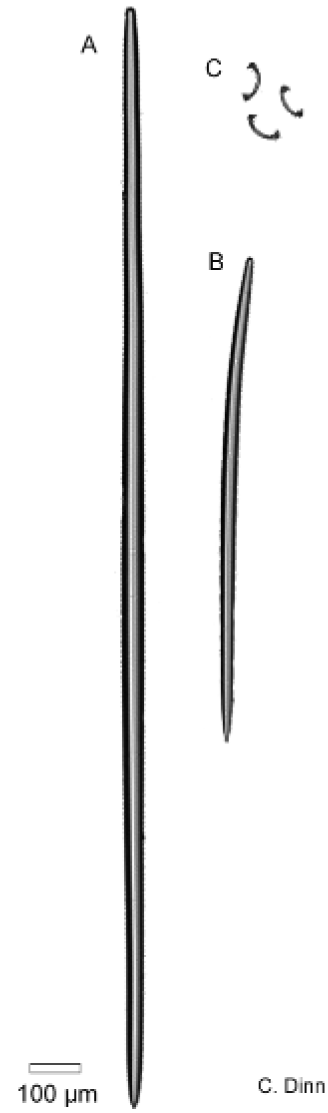
Chondrocladia (Chondrocladia) grandis (Verrill, 1879)



Top: *in situ.* Middle/bottom: whole on-board.

Sample	CMNI 2018-0209, CMNI 2018-0210, CMNI 2018-0211
Family	CLADORHIZIDAE
Synonyms	*Chondrocladia (Chondrocladia) arctica* (Hansen, 1885) *Chondrocladia (Chondrocladia) gigantea* (Hansen, 1885) *Chondrocladia (Chondrocladia) nucleus* (Hansen, 1885) *Chondrocladia gigantea* (Hansen, 1885)· *Chondrocladia grandis* (Verrill, 1879)· *Chondrocladia nucleus* (Hansen, 1885) *Cladorhiza grandis* Verrill, 1879 *Cladorhiza nobilis* Fristedt, 1887 *Desmacidon arctica* Hansen, 1885 *Desmacidon clavatum* Hansen, 1885 *Desmacidon giganteum* Hansen, 1885 *Desmacidon nucleus* Hansen, 1885
Collection Details	Pond Inlet 72.836° N, -77.594° W, Depth 416 m Lancaster Sound 74.276° N, -83.364° W, Depth 719 m
Form	Pedunculate with large fleshy lobed projections. Has large basal root portion to anchor the sponge into soft sediments.
Size	Can be >30 cm tall
Colour	Beige to pink.
Consistency	Firm, slightly flexible.
Surface	Rough, spicules from the surface can shed easily.
Spicules	Megascleres are mycalostyles in two size categories. Mycalostyles I (A) are 2009 (1644-2229) x 45-40-49) µm N =8, Mycalostyles II (B) are 895 (692-1118) x 25 (20-30) µm. Microscleres are anchorate isochelae (C) 68 (60-74) µm in length. Very few small sigmancistras were seen but not measured.
Habitat	Sandy substrates.
Distribution (WPD)	Amphi-Atlantic
Remarks	This specimen fits the description of the outer morphology of *C. grandis* in Hestetun *et al.* (2017).

Megascleres and anchorate isochelae fit the description, but smaller anchorate isochelae (~21µm) were not seen, though in Hestutun *et al.,* (2017) these spicules are noted as not being as common. These spicules may be localized in different portions of the sponge that were not dissolved. This sponge was only seen in soft sediments and is one of the two species of sponge found in Lancaster Sound, where it lives amongst fields of *Umbellula* sea pens.

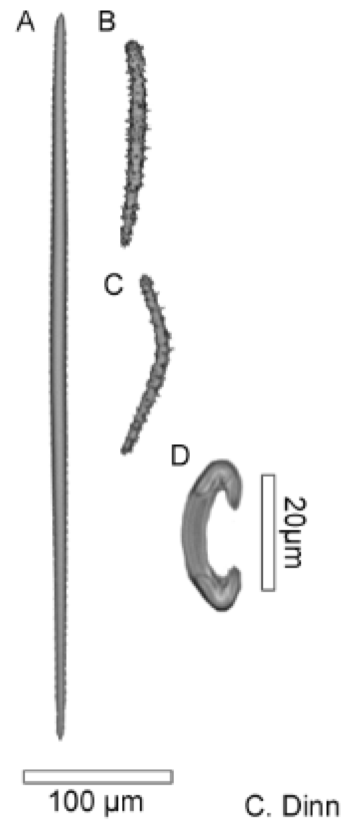


References Hestetun *et al.* (2017)

Crella (Yvesia) pyrula (Carter, 1876)

Shown whole.

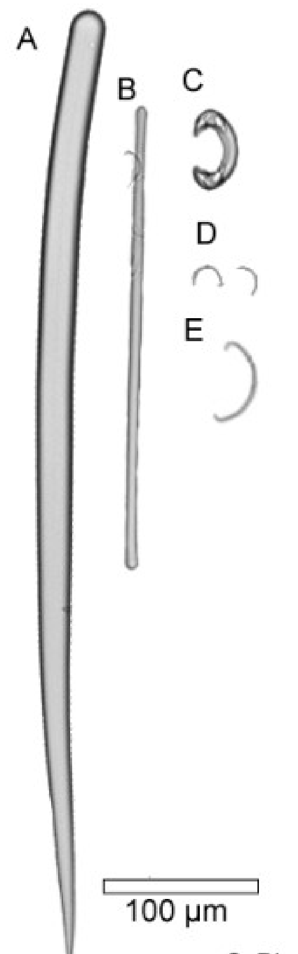
Sample	CMNI 2018-0149
Family	CRELLIDAE
Synonyms	*Cometella pyrula* Carter, 1876 *Crella lobata* (Arnesen, 1903) *Crella pedunculata* (Topsent, 1890) *Crella pyrula* (Carter, 1876) *Grayella pyrula* (Carter, 1876) *Reniera membranacea* Hansen, 1885 *Sclerilla arctica* Hansen, 1885 *Sclerilla dura* Hansen, 1885 *Yvesia lobata* Arnesen, 1903 *Yvesia pedunculata* Topsent, 1890 *Yvesia pyrula* (Carter, 1876) *Yvesiella pyrula* (Carter, 1876)
Collection Details	Western Greenland shelf 67.967° N, -59.484° W, Depth 877 m
Form	Stalked. The distal portion was mostly dislodged after collection.
Size	9 cm long.
Colour	Yellow.
Consistency	Firm.
Surface	Smooth.
Spicules	The megascleres are long, smooth tornotes (A) 440 (394-485) x 11.7 (10-13) µm, and entirely spined acanthostyles (B, C) 140 (115-190) x 12 (8-18) µm. Microscleres are isochelae (D) 23 (18-28) µm in length N=27.
Habitat	Found growing on *Keratoisis* coral skeletons.
Distribution (WPD)	Amphi-Atlantic.
Remarks	Arndt (1935) suggests that the form can have a more lobate body with many porefields. This specimen was small however, thus the lobed form may be more indicative of older sponges. Porefields were not obvious in this specimen. Boury-Esnault *et al.,* (1994) state that the inhalant pores form sieves, but this was not seen in this specimen either.
References	Arndt (1935), Boury-Esnault *et al.* (1994).



Lissodendoryx (Lissodendoryx) complicata (Hansen, 1885)

Shown whole.

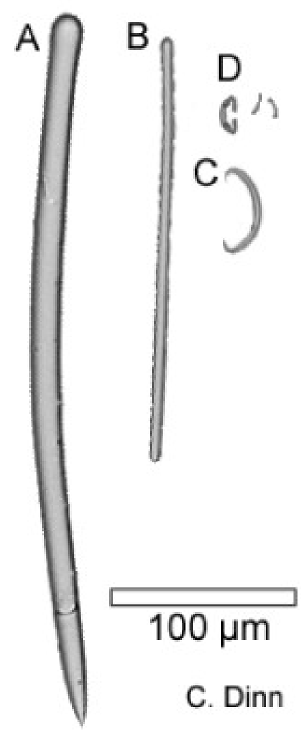
Sample	CMNI 2018-0140
Family	COELOSPHAERIDAE
Synonyms	*Clathria corallorhizoides* Fristedt, 1887 *Lissodendoryx complicata* (Hansen, 1885) *Lissodendoryx corallorhizoides* (Fristedt, 1887) *Reniera complicata* Hansen, 1885
Collection Details	western Greenland shelf 67.967° N, -59.484° W, Depth 877 m
Form	Compressed branches that arise from a single basal stalk.
Size	Branches are about 5 cm long.
Colour	Yellow to beige.
Consistency	Flexible.
Surface	Slightly hispid, with small depressions.
Spicules	Megascleres are large, smooth, slightly bent styles (A) 581 (515-686) x 24 (18-28) µm, and smooth tylotes (B) 289 (233-363) 6 (3.5-8.6) µm. Smooth strongyles were uncommon 279 (120-397) x 33 (27-46) µm N=6. Microscleres are isochelae (C) 49 (41-56) µm in length, small sigmas (D) 19 (15-23.5) µm in length, and uncommon large sigmas (E) 50 (45-57) µm in length N=4.
Habitat	Found growing amongst dead *Keratoisis* coral skeletons.
Distribution (WPD)	Amphi-Atlantic as well as Northern Russia.
Remarks	The specimen was very small. This species can grow in large bushes and have an elaborately branched form.
References	Boury-Esnault *et al.* (1982), Tompkins *et al.* (2017).



Lissodendoryx (Lissodendoryx) indistincta (Fristedt, 1887)

Top: whole. Bottom: in pieces.

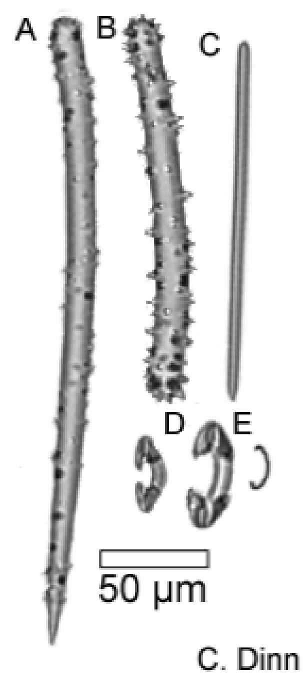
Sample	CMNI 2018-0182, CMNI 2018-0192
Family	COELOSPHAERIDAE
Synonyms	*Ectyodoryx indistincta* (Fristedt, 1887) *Hastatus indistincta* Fristedt, 1887 *Hastatus indistinctus* Fristedt, 1887 *Lissodendoryx indistincta* (Fristedt, 1887) *Zetekopsis indistinctus* (Fristedt, 1887)
Collection Details	Frobisher Bay 63.639° N, -68.627° W, Depth 141 m 62.868° N, -66.746° W, Depth 288 m
Form	Massive, lobed, many large oscula.
Size	10 cm by 10 cm but could grow larger as only fragments were collected.
Colour	Yellow to brown.
Consistency	Soft, slimy.
Surface	Has many depressions. Large oscula are present at the distal portions but collapse after collection.
Spicules	Megascleres are large and smooth styles (A) 338 (341-412) x 15 (8.5-19.5) 230 µm, tornotes (B) are 229 (201-249) x 7.7 (5.7-9.6) µm. Microscleres are sigmas (C) 44 (38-52) µm in length, large isochelae are in two size categories, the larger (D) are 24 (19-38) µm in length, and the smaller are 11.6 (9-16) µm in length.
Habitat	Unknown.
Distribution (WPD)	Amphi-Atlantic.
Remarks	Fits the description in Tompkins *et al*., (2017).
References	(Tompkins *et al.*, 2017).



Lissodendoryx (Lissodendoryx) lundbecki Topsent, 1913

Top: *in situ*. Bottom: collected as a piece.

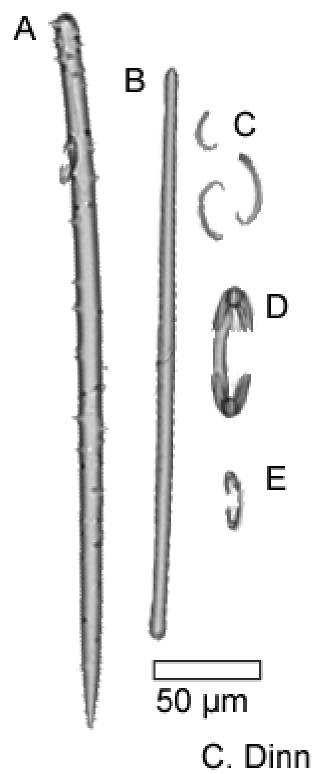
Sample	CMNI 2018-0207
Family	COELOSPHAERIDAE
Synonyms	*Lissodendoryx lundbecki* Topsent, 1913
Collection Details	Pond Inlet 72.832° N, -77.602° W, Depth 767 m
Form	Branching, multilobate.
Size	Small, only a fragment was collected 3 x 3 cm.
Colour	Beige to light grey.
Consistency	Soft but incompressible.
Surface	The surface is covered in many depressions and is slightly hispid.
Spicules	The megascleres are acanthostyles (A) 297 (265-320) x 15.4 (13-17) µm, acanthostrongyles (B) 207 (186-229) x 19 (15-24) µm N = 18, and tornotes (C) 190 (156-208) x 7.5 (5-9.5) µm N=21. Microscleres are isochelae in two size categories (D) 51 (30-63) µm and 28 (22-40) µm in length, and sigmas (E) that are 25 (21-29.5) µm in length N =27.
Habitat	This sponge was found growing on a sandy bottom.
Distribution (WPD)	NW Atlantic and Arctic, Northern Russia, Alboran Sea, Northern Norway and Finnmark.
Remarks	Branches may arise from a more leaf-shaped base as described by Tompkins *et al.* (2017). Acanthostyles are sometimes modified into acanthostrongyles, which were not described previously, however the presence of two categories of anisochelae and only one size category of sigma, as well as the outer morphology do appear to fit the description of *L. lundbecki.*
References	Tompkins *et al.* (2017).



Lissodendoryx sp. Topsent, 1892

Collected as a piece.

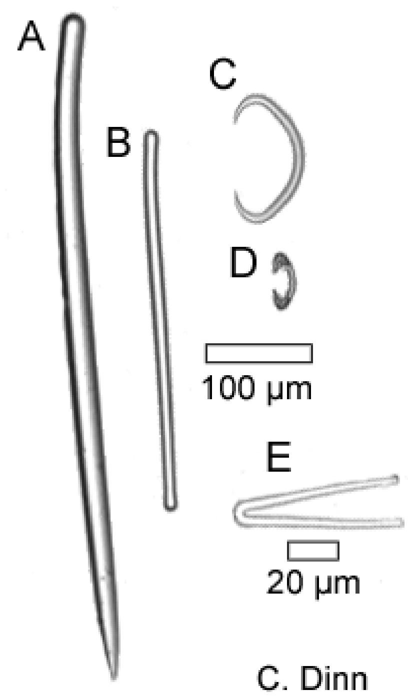
Sample	CMNI 2018-0186
Family	COELOSPHAERIDAE
Collection Details	Frobisher Bay 63.639° N, -68.627° W, Depth 141 m
Form	Bundles of spongin radiating outwards from the point of attachment.
Size	Specimen is about 6 cm in breadth, though may be a portion of a larger sponge.
Colour	Brown.
Consistency	Soft, fibrous.
Surface	Has a thin translucent membrane covering fibourous tracts.
Spicules	Megascleres are acanthostyles (A) 325 (237-387) x 12 (7-14) µm, and tylotes (B) 275 (245-361) x 8 (6-11) µm. Microscleres are sigmas in two sizes (C) 67 (39-77) µm and 27 (20-34) µm in length, and isochelae in two sizes 64 (55-71) µm (D) and 27 (17-29) µm (E) in length.
Habitat	Unknown.
Distribution (from Tompkins *et al.* 2017)	Northern Hudson Strait/Ungava Bay.
Remarks	Fits the description of a similar sponge described in Tompkins *et al.* (2017) where tylotes and acanthostyles are distinctive characteristics though was not formally described as a species. This sponge was found with mollusc eggs embedded in the tissue.
References	Tompkins *et al.* (2017)



Forcepia (Forcepia) fabricans (Schmidt, 1874)

Shown whole.

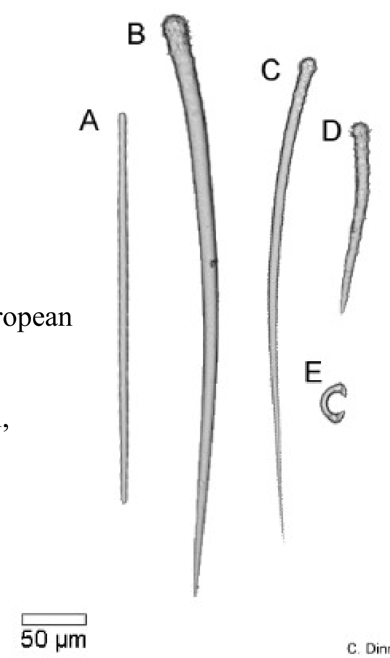
Sample	CMNI 2018-0174
Family	COELOSPHAERIDAE
Synonyms	*Esperia fabricans* Schmidt, 1874 *Forcepia fabricans* (Schmidt, 1874) *Forcipina bulbosa* Vosmaer, 1885 *Hamigera (Forcipina) fabricans* (Schmidt, 1874)
Collection Details	Frobisher Bay 62.954° N, -67.139° W, Depth 402 m
Form	Cushion shaped.
Size	About 6 cm in diameter.
Colour	Yellow.
Consistency	Firm. Thick mucous.
Surface	Several large oscula (<5mm) on the upper portion. Very small papillae are noticeable on the upper portion.
Spicules	Megascleres are styles (A) 610 (544-667) x 25 (22-29) µm, and tylotes (B) 367 (312-408) x 14 (11-18) µm. Microscleres are sigmas (C) 239 (111-158) µm in length, isochelae (D) 48 (40-54) µm in length, and forceps (E) with a length of ~53 µm and width at the top of the arch of ~3.8µm. Smaller forceps were present, but not common.
Habitat	Rocky bottoms.
Distribution (WPD)	Amphi-Atlantic.
Remarks	Fits the description in Tompkins *et al.* (2017), though is more yellow in colour.
References	Tompkins *et al.* (2017).



Hymedesmia (Hymedesmia) paupertas (Bowerbank, 1866)

Top: *in situ*. Bottom: collected in pieces.

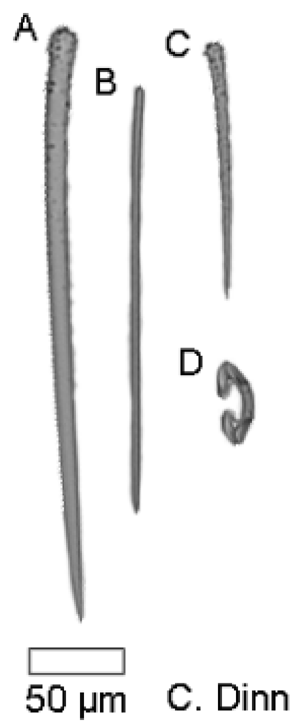
Sample	CMNI 2018-0086
Family	HYMEDESMIIDAE
Synonyms	*Anchinoe paupertas* (Bowerbank, 1866) *Ectyodoryx paupertas* (Bowerbank, 1866) *Hymedesmia paupertas* (Bowerbank, 1866) *Hymeniacidon paupertas* Bowerbank, 1866 *Myxilla paupertas* (Bowerbank, 1866)
Collection Details	North Labrador Sea 60.315° N, -61.880° W, Depth 286 m
Form	Encrusting, very small.
Size	~5mm, but was seen to encrust large portions of boulders in ROV video.
Colour	Blue to greenish.
Consistency	Firm.
Surface	See Ackers, 1992.
Spicules	Megascleres are tornotes (A) 310 (282-342) x 8.3 (6.3-10.7), long acanthostyles (B, C) (less common) 453 (403-558) x 14.8 (7.5-18.5) µm N = 6, short acanthostyles are fully spined (D) 171 (152-190) x 11 (7.5-14.1) µm. Microscleres are isochelae (E) 35 (32.7-38.2) µm N = 7.
Habitat	Rocky bottom. Was collected encrusting on a rock.
Distribution (WPD)	Azores, Cape Verde, Celtic Seas, European Waters, South European Atlantic shelf
Remarks	Fits the description in Ackers, 1992. Specimen was very small, therefore few spicules could be measured.
References	Ackers *et al.* (1992)



Hymedesmia sp. Bowerbank, 1864

Sample	CMNI 2018-0193
Family	HYMEDESMIIDAE
Collection Details	Frobisher Bay 62.868° N, -66.746° W, Depth 288 m
Form	Massive, lobate, and slightly branching.
Size	Individuals are about 4 cm in breadth and up to 3 cm in height.
Colour	Beige to yellow.
Consistency	Soft.
Surface	Pore fields cover the outer surfaces.
Spicules	Megascleres are acanthostyles in two sizes 292 (248-325) x 12.6 (9-17) µm, and 131 (97-156) x 8.3 (6-10.7) µm, and tornotes with one end thicker than the other 214 (186-247) x 5.8 (4.3-8) µm. Microscleres are isochelae 39 (28.5-51) µm.
Habitat	Unknown.
Distribution (WPD)	Unknown.
Remarks	Since *Hymedesmia* and *Phorbas* share similar spicule characters, this sponge may actually be *Phorbas* sp.
References	Hooper and Van Soest (2002)

Collected in pieces.



Phorbas sp. Duchassaing & Michelotti, 1864

Shown whole.

Sample — CMNI 2018-0131

Family — HYMEDESMIIDAE

Synonyms —
Anchinoe Gray, 1867
Bipocillopsis Koltun, 1964
Clathrissa Lendenfeld, 1888
Grayax Laubenfels, 1936
Lissopocillon Ferrer-Hernandez, 1916
Merriamium Laubenfels, 1936
Plumohalichondria Carter, 1876
Podotuberculum Bakus, 1966
Pronax sensu Gray, 1867: 536
Pronaxella Burton, 1931
Stylostichon Topsent, 1892
Suberotelites Schmidt, 1868

Collection Details — North Labrador Sea (SE Baffin shelf)
63.004° N, -60.642° W, Depth 457 m

Form — Thickly encrusting. Collected growin on gastropod shell.

Size — About 10 cm long, over 1 cm thick in portions.

Colour — Yellow

Consistency — Firm.

Surface — Irregular, with many ridges and folds.

Skeleton — Tornotes are more common at the surface, often perpendicular to it but generally scattered. The chelae are concentrated at the surface, with stigmata found throughout the choanosome. The acanthostyles form plumose bundles and are echinated by smaller acanthostyles.

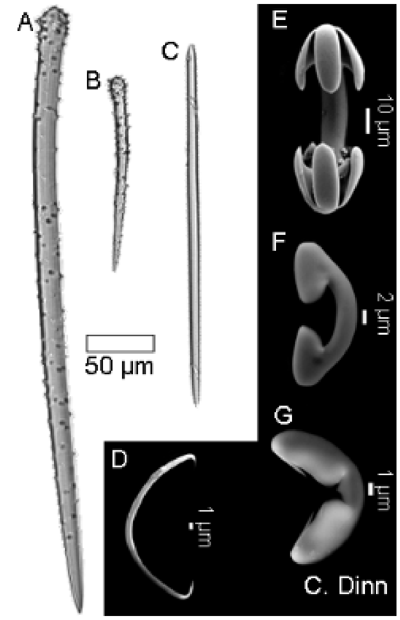
Spicules — Megascleres are acanthostyles 405 (357-470) µm x 19 (16-25) µm, echinating entirely spined acanthostyles are 149 (110-249) x 12 (8-14) µm, and smooth tornotes 265 (231-467) µm. Microscleres are sigmas 48 (28-76) µm in length, and arcuate isochelae in three size categories 55 (24-74) µm, 27 (18-42) µm, and 13 (10.5-20) µm. The smallest isochelae have a very short shaft.

Habitat — Rocky bottoms. Found encrusting a gastropod shell.

Distribution — Unknown.

(WPD)

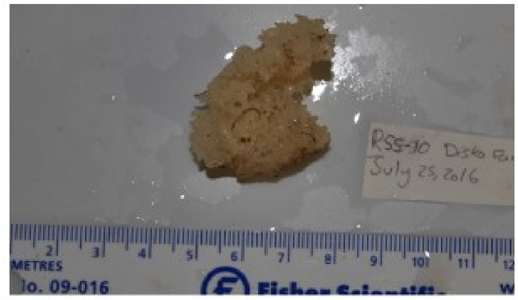
Remarks — This species is most similar to the three Phorbas species described with sigmas, *P. dives, P. bihamiger,* and *P. microchelifer,* however it has a third category of isochelae. The largest isochelae in this specimen are almost twice the size of the largest isochelae in these known species.
The described species are noted as living in shallow water, whereas this specimen was found in deep water. The skeleton with echinating acanthostyles within plumose bundles assures the placement in the genus *Phorbas.*



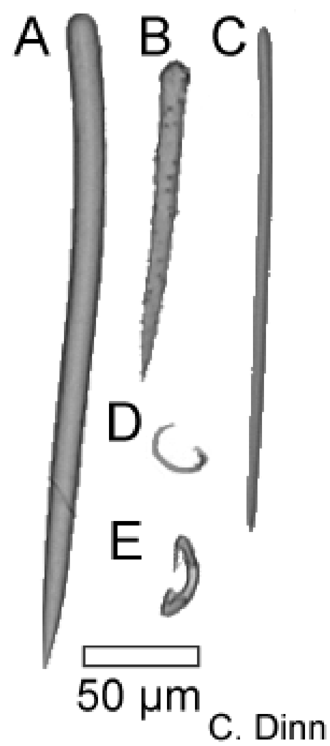
References — Ackers *et al.* (1992), Hooper and Van Soest (2002), Waller (1878)

Phorbas microchelifer (Cabioch, 1968)

Sample	CMNI 2018-0138
Family	HYMEDESMIIDAE
Synonyms	*Pronax microchelifer* (Cabioch, 1968) *Stylostichon microcheliferum* Cabioch, 1968
Collection Details	Western Greenland shelf (Disko Fan) 67.967° N, -59.485° W, Depth 878 m
Form	Likely massively encrusting. Found growing on dead *Keratoisis* coral skeletons.
Size	A portion about 3 cm wide was collected.
Colour	Off-white
Consistency	Soft, friable.
Surface	Irregular. Pore fields are not consistent along the body.
Spicules	Megascleres are very faintly spined acanthostyles (A) 288 (245-315) x 14 (11-16) µm, echinating acanthostyles (B) are entirely spined and are less common 151 (136-181) x 9.6 (5-12) µm N = 11, and tornotes (C) 199 (134-222) x 703 (5.7-10.7) µm. Microscleres are sigmas (D) 26.6 (22-31) µm in length, and arcuate isochelae (E) 36 (27-50) µm in length.
Habitat	Was found growing on dead *Keratoisis* coral skeleton.
Distribution (WPD)	European waters.
Remarks	This specimen was collected growing on dead coral skeleton, and there was a crinoid attached to the sponge, therefore only a portion was collected. The size of the lightly spined acanthostyles, echinating acanthostyles, tornotes, and stigmata fit the original description. The size of the arcuate isochelae are larger in this specimen, however. The spines on the acanthostyles in this specimen are much more finely spined and most appear to be styles.



Collected as a piece held by a crinoid.



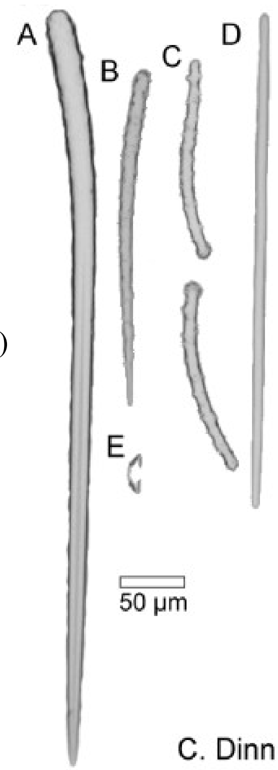
The species is known from shallow water ~ 30 m, however this specimen was found in very deep water on the Western Greenland shelf. Further DNA work on the genus is required to distinguish it from sigma bearing *Phorbas* species.

References Cabioch (1968)

Plocamionida ambigua (Bowerbank, 1866)

Shown whole.

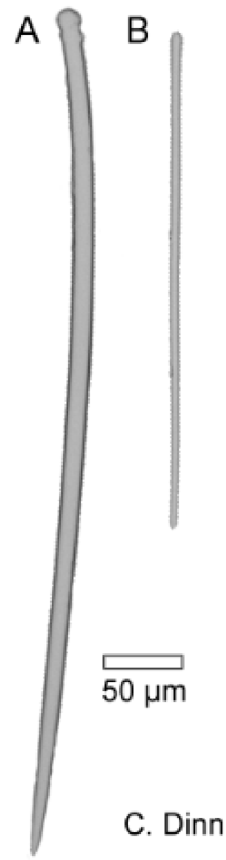
Sample	CMNI 2018-0090
Family	HYMEDESMIIDAE
Synonyms	*Antho lundbecki* (Breitfuss, 1912) *Hastatus ambiguus* (Bowerbank, 1866) *Hymedesmia indistincta* Bowerbank, 1874 *Microciona ambigua* Bowerbank, 1866 *Myxilla lundbecki* Breitfuss, 1912 *Placomia ambigua* (Bowerbank, 1866) *Plocamia ambigua* (Bowerbank, 1866) *Plocamia lundbecki* (Breitfuss, 1912)
Collection Details	Northern Labrador Sea (Saglek Bank) 60.313° N, -61.880° W, Depth 279 m
Form	Encrusting.
Size	Very thinly encrusting but covered a 10 cm wide portion of rock.
Colour	Pink.
Consistency	Appears soft, slightly hispid.
Surface	Mostly even, but portions are lumpy after collection.
Spicules	Megascleres are acanthostyles in two size categories (A) 706 (524-923) x 24 (19-31) µm N =15, and (B) 297 (168-481) x 13.7 (9-22.5) µm, acanthostrongyles (C) that are entirely spined 144 (123-160) x 10.6 (6-12.5) µm, and tornotes (D) 352 (289 -595) x 8.5 (6.5-10.6) µm. Microscleres are palmate isochelae (E) 30.6 (27-36) µm long.
Habitat	Encrusting on rocks.
Distribution (WPD)	Amphi-Atlantic.
Remarks	Descriptions of this species show high variability of spicule sizes. However, the spicule complement, colour, and habit of the sponge are similar to the description in Ackers *et al.* (1992)
References	Ackers *et al.* (1992)



Plocamionida sp. Topsent, 1927

Shown whole.

Sample	CMNI 2018-0088
Family	HYMEDESMIIDAE
Synonyms	*Hymendectyon* Bakus, 1966
Collection Details	Northern Labrador Sea (Saglek Bank) 60.313° N, -61.880° W, Depth 279 m
Form	Encrusting, irregular.
Size	1 x 1 cm.
Colour	Yellow.
Consistency	Slightly hispid.
Surface	Irregular.
Spicules	Megascleres are styles (A) with a faintly spined head that may be tylote 508 (446-567) x 11.5 (8.7-13) µm and inequiended tornotes (B) 314 (279-339) x 6.6 (4.8-7.8) µm. Microscleres were not seen in spicule preparations though outer surface of sponge may have been lost upon collection.
Habitat	Encrusting on rocks.
Distribution (WPD)	Unknown.
Remarks	The lack of microscleres casts doubt on the identification of this specimen, however, COI sequences suggest the genus. This sponge was growing sympatrically with *P. ambigua*, though the colour and form of the sponge is clearly different from that species.
References	Hooper and Van Soest (2002)

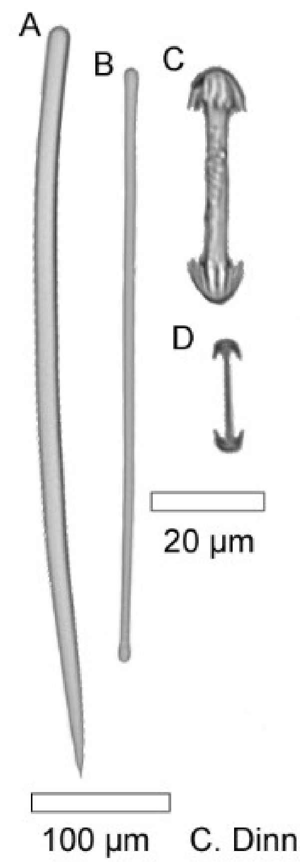


Iotroata affinis (Lundbeck, 1905)

Top: arrow shows specimen *in situ.*

Bottom: shown whole.

Sample	CMNI 2018-0147, CMNI 2018-0151
Family	IOTROCHOTIDAE
Synonyms	*Iotrochota affinis* Lundbeck, 1905
Collection Details	Western Greenland shelf (Disko Fan) 67.967° N, -59.484° W, Depth 877 m
Form	Massive.
Size	About 10 cm wide.
Colour	Buff to beige.
Consistency	Smooth, slippery.
Surface	Smooth appearance.
Spicules	Megascleres are styles, often curved and sometimes flexus (A) 544 (503-603) x15.5 (13-19.5) µm, tylotes (B) 389 (325 -441) x 7.7 (6-9.8) µm, and uncommon thick strongyles 362 (326-399) x 20 (17-22.5) µm N = 3. Microscleres are birotulae in two size categories 43 (34-52) µm in length (C), and 1.95 (16.5-24) µm in length (D).
Habitat	The sponge was found growing on dead coral skeleton. *Haliclona (Reniera)* sp. *1* was found growing inside the osculum of one specimen.
Distribution (WPD)	East Greenland shelf.
Remarks	Lundbeck (1905) suggests there are three species of *Iotroata* (previously *Iotrochota*) with two size categories of birotulae. This specimen does not have acanthostyles, and therefore does not fit the description of *I. spinosa*, and the large birotules in this specimen are much larger than those in *I. polydentata.* This therefore strongly suggests that this specimen is *I. affinis*. The uncommon strongyles may just be ill-formed styles, but are noticeably thicker than any measured styli, therefore they may have been missed in previous descriptions, or may simply be a spicule variation on the Western Greenland shelf compared to the type specimen which was collected in the east.



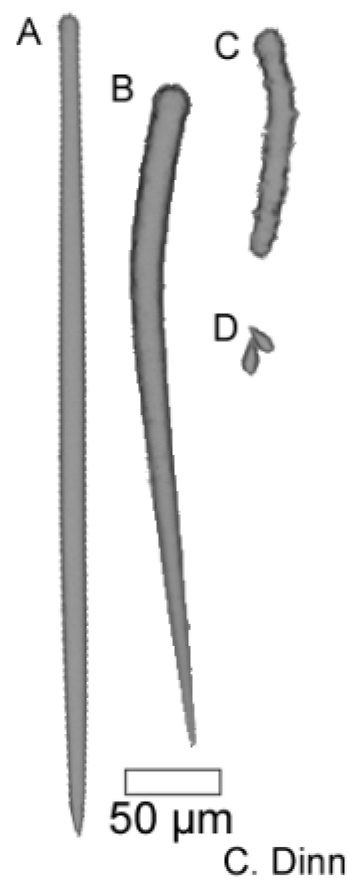
Lundbeck (1905) considered the number of teeth on the birotulae to be a diagnostic character, and there appear to be 12 or more teeth on the larger size, but the teeth on the smaller size spicules were not easily counted.

References (Lundbeck, 1905)

Antho (Acarnia) signata (Topsent, 1904)

Shown whole.

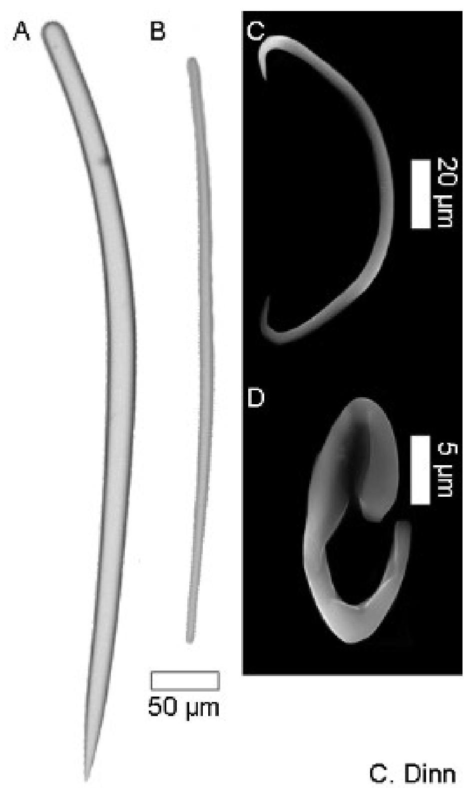
Sample	CMNI 2018-0079
Family	MICROCIONIDAE Subfamily OPHLITASPONGIINAE
Collection Details	Northern Labrador Sea (NE Hatton Basin) 61.489° N, -60.839° W, Depth 615 m
Form	Encrusting.
Size	2 cm wide crust.
Colour	Off-white.
Consistency	Hard.
Surface	Hispid.
Spicules	Megascleres are styles, uncommonly very long 1081 (691-1472) x 26 µm N = 2, and most commonly smooth with microspined heads 402 (355-446) x 14.7 (12-18) µm, acanthostyles are fully spined and are 357 (273-419) x 17 (12-19.5) µm N = 8, and entirely spined acanthostrongyles 126 (108-157) x 14 (10.5-20) µm. Microscleres are toxas 94 (70-130) µm in length N= 7 (not shown) and anisocleistochelae 14.6 (12.2-18) µm long.
Habitat	Encrusting on rocky bottoms.
Distribution (WPD)	South European Atlantic shelf, Saharan upwelling, Ionian Sea, Azores.
Remarks	The anisocleistochelae are diagnostic in this species, however in this specimen they appear completely fused into teardrop shaped spicules. Scanning electron microscopy is needed to identify these microscleres. Van Soest *et al.* (2013) suggest that spicules in this species are quite variable in size, so despite the fact that this species has only been found further south in the Atlantic, it fits the species description.
References	Van Soest *et al.* (2013), Topsent (1904)



Mycale (Anomomycale) titubans (Schmidt, 1870)

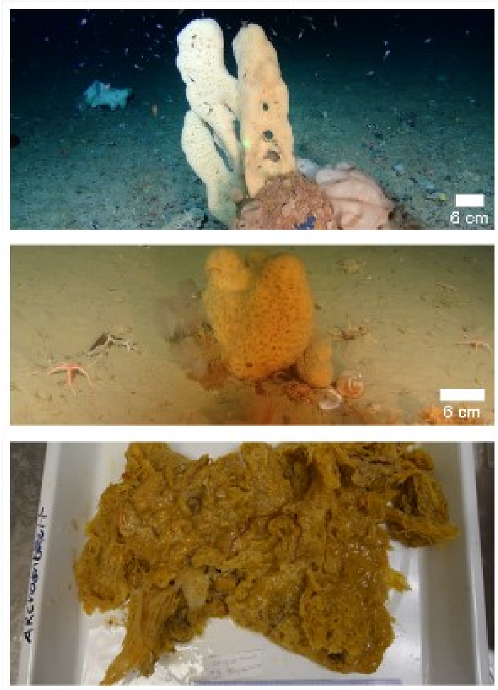
Sample	CMNI 2018-0109
Family	MYCALIDAE
Synonyms	*Anomomycale titubans* (Schmidt, 1870) *Desmacidon titubans* Schmidt, 1870 *Mycale titubans* (Schmidt, 1870)
Collection Details	Northern Labrador Sea (Saglek Bank) 60.469° N, -61.289° W, Depth 401 m
Form	Encrusting, irregular.
Size	4 cm wide by 1-2 cm high
Colour	Bright yellow
Consistency	Firm.
Surface	Hispid.
Skeleton	Large styles form the primary skeleton forming a polyspicular reticulation. The smaller styles either echinate these tracts or are bundled at the surface. Microscleres are scattered throughout the sponge but concentrated at the surface.
Spicules	Megascleres are styles in two categories, (A) 565 (484-646) x 19.6 (16-24) µm and (B) 425 (350-595) x 9.6 (7.5-16) µm. The microscleres are sigmas (C) 70 (55-97) µm in length and anomochelae (D) – also described as “cleistochelate” anisochelae (Van Soest *et al.*, 2014*)* 28 (26-30) µm in length. Sometimes these anomochelae are more anisochelae-like.
Habitat	Was found associated with *Biemna variantia* on a rocky bottom habitat.
Distribution (WPD)	Azores, South European shelf, South and West Iceland, Off the coast of Florida.
Remarks	Sigmas are not as long (up to 262µm) as those in the description by Boury-Esnault & Van Beveren (1982) but are more similar to those described by Van Soest *et al.* 2014) (50-130 µm) and Topsent (1928) (70-115 µm). The

Top: shown whole. Bottom: arrow shows sponge growing on *Biemna.*



	presence of anisochelae as well as anomochelae is not described elsewhere, but this specimen may show how these spicules transition from the standard form to the more derived anomochelae.
References	Boury-Esnault *et al.* (1982), Van Soest *et al.* (2014)

Mycale lingua (Bowerbank, 1866)



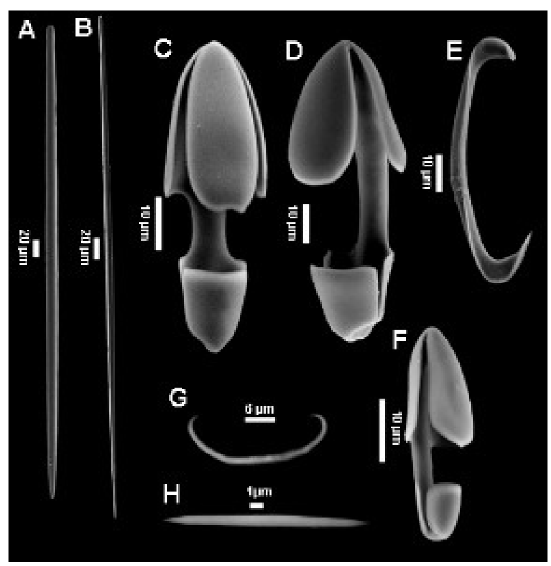
Top/middle: *in situ.* Bottom: piece on-board.

Sample CMNI 2018-0053, CMNI 2018-0071, CMNI 2018-0152, CMNI 2018-0167, CMNI 2018-0196

Family MYCALIDAE

Synonyms
Desmacidon constrictus Bowerbank, 1866
Esperella lingua (Bowerbank, 1866)
Esperella placoides (Carter, 1876)
Esperella vosmaeri Levinsen, 1887
Esperia constricta (Bowerbank, 1866)
Esperia lingua (Bowerbank, 1866)
Esperia lucifera Schmidt, 1873
Esperia placoides Carter, 1876
Hymeniacidon lingua Bowerbank, 1866
Mycale (Mycale) vosmaeri (Levinsen, 1887)
Mycale lingua (Bowerbank, 1866)
Mycale placoides (Carter, 1876)
Mycale vosmaeri (Levinsen, 1887)
Raphioderma coacervata Bowerbank in Norman, 1869
Raphiodesma lingua (Bowerbank, 1866)

Collection Details
Frobisher Bay
63.111° N, -67.518° W, Depth 459 m
62.954° N, -67.139° W, Depth 402 m
62.868° N, -66.746° W, Depth 288 m
Northern Labrador Sea (NE Hatton Basin)
61.440° N, -60.665° W, Depth 631 m
Northern Baffin Bay /Nares Strait
76.317° N, -75.771° W, Depth 333 m
western Greenland shelf (Disko Fan)
67.967° N, -59.484° W, Depth 877 m



Form Massive, lobed, sometimes erect.

Size Variable. Can be quite large up to 30 cm in diameter.

Colour Yellow to light orange.

Consistency Soft, with firm roots near the base.

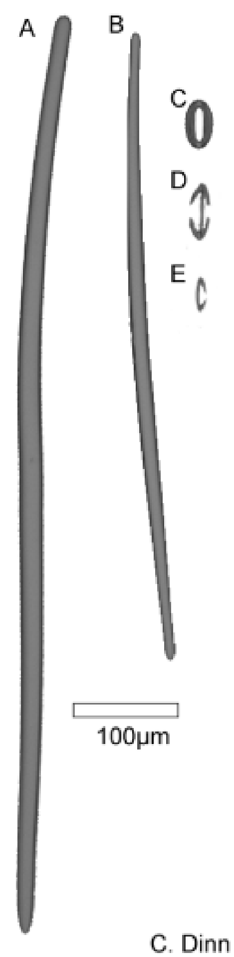
Surface Distinguished by conspicuous surface furrows *in situ*, these collapse after collection and appear like a soft mass near the distal portions.

Spicules	Spicules consist of styles/mycalostyles (A) 514 (400-590) x 16 (12-20) µm, anisochelae I (C-E) 73(52-88) µm, anisochelae II (F) 37.5(28.5-50) µm, sigmas (G) 20(14.5-26) µm, and raphides (H) which were rare and did not form conspicuous trichodragmas in the Frobisher Bay specimen 43 (30-53) µm n=16.
Habitat	Rocky bottoms.
Distribution (WPD)	Amphi-Atlantic.
Remarks	This species is large and conspicuous *in situ* and after collection. *(Mycale) loveni* (Fristedt, 1887) has been suggested to occur in this region but has not been collected nor confirmed in the WPD. In the eastern Canadian specimens, only two size categories of anisochelae were found. Some descriptions of this species state that there may be three sizes of anisochelae (Boury-Esnault, 1994).
References	Ackers *et al.* (1992), Boury-Esnault *et al.* (1994)

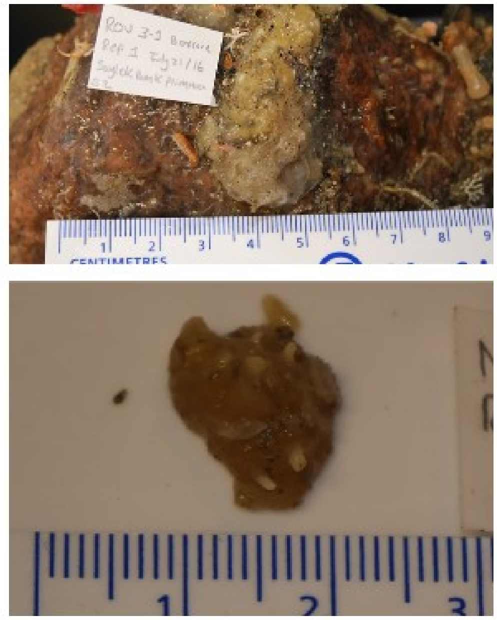
Melonanchora elliptica Carter, 1874

Top: attached to rock. Bottom: shown whole.

Sample	CMNI 2018-0107
Family	MYXILLIDAE
Collection Details	Northern Labrador Sea (Saglek Bank) 60.463° N, -61.280° W, Depth 427 m
Form	Encrusting with tubercles.
Size	Crusts are about 3 cm wide.
Colour	Dermal membrane is more or less clear, and the underlying choanosome is yellow.
Consistency	Soft and compressible.
Surface	The dermal membrane is smooth, with large ~2mm oscula. The oscula look like extended tubercles after collapse.
Spicules	Megascleres are styles, though only bluntly pointed (A) 833 (749-923) x 23 (18.5-26) µm N=13, and tylotes (B) 623 (554-693) x 15.5 (12.6-18.6) µm. Microscleres are sphaerancoras (C) 50 (43-53) µm in length N = 28, and anchorate isochelae in two sizes (D) 55 (35-64) µm in length N=28 and (E) 22 (18-27.6) µm in length.
Habitat	Rocky bottoms
Distribution (WPD)	European waters, western Mediterranean, northern Norway and Finnmark, South and west Iceland, eastern Greenland.
Remarks	The "bladder-like" body form described by Van Soest (2002) is not noticeable in these specimens as they were encrusting rocks. This species can look superficially similar to *Tedania (Tedania) suctoria* (Schmidt, 1870), though the spicules are distinctive between the two species.
References	Hooper and Van Soest (2002)

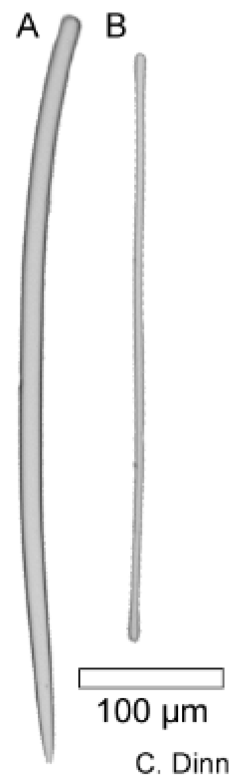


Tedania (Tedania) suctoria (Schmidt, 1870)



Top: attached to rock. Bottom: shown whole.

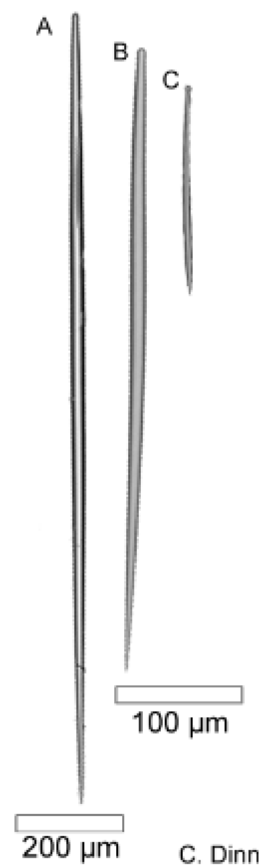
Sample	CMNI 2018-0097, CMNI 2018-0084, CMNI 2018-0085
Family	TEDANIIDAE
Synonyms	*Tedania conuligera* Topsent, 1892 *Tedania increscens* Schmidt, 1875 *Tedania suctoria* Schmidt, 1870
Collection Details	Northern Labrador Sea (Saglek Bank) 60.315° N, -61.880° W, Depth 286 m 60.466° N, -61.278° W, Depth 452 m
Form	Encrusting with small erect papillae.
Size	Up to 5 cm wide.
Colour	Off-white to yellow-orange.
Consistency	Soft.
Surface	Papillated.
Spicules	Megascleres are styles (A) 477 (355-428) x 13.4 (9-15) µm, and tylotes (B) 387 (347-481) x 6.7 (4.4-12) µm. Microscleres are onychaetes (not shown) that often appear like very thin oxeas though are finely spined 270 (197-296) x 3.8 (2.7-5.2) µm.
Habitat	Encrusting on rocks and boulders.
Distribution (WPD)	Amphi-Atlantic.
Remarks	Fits the descriptions by Lundbeck (1910) and Topsent (1928). This sponge can look very similar to *Melonanchora elliptica* Carter, 1874, but the spicule complements are distinctive. Oscula at the distal end of the papillae are not as large in this species as in *Melonanchora*.
References	Lundbeck (1910), Topsent (1928)



Polymastia uberrima (Schmidt, 1870)

Top: *in situ*. Bottom: shown whole

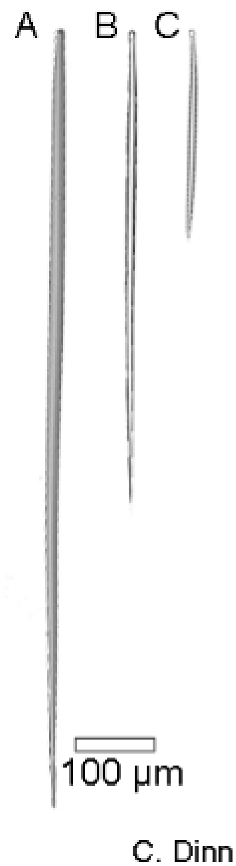
Sample	CMNI 2018-0093, CMNI 2018-0103, CMNI 2018-0096
Family	POLYMASTIIDAE
Synonyms	*Polymastia infrapilosa* Topsent, 1927 *Rinalda uberrima* Schmidt, 1870
Collection Details	Northern Labrador Sea (Saglek Bank) 60.468° N, -61.287° W, Depth 412 m 60.466° N, -61.278° W, Depth 452 m
Form	Cushion shaped, ovoid to spherical.
Size	Up to 5 cm in diameter.
Colour	Yellow, brown choanosome.
Consistency	Firm with soft papillae.
Surface	Smooth with several large papillae on the upper surface.
Spicules	Megascleres are primary strongyloxea (A) 1399 (885-1682) x 28 (23-33) µm, intermediary tylostyles (B) 542 (409-762) x 15 (11-26) µm, and ecotosomal tylostyles (C) which are often curved 178 (127-216) x 13 (9.4-15) µm.
Habitat	Growing on boulders and rocks.
Distribution (WPD)	European waters, northern Norway and Finnmark, north and east Barents Sea, and South and west Iceland. Described as Amphi-Atlantic by Plotkin *et al.* (2017).
Remarks	Primary spicules are slightly longer and thicker and ectosomal tylostyles are slightly shorter than described in Boury-Esnault (1987), but COI sequences strongly suggest *P. uberrima*. Spicules are noted by Plotkin *et al.,* 2017 as being quite variable in size, and fit the measurements for specimens collected on the Grand Banks of Newfoundland.
References	Vacelet and Boury-Esnault (1987), Plotkin *et al.* (2017).



Polymastia thielei Koltun, 1964


Shown whole.

Sample	CMNI 2018-0121, CMNI 2018-0125, CMNI 2018-0154, CMNI 2018-0169, CMNI 2018-0194
Family	POLYMASTIIDAE
Collection Details	Frobisher Bay 62.953° N, -67.139° W, Depth 402 m 62.567° N, -66.282° W, Depth 377 m North Labrador Sea (SE Baffin shelf) 62.987° N, -60.629° W, Depth 500 m 63.004° N, -60.643° W, Depth 457 m western Greenland shelf 68.260° N, -59.823° W, Depth 1148 m
Form	Cushion shaped.
Size	Up to 7 cm in diameter.
Colour	Beige to light brown, with a dark brown choanosome.
Consistency	Firm.
Surface	Smooth with papillae scattered over body.
Spicules	The principal styles (A) are 964 (712-1181) µm x 22 (16-28) µm N=120, intermediary tylostyles (B) are 546 (409-750) µm x 15 (8.5-21.5) µm N=120, and small, often curved tylostyles (C) are 250 (160-312) µm x 12 (5.5-22) µm, N=120
Habitat	Hard bottom habitats.
Distribution (WPD)	North East Greenland shelf, Northern Norway and Finnmark, North and East Barents Sea, Southern Norway. Described as having a whole NE Atlantic Distribution by Plotkin *et al.* (2017), with one record on the Eastern Grand Banks.
Remarks	From specimens and ROV video collected in the eastern Canadian Arctic, this species is likely distributed throughout the whole eastern Canadian Arctic, as far north as Pond Inlet and potentially to Lancaster Sound. This species is clearly distinguished from congeneric species by having papillae on the whole spherical surface. COI sequences can also distinguish this species from *P. uberrima* quite clearly.
References	Koltun (1966), Plotkin *et al.* (2017)



Polymastia grimaldii (Topsent, 1913)

Shown whole.

Sample	CMNI 2018-0178
Family	POLYMASTIIDAE
Synonyms	*Polymastia mamillaris var. grimaldii* (Topsent, 1913) *Polymastia mamillaris var. hyperborea* Hentschel, 1916 *Radiella grimaldii* (Topsent, 1913) *Trichostemma grimaldii* Topsent, 1913
Collection Details	Frobisher Bay 63.663° N, -68.420° W, Depth 84 m
Form	Large, semicircular cushion with many papillae and wide tuft of spicules around the periphery.
Size	Greater than 15 cm in diameter.
Colour	Yellow, with brown spicule tufts due to entrapped mud.
Consistency	Firm, with soft papillae.
Surface	Completely covered in long papillae, but hispid around the spicule tufts.
Spicules	Primary spicules are strongyloxeas 1523 (1043-2239) x 26 (12-34) µm, intermediate tylostyles are 501 (245-819) x 14 (10-29) µm, and small tylostyles are 206 (148-281) x 11.4 (7.3-15.6) µm. Exotyles from the spicule tuft are quite long and often broken but can be >6000 µm. See Plotkin *et al.* (2017) for spicule images.
Habitat	Unknown.
Distribution (WPD)	Eastern Greenland, Northeast Ireland, North and East Barents Sea. Reported from Newfoundland waters and Northwest Iceland by Plotkin *et al.,* (2017)
Remarks	The body form and extent of the exotyle tuft are distinctive of this species. Care should be taken not to confuse this species with *Polymastia hemisphaerica* (Sars, 1872), but the spicules are much longer in that species.
References	Plotkin *et al.* (2017)

Polymastia andrica de Laubenfels, 1949


Whole individuals.

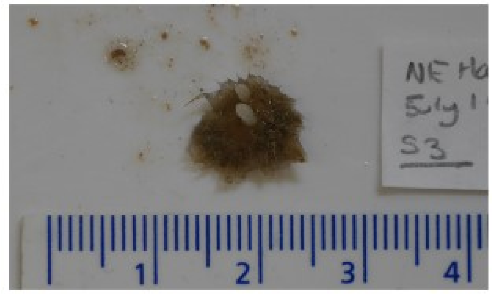
Sample	CMNI 2018-0200
Family	POLYMASTIIDAE
Collection Details	Lancaster Sound 74.157° N, -80.468° W, Depth 786 m
Form	Cushion shaped, very long papillae (up to 1 cm long) and a tuft of spicules along the periphery.
Size	About 2 cm in diameter.
Colour	Brown.
Consistency	Firm.
Surface	Hispid, with trapped mud.
Spicules	Principal styles/subtylostyles are 1062 (647-1987) x 21 (14.7-33.8) µm, intermediate tylostyles are 521 (334-780) x 13.2 (10.4-16.7) µm, and small tylostyles 176 (154-204) µm. Exotyles are often broken 1898 (1552-2337) x 16.4 (13-19) µm N=3, though exotyles likely attain longer lengths.
Habitat	Sandy bottoms.
Distribution (WPD)	Gulf of St. Lawrence, Northern Norway and Finnmark, Southern Norway.
Remarks	Matches the description in Plotkin *et al.,* (2017). Long papillae are distinctive. This is one of only two sponges collected or seen in Lancaster Sound.
References	Plotkin *et al.* (2017)

Tentorium semisuberites (Schmidt, 1870)

Top: attached to rock. Bottom: individual which was attached to *Keratoisis* coral.

Sample	CMNI 2018-0072, CMNI 2018-0083, CMNI 2018-0101, CMNI 2018-0104, CMNI 2018-0144, CMNI 2018-0163, CMNI 2018-0195, CMNI 2018-0199
Family	POLYMASTIIDAE
Synonyms	*Thecophora elongata* Marenzeller, 1877 *Thecophora ibla* Thomson, 1873 *Thecophora semisuberites* Schmidt, 1870
Collection Details	Frobisher Bay 62.954° N, -67.140° W, Depth 402 m 62.567° N, -66.172° W, Depth 377 m Northern Labrador Sea (NE Hatton Basin) 61.440° N, -60.664° W, Depth 620 m Northern Labrador Sea (Saglek Bank) 60.315° N, -61.881° W, Depth 286 m 60.466° N, -61.278° W, Depth 452 m 60.463° N, -61.280° W, Depth 427 m western Greenland shelf (Disko Fan) 67.967° N, -59.484° W, Depth 877 m western Greenland shelf 68.260° N, -59.823° W, Depth 1148 m Northern Baffin Bay/Nare's Strait 77.756° N, -76.650° W, Depth 400 m
Form	Toadstool shaped, columnar sponge with a convex upper portion scattered with papillae.
Size	Up to 3 cm tall.
Colour	Beige to grey, the upper portion is usually darker than the columnar body.
Consistency	Firm, bladder-like.
Surface	Smooth.
Spicules	Principal tylostyles are 1447 (1012-1713) x 20 (18-22) µm N=12, intermediate tylostyles are 1025 (855-1217) x 28 (23-33) N = 5, and small stout tylostyles are 417 (307-543) x 19 (13.6-24.5) µm. See Plotkin *et al.* (2017) for spicule images.
Habitat	Attached to hard surfaces including boulders, dead coral skeletons, and small pebbles.
Distribution (WPD)	Cosmopolitan.
Remarks	This is an easily identified species visually. The columnar body and round distal portion are distinctive.
References	Arndt (1935), Plotkin *et al.* (2017)

Spinularia cf. *sarsii* (Ridley & Dendy, 1886)



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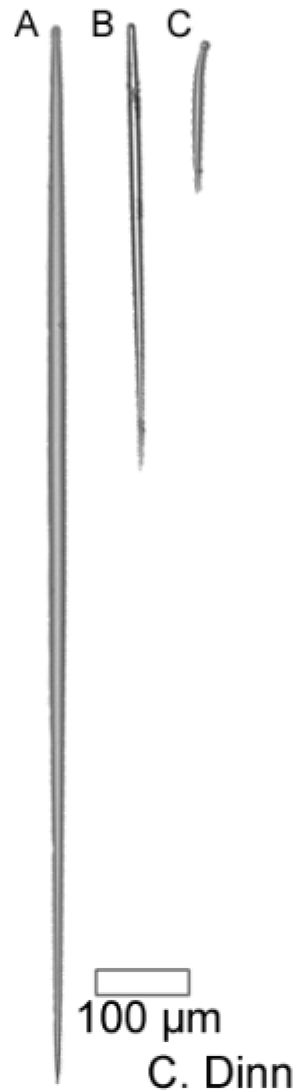
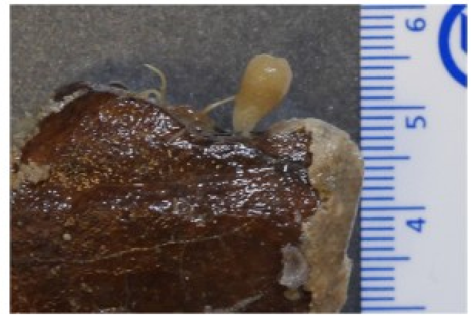
Sample	CMNI 2018-0078
Family	POLYMASTIIDAE
Synonyms	*Radiella sarsii* (Ridley & Dendy, 1886) *Trichostemma sarsii* Ridley & Dendy, 1886
Collection Details	Northern Labrador Sea (NE Hatton Basin) 61.489° N, -60.839° W, Depth 615 m
Form	Flat, discoid, with a fringe of spicules along the periphery. Few tiny papillae appear on the upper portion in the centre of the sponge.
Size	1 cm in diameter.
Colour	Brown, lighter towards the centre of the sponge.
Consistency	Firm.
Surface	Hispid.
Spicules	Principal styles to tylostyles (A) are 911 (632-1122) x 16.5 (11-19) µm, intermediate tylostyles (B) are 385-402 x 11-12 µm N = 2, small tylostyles (C) are 145 (122-181) x 7.2 (3.6-10.3) µm. Exotyles were not measured.
Habitat	Hard bottom.
Distribution (WPD)	Atlantic Ocean south of the Grand Banks.
Remarks	The spicules described in Plotkin *et al.* (2017) are longer than in this specimen, however the general body form appears to fit this species. The genus *Spinularia* is problematic, and thus more work is required to identify specimens to species.
References	Plotkin *et al.* (2017)

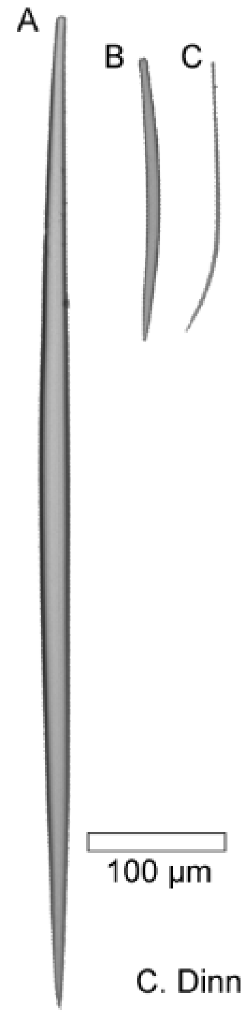


Quasillina brevis (Bowerbank, 1861)



Shown whole.

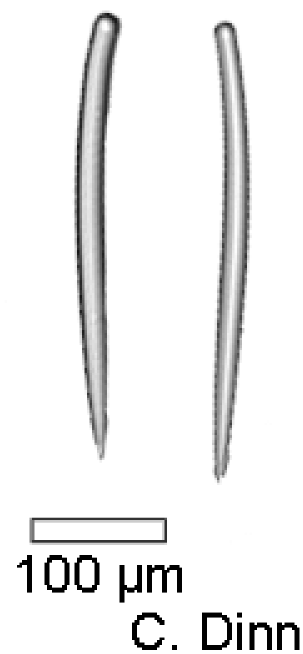
Sample	CMNI 2018-0076
Family	POLYMASTIIDAE
Synonyms	*Bursalina muta* Schmidt, 1875 *Euplectella brevis* Bowerbank, 1861 *Polymastia brevis* (Bowerbank, 1861)
Collection Details	Northern Labrador Sea (NE Hatton Basin) 61.490° N, 60.839° W, Depth 615 m
Form	Bladder-like, club shaped sponge.
Size	Less than 1cm in height.
Colour	Pale yellow.
Consistency	Firm.
Surface	Smooth.
Spicules	The principal spicules are subtylostyles to styles (A) 785 (560-996) x 22 (14-28.5) µm. Small tylostyles are divisible in two categories: the thicker ones (B) are 184 (153-210) x 9 (7.5-11.7) µm; and the thinner ones (C) are 185 (154-216) x 6 (3.4-8.5) µm. The thinner tylostyles are often bent near the pointed end.
Habitat	Was found in a rocky bottom habitat.
Distribution (WPD)	Amphi-Atlantic. Not previously recorded from the North Labrador Sea.
Remarks	The thin, bent small tylostyles are characteristic of *Q. richardi* Topsent, 1913, however Plotkin *et al.* (2017) suggest that this description by Topsent was based on the idea that northern Norwegian specimens only had these slightly bent spicules, however this is not the case. Therefore, until genetic material becomes available, *Q. richardi* should be considered a junior synonym of *Q. brevis.*
References	Plotkin *et al.* (2017)



Plicatellopsis sp. Burton, 1932 (W. Greenland shelf morph)

Top: *in situ.* Bottom: Shown whole.

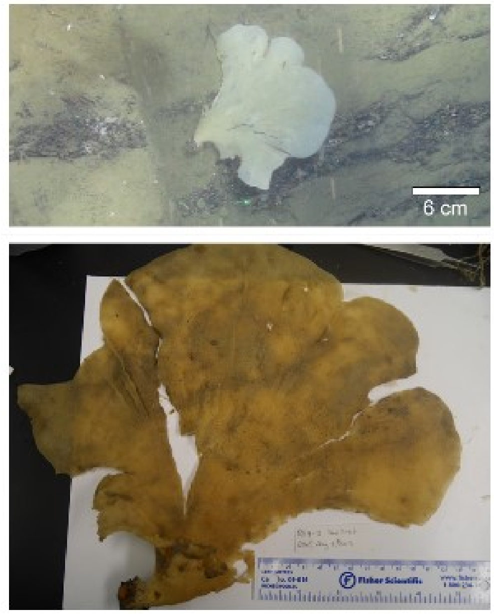
Sample	CMNI 2018-0135, CMNI 2018-0136, CMNI 2018-0145
Family	SUBERITIDAE
Collection Details	western Greenland shelf (Disko Fan) 67.967° N, -59.484° W, Depth 877.6 m
Form	Fan shaped, larger specimens have a characteristic "swiss-cheese" growth form with large holes in the fan.
Size	Up to 15 cm in diameter.
Colour	White *in situ*, off-white to light yellow after collection.
Consistency	Moderately firm and difficult to tear.
Surface	Minute indentations are scattered over outer surface.
Skeleton	Appears to have bundles of styles at the surface, though more sections are likely needed.
Spicules	The spicules are only styles 333 (284-389) x 19.8 (14.7-25.8) µm. These styles are sometimes faintly tylote with a characteristic bend near the head.
Habitat	Growing amongst dead *Keratoisis* coral skeletons. This species was a common and noticeable sponge throughout the coral-dominated habitat.
Distribution (WPD)	Unknown.
Remarks	The fan shape of these specimens and the skeleton formed of styles cause difficulty in identifying the genus. *Plicatellopsis* is a genus of sometimes-flabellate sponge with spicule bundles in the extra axial skeleton, but most species have tylostyles. *Homaxinella* contains sponges with more branching, arborescent forms and have styles as spicules, but the skeleton does not have spicule bundles near the surface.



	However, a new species of *Plicatellopsis* from the Bering Sea shows a similar growth form to this specimen, a fan with a clear stalk. However, *Plicatellopsis borealis* Lehnert & Stone, 2017 has two size categories of tylostyles (though many appear to be styles). COI sequences of these sponges are similar to both *Plicatellopsis* and *Homaxinella.* Further work to identify this species is required. This smaller specimen of this species was found on the Western Greenland shelf, but a larger morph was found at the Pond Inlet site.
References	Hooper and Van Soest (2002), Lehnert and Stone (2017)

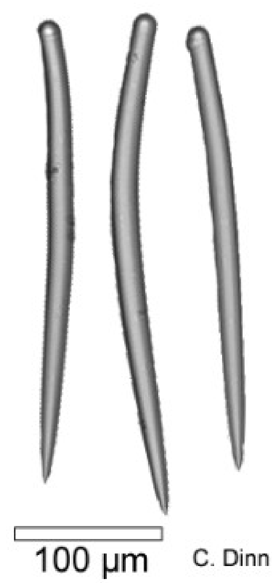
Plicatellopsis sp. Burton, 1932 (Pond Inlet Morph)

Sample	CMNI 2018-0202
Family	SUBERITIDAE
Collection Details	Pond Inlet 72.829° N, -77.609° W, Depth 856 m
Form	Large, fan shaped sponge that forms a funnel at the base. The single stalk attaches to a hard substrate.
Size	The sponge is > 30 cm in height and width.
Colour	Buff to light yellow. Appears bone white *in situ.*
Consistency	Very soft and thin. The sponge is easily damaged.
Surface	Indentations are aligned in longitudinal tracts along the outer surface of the sponge.



Top: *in situ.* Bottom: Shown whole.

Spicules	Only styles 317 (258-359) x 18 (14-21) µm. These spicules often appear more tylostyle-like with irregular heads.
Habitat	This specimen was found growing on a bedrock wall. Previous descriptions of the species are described in shallower water up to 325 m.
Distribution (WPD)	Unknown.
Remarks	Further work to identify this species is required. COI sequences are identical for both the Pond Inlet morph and the western Greenland shelf specimen, so this species is quite variable in body morphology, though the two morphs were not found outside of their respective collections sites. This specimen appeared to fit the description of *Semisuberites cribosa* (Miklucho-Maclay, 1870), which is reported from the area. However, spicules were less variable in size and DNA confirms that this sponge is not related to the genus *Semisuberites*.
References	Hooper and Van Soest (2002), Lehnert and Stone (2017)

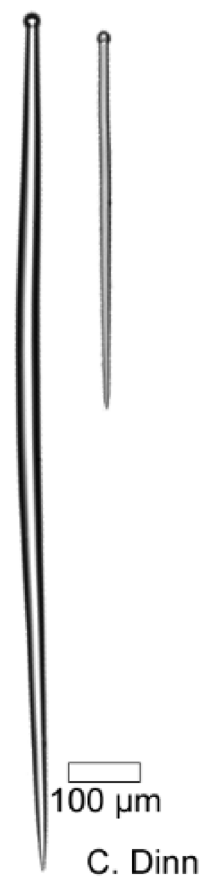


Pseudosuberites sp. Topsent, 1896

Sample	CMNI 2018-0143
Family	SUBERITIDAE
Collection Details	Western Greenland shelf (Disko Fan) 67.967° N, -59.484° W, Depth 877.6 m
Form	Encrusting.
Size	Can encrust entire dead *Keratoisis* coral skeletons.
Colour	White *in situ*, off-white after collection.
Consistency	Firm.
Surface	Slightly hispid.
Spicules	Spicules are tylostyles which may be separated in two size categories based on thickness. The larger tylostyles (A) are 1060 (823-1279) x 33.5 (20.7-42.3) µm, and the thinner tylostyles (B) are more variable in size 595 (346-852) x 16.5 (12.6-23) µm. These size categories may not be true, and tylostyles may just be highly variable.
Habitat	Found encrusting on dead *Keratoisis* coral skeletons.
Distribution (WPD)	Unknown.
Remarks	Spicules are similar to those found in *Pseudosuberites hyalinus* (Ridley & Dendy, 1887), although this species is more massively encrusting. The global distribution of *P. hyalinus* is also disputed in the WPD and Systema Porifera, so until more work is done on the genus this sponge can only be placed in the genus *Pseudosuberites*. It should also be noted that *P. hyalinus* was only collected at depths less than 200 m whereas this specimen was collected at nearly 900 m depth.
References	Hooper and Van Soest (2002)

Top: shown encrusting *Keratoisis* coral.

Bottom: *in situ*.

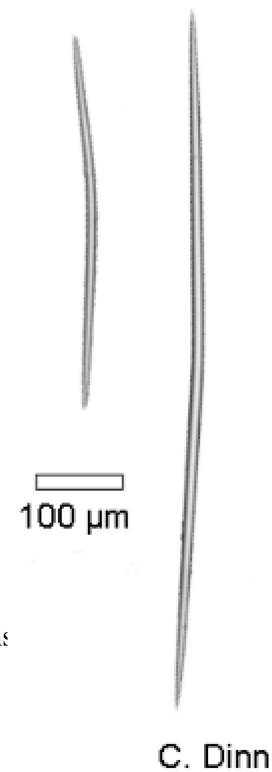


Halichondria (Eumastia) sitiens (Schmidt, 1870)

Top: pieces showing choanosome.

Bottom: pieces growing on worm tubes.

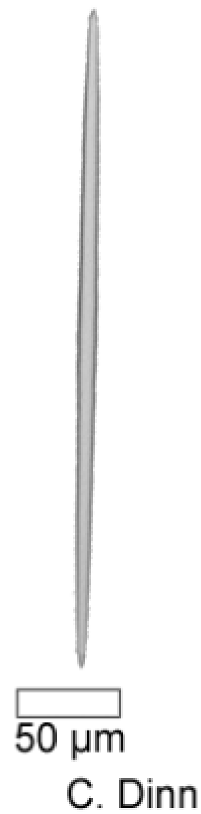
Sample	CMNI 2018-0055, CMNI 2018-0066, CMNI 2018-0181, CMNI 2018-0188
Family	HALICHONDRIIDAE
Synonyms	*Amorphina nodosa* Fristedt, 1887 *Cioxeamastia polycalypta* de Laubenfels, 1942 *Eumastia sitiens* Schmidt, 1870 *Halichondria borealis* (Miklucho-Maclay, 1870) *Halichondria borealis* var. papillosa (Miklucho-Maclay, 1870) *Halichondria nodosa* (Fristedt, 1887) *Halichondria sitiens* (Schmidt, 1870) *Pellina sitiens* (Schmidt, 1870) *Spuma borealis* Miklucho-Maclay, 1870 *Spuma borealis var. papillosa* Miklucho-Maclay, 1870
Collection Details	Frobisher Bay 63.557° N, -68.247° W, Depth 104 m 63.664° N, -68.421° W, Depth 87 m 63.639° N, -68.627° W, Depth 141 m 63.359° N, -68.182° W, Depth 119 m
Form	Cushion shaped with large papillae or finger-like with less of a cushion base growing on tube worms.
Size	Up to 7 cm in length.
Colour	Yellow.
Consistency	Very soft.
Surface	Smooth, thin dermal membrane covers the entire surface.
Spicules	The only spicules are oxeas in a single variable size category 635 (287-1003) x 15 (11-19) µm.
Habitat	Attached to polychaete tubes or other hard substrates.
Distribution (WPD)	Whole Northern Hemisphere.
Remarks	The finger-like growth forms are not consistent with previous descriptions of the species, but due to the similar spicule complement and form of the papillae, this specimen is treated as the same species here.
References	(Hooper & Van Soest, 2002)



Halichondria (Halichondria) panicea (Pallas, 1766)

Shown whole.

Sample	CMNI 2018-0091
Family	HALICHONDRIIDAE
Synonyms	Many, listed in WPD.
Collection Details	Northern Labrador Sea 60.313° N, -61.880° W, Depth 279 m
Form	Encrusting.
Size	1 cm.
Colour	Yellow.
Consistency	Soft.
Surface	Smooth.
Spicules	The only spicules are smooth fusiform oxeas 346 (283-416) µm.
Habitat	Encrusting on rocks.
Distribution (WPD)	Cosmopolitan.
Remarks	Many synonymized species and a global distribution with a similar size of oxea strongly suggest this species.
References	Hooper and Van Soest (2002)



Halichondria sp. Fleming, 1828

Collected as a piece.

Sample — CMNI 2018-0191

Family — HALICHONDRIIDAE

Collection Details — Frobisher Bay
62.868° N, -66.746° W, Depth 288 m

Form — Tracts of spongin appear confused underneath a clear membrane.

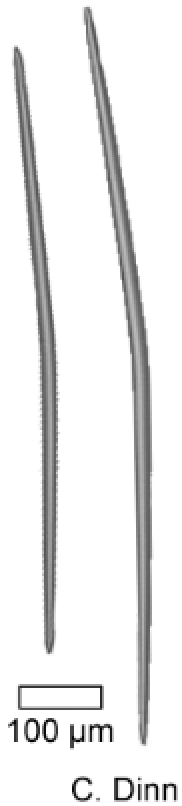
Size — 15 cm wide.

Colour — Yellow, with a clear transparent membrane on the outer surface.

Consistency — Soft.

Surface — Uneven membrane covers conspicuous spongin fibres.

Spicules — Only oxeas that are bent 613 (363-900) 18.7 (13.9-26.2) µm.



Habitat — Unknown.

Distribution (WPD) — Unknown.

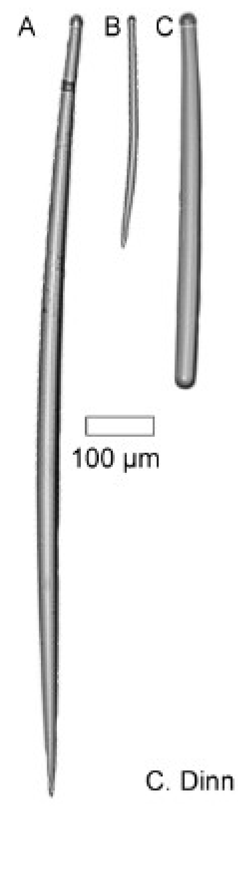
Remarks — The species of this specimen is unknown. The growth form is quite different than *H. sitiens*, therefore they are unlikely the same species. This specimen does not appear to be *Halichondria genitrix* (Schmidt, 1870) based on the distinct bend of the spicules in that species, however due to the shiny skin and sandy nature of the specimen it may indeed be *H. agglomerans* (Cabioch, 1968). Until the specimen is reliably photographed *in situ*, or DNA sequencing attempted, it is unlikely to be properly identified.

References — Boury-Esnault and Lopes (1985), Hooper and Van Soest (2002)

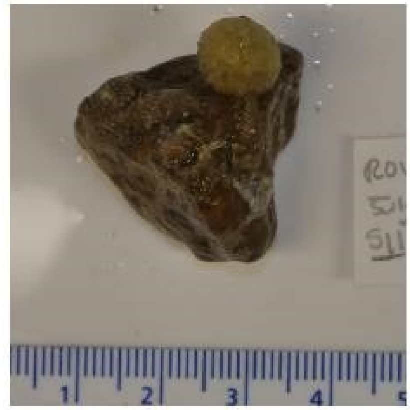
Hymeniacidon sp. Bowerbank, 1858

Top: pieces. Bottom: many pieces collected in trawl.

Sample	CMNI 2018-0123, CMNI 2018-0127, CMNI 2018-0164
Family	HALICHONDRIIDAE
Synonyms	*Amorphilla* Thiele, 1898 *Laxosuberites* Topsent, 1896 *Rhaphidostyla* Burton, 1935 *Rhaphoxiella* Burton, 1934 *Stylinos* Topsent, 1891 *Stylohalina* Kirk, 1909 *Stylotella* Lendenfeld, 1888 *Thieleia* Burton, 1932
Collection Details	Northern Labrador Sea (SE Baffin shelf) 63.002° N, -60.645° W, Depth 456 m 63.004° N, -60.643° W, Depth 457 m 63.003° N, --60.640° W, Depth 458 m
Form	Finger-like growth forms.
Size	Less than 10 cm tall.
Colour	Yellow.
Consistency	Soft.
Surface	The surface is soft and smooth surface with a raised dermal membrane over visible canals.
Spicules	These specimens only have megascleres, there are large tylostyles/styles (A) 1000 (638-1620) x 24.8 (16.7-38.5) µm and short tylostyles (B) 428 (307-613) x 15.9 (10.5-21.7) µm. There are uncommon clavulate (club-shaped) tylostrongyles (C) 578 (212-1118) x 38.5 (24.7-52.2) µm N = 10.
Habitat	Rocky bottoms.
Distribution (WPD)	Unknown
Remarks	This sponge can occur in large aggregations as many fragments were collected in single Agassiz trawls. The COI sequence of this specimen strongly suggests the genus, though the species is unknown.
References	Hooper and Van Soest (2002)

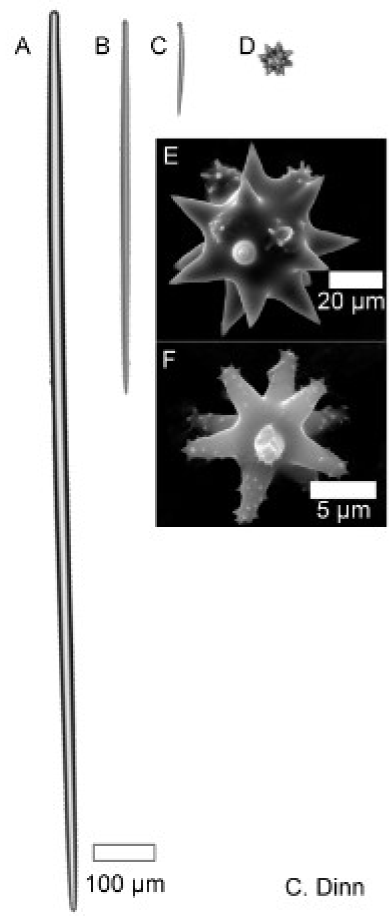


Tethya cf. *norvegica* Bowerbank, 1872



Shown whole.

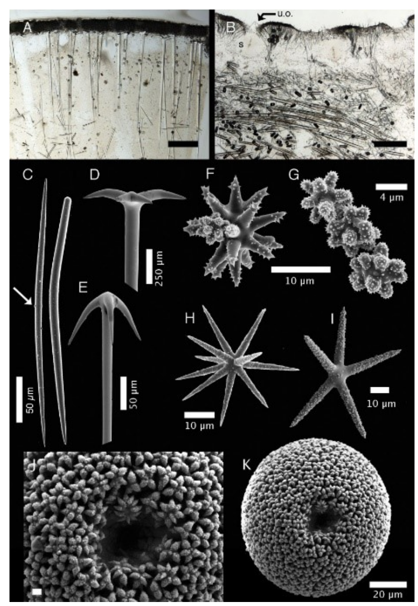
Sample	CMNI 2018-0119
Family	TETHYIDAE
Synonyms	*Tethya lyncurium var. obtusum* Vosmaer, 1882.
Collection Details	Northern Labrador Sea (Saglek Bank) 60.469° N, -61.289° W, Depth 401 m
Form	Spherical.
Size	Less than 1 cm.
Colour	Yellow cortex, brown choanosome.
Consistency	Firm.
Surface	Lightly hispid, appears slightly uneven/furrowed.
Spicules	The spicules are strogyloxeas (A) which are rounded at both ends, but one end is slightly narrower 1298 (960-1601) x 23.5 (16-29) µm, styles (B) 734 (498-893) x 15 (10-21.6) µm and short tylostyles (C) 139 (120 -162) x 10 (7.7-13.4) µm. The microscleres are asters, megasters are sperasters (D, E) 56 (46-69) µm, and micrasters are small oxyasters (F) 9.9 (5.1-15.8) µm. The micrasters are often fused into the larger megasters.
Habitat	Attached to a pebble in a rocky bottom habitat.
Distribution (WPD)	Ireland, European waters, the North Sea, Barents Sea, northern Norway and Finnmark.
Remarks	The COI sequence of this specimen is only 1 bp different from *T. norvegica*, therefore it is currently assumed to be this species. However, the presence of small tylostyles which are not noted in any description of *T. norvegica*, and fusion of round megasters and micrasters casts doubt on the species affinity of this specimen.
References	Sarà *et al.* (1992)



Geodia barretti Bowerbank, 1858

Sample	CMNI 2018-0070, CMNI 2018-0126
Family	GEODIIDAE
Synonyms	*Cydonium barretti* (Bowerbank, 1858) *Geodia simplicissima* Burton, 1931
Collection Details	Northern Labrador Sea (NE Hatton Basin) 61.440° N, -60.665° W, Depth 615 m Northern Labrador Sea (SE Baffin shelf) 63.004° N, -60.643° W, Depth 457 m
Form	Massive, spherical with large oscula.
Size	Variable, often greater than 10 cm in diameter.
Colour	White to grey.
Consistency	Hard.
Surface	Hispid.
Spicules	Spicules include anatriaenes, long oxeas, dichotriaenes, microxeas, sterrasters, oxyasters, and strongylasters. See Cárdenas *et al.,* (2013) for measurements.
Habitat	Rocky bottoms.
Distribution (WPD)	Amphi-Atlantic.
Remarks	The lack of speroxyasters, size of the sterrasters (65-130µm), and presence of microxeas assures the assignment of these specimens to this species.
References	Cárdenas *et al.* (2013)

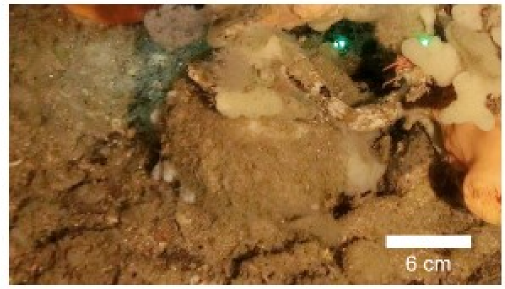
Top: collected pieces Bottom: *in situ.*



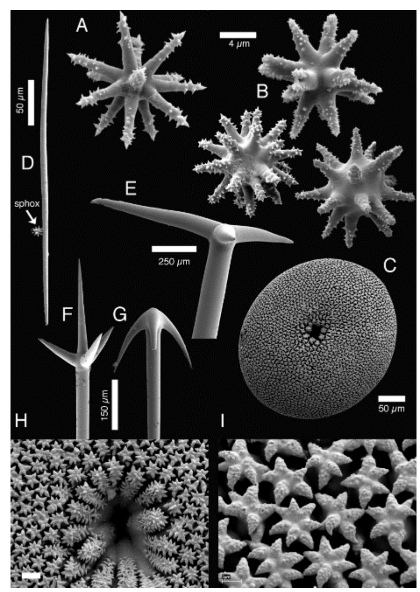
From Cárdenas *et al.* (2013)

Geodia macandrewii Bowerbank, 1858

Sample	CMNI 2018-0067
Family	GEODIIDAE
Synonyms	*Cydonium normani* Sollas, 1888 *Geodia normani* (Sollas, 1888)
Collection Details	Northern Labrador Sea (NE Hatton Basin) 61.341° N, -61.160° W, Depth 632 m
Form	Massive, spherical, very hispid.
Size	15 cm in diameter.
Colour	The surface looks brown due to mud trapped in the surface spicules. The cortex is off-white to beige and the cortex is pinkish.
Consistency	Hard.
Surface	Very hispid. Other encrusting organisms (bryozoans) are found on the surface spicules.
Spicules	Spicules include anatrianes, oxeas, microxeas, protriaenes, dichotrianes, spheroxyasters, sterrasters, and oxyasters. See Cárdenas *et al.,* (2013) for measurements.
Habitat	Rocky bottoms.
Distribution (WPD)	Amphi-Atlantic.
Remarks	Notably, the sterrasters are ~315 µm long, which distinguishes this species from other *Geodia* species. Upon collection, the dermal spicules may break off and the sponge will appear smooth, like congeneric species. However, the thick cortex formed by large sterrasters is distinctive.
References	Cárdenas *et al.* (2013)

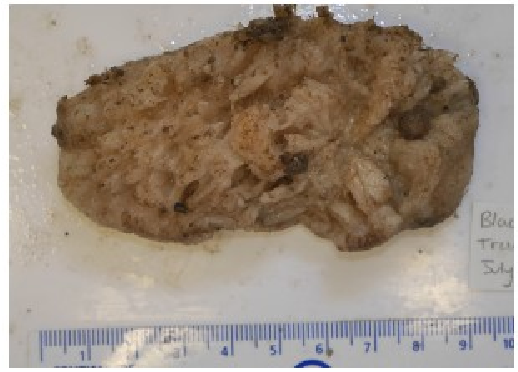


Top: *in situ.* Bottom: whole showing choanosome.



From Cárdenas *et al.* (2013)

Thenea cf. *muricata* (Bowerbank, 1858)



Collected as a piece.

Sample	CMNI 2018-0160, CMNI 2018-0162
Family	THENEIDAE
Synonyms	*Clavellomorpha minima* Hansen, 1885 *Dorvillia agariciformis* Kent, 1870 *Stelletta echinoides* Schmidt, 1877 *Stelletta profunditatis* Schmidt, 1880 *Tethea muricata* Bowerbank, 1858 *Tethya muricata* (Bowerbank, 1858) *Thenea intermedia* Sollas, 1888 *Thenea wallichii* (Wright, 1870) *Tisiphonia agariciformis* (Kent, 1870) *Wyvillethomsonia wallichii* Wright, 1870
Collection Details	Western Greenland shelf 68.259° N, -59.823° W, Depth 1148 m
Form	Massive, sub-spherical.
Size	Up to 10 cm long.
Colour	Brown.
Consistency	Firm.
Surface	Hispid.
Spicules	Spicules are protriaenes, length ~3600 x 72 µm with clads ~521 µm. Dichotrianes are ~3800 x ~84 µm, with protoclads ~200 µm and deuteroclads ~481 µm. Oxeas are ~4650 x 77µm. Anatrianes are ~7000 x 39 µm with clads ~130 µm. Microscleres are plesiasters ~102 µm and ~23 µm and streptasters (spirasters) ~15 µm.
Habitat	Unknown.
Remarks	This genus is very difficult to identify without an intact specimen with a visible osculum, spicules are also in many categories and require extensive measurements. These specimens are tentatively grouped into *T. muricata* based solely on the size of the plesiasters which are slightly larger than those reported in *T. valdiviae.* However, it is unclear whether these specimens are in fact different from the other *Thenea* specimens collected in the same locality.
References	Cardenas and Rapp (2012)

Thenea sp. 1 Gray, 1867

Shown whole.

Sample	CMNI 2018-0058
Family	THENEIDAE
Synonyms	*Ancorina* (*Thenea*) Lendenfeld, 1903 *Clavellomorpha* Hansen, 1885 *Dorvillia* Kent, 1870 *Tisiphonia* Thomson, 1869 *Wyvillethomsonia* Wright, 1870
Collection Details	Frobisher Bay 63.663° N, -68.422° W, Depth 80 m
Form	Sub-spherical, the base is an inch-thick layer of mud.
Size	10 cm long.
Colour	White surface, orange choanosome.
Consistency	Firm.
Surface	Hispid.
Spicules	Spicules are protriaenes 6350 (4648-8302) x 53 (38-58) µm N = 17, dichotrianes in two size categories, the longer being 5514 (4541-6598) x 74 (55-88) µm N = 9 with protoclads 345 (184-580) µm and deuteroclads being 500 (227-823) µm. Short dichotrianes are 3925x 65 µm with protoclads 390 µm and deuteroclads 221 µm N= 2. Anatrianes were uncommon and had a width of 38 µm N = 1 and clads 126 µm long N = 5. Oxeas are 5618 (4078-7143) 53 (33-109) µm N = 10. Microscleres are plesiasters ~76.5 µm N = 2 and spirasters ~23 µm long N = 7.
Habitat	Soft sediments.
Distribution (WPD)	Unknown.
Remarks	This sponge is considered a different species than the deep-water specimens collected mainly due to the colour of the choanosome. No noticeable sieve was present in the osculum, therefore identification based on outer morphology is difficult.
References	Cardenas and Rapp (2012)

Thenea sp. 2 Gray, 1867

Collected as a piece.

Sample	CMNI 2018-0155, CMNI 2018-0156, CMNI 2018-0158, CMNI 2018-0159
Family	THENEIDAE
Synonyms	*Ancorina* (*Thenea*) Lendenfeld, 1903 *Clavellomorpha* Hansen, 1885 *Dorvillia* Kent, 1870 *Tisiphonia* Thomson, 1869 *Wyvillethomsonia* Wright, 1870
Collection Details	Western Greenland shelf 68.259° N, -59.823° W, Depth 1148 m
Form	Sub-spherical.
Size	About 5 cm in diameter.
Colour	Dark brown.
Consistency	Firm.
Surface	Hispid.
Spicules	Spicules are dichotrianes that are sometimes flexus with a slight thickening under the clads and sometimes the deuteroclad has an axial bend 7035 (5751-7693) x 106 (76-130) µm N = 12, protoclads are 307 (210-392) and deuteroclads 811 (484-1083) µm. Oxeas were very thin, and none were unbroken. Microscleres are plesiasters 35 (22-68) µm tip-to-tip and spirasters 25 (16-37) µm tip-to-tip.
Habitat	Unknown.
Distribution (WPD)	Unknown.
Remarks	The external morphology and presence of large, thin oxeas and smaller microscleres distinguish these specimens from the suspected *T. muricata* specimens collected in the same locality. Further work needs to be done on these specimens to assure correct species assignment.
References	Cardenas and Rapp (2012)

Tetilla sibirica (Fristedt, 1887)

Sample	CMNI 2018-0165, CMNI 2018-0183
Family	TETILLIDAE
Synonyms	*Tethya sibirica* Fristedt, 1887
Collection Details	Frobisher Bay 63.643° N, -68.609° W, Depth 65 m 63.639° N, -68.627° W, Depth 141 m
Form	Massive, spherical.
Size	Up to 20 cm in diameter.
Colour	Grey.
Consistency	Firm.
Surface	Hispid.
Spicules	The spicules consist of large oxeas 2811 (1784-4080) x 37 (28-54) µm, short oxeas are 1026 (754-1290) x 40 (26-52) µm, anatriaenes are 3030 (1992-4378) x 21 (9-35) µm, protriaenes, sometimes with one whip-like clad are 2219 (1150-3452) x 21 (6-29) µm, clads are 57 (29-83) µm, whip-like clads, when present are 91 (64-113) µm, and sigmaspires are 17 (11-20) µm in length.
Habitat	Soft bottoms.
Distribution (WPD)	High Arctic, Barents Sea, Northern Russia
Remarks	A common sponge in inner Frobisher Bay on sandy substrates.
References	Koltun (1966)

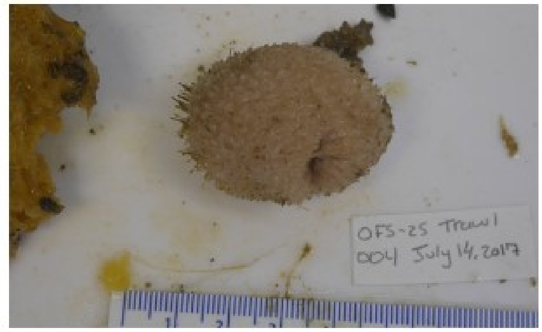
Top: whole on-board. Bottom: *in situ.*

Craniella cf. *polyura* (Schmidt, 1870)

Collected as a piece.

Sample	CMNI 2018-0184
Family	TETILLIDAE
Synonyms	*Lophurella lophura* Gray, 1872 *Polyurella schmidtii* (Gray, 1870) *Tetilla polyura* Schmidt, 1870
Collection Details	Frobisher Bay 63.639° N, -68.627° W, Depth 141 m
Form	Massive, ovoid.
Size	3cm tall by 1.5 cm wide.
Colour	Brown.
Consistency	Firm.
Surface	Hispid.
Spicules	The spicules consist of large oxeas that are often thicker on one end 2206 (1610-3453) x 28 (15-41) µm, short, very thin oxeas 441 (251-1199) x 9 (4-17) µm, protriaenes with one whip-like clad have a shaft length of 1905 (888-5879) x 16 (8-29) µm with clads 105 (36-183) µm which includes both short and long whip-like clads. Anatriaenes were uncommon and only one was found fully intact with a length of 7017µm, the shaft width is 14 (8-20) µm n=20, and the clads were 77 (57-94) µm, sigmaspires with a centrotylotic swelling were 13 (10-18) µm in length.
Habitat	Soft bottoms.
Distribution (WPD)	Barents Sea, the Kara Sea, the Laptev Sea, Greenland waters, Norway, the Azores, and Baffin Bay
Remarks	This sponge is distinguished from the sympatric *T. sibirica* by having sigmaspires with a centrotylotic swelling and by having an ovoid shape rather than being spherical. This sponge is likely very closely realted to *Tetilla sibirica* due to the similarities in spicule complements and body form, therefore the genus is in need of revision.
References	Van Soest (2016), Vosmaer (1885)

Craniella cf. *cranium* (Müller, 1776)



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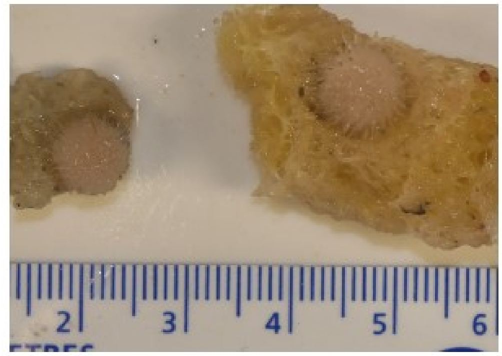
Sample	CMNI 2018-0168, CMNI 2018-0170, CMNI 2018-0173, CMNI 2018-0175
Family	TETILLIDAE
Synonyms	*Alcyonium cranium* Müller, 1776 *Craniella muelleri* Vosmaer, 1885 *Spongia pilosa* Montagu, 1814 *Tethya abyssorum* Carter, 1876 *Tethya cranium* (Müller, 1776) *Tethya cranium* abyssorum Carter, 1876 *Tethya cranium* infrequens Carter, 1876 *Tethya gravata* Hyatt, 1878 *Tethya infrequens* Carter, 1876 *Tethya pilosa* (Montagu, 1814) *Tethya unca* Bowerbank, 1872 *Tethyopsilla infrequens* (Carter, 1876) *Tetilla abyssorum* (Carter, 1876) *Tetilla cranium* (Müller, 1776) *Tetilla gravata* (Hyatt, 1878) *Tetilla infrequens* (Carter, 1876)
Collection Details	Frobisher Bay 62.954° N, -67.139° W, Depth 402 m
Form	Spherical with a distinctly papillated surface.
Size	Up to 5 cm in diameter.
Colour	Beige to pinkish.
Consistency	Firm.
Surface	Connulose, warty papillae are spread along the whole surface. Spicules are often protruding giving a hispid appearance.
Spicules	Spicules are stout oxeas 362 (267-442) x 28 (21-34) µm, long oxeas tapered at one end 1485 (943-2079) x 29 (21-37) µm N = 19, and protriaenes that were not seen unbroken, with a width of 22 (18-29) µm N = 7 and a clad length of 159 (143-175) µm N =12 and sigmaspires ~15 µm in length.
Habitat	Often growing on *Mycale lingua.*
Distribution (WPD)	Amphi-Atlantic.
Remarks	The true placement of some synonyms of this species is debated. *C. cranium* may contain genetically distinct species that are in need of revision.
References	Arndt (1935)

Craniella sp. Schmidt, 1870

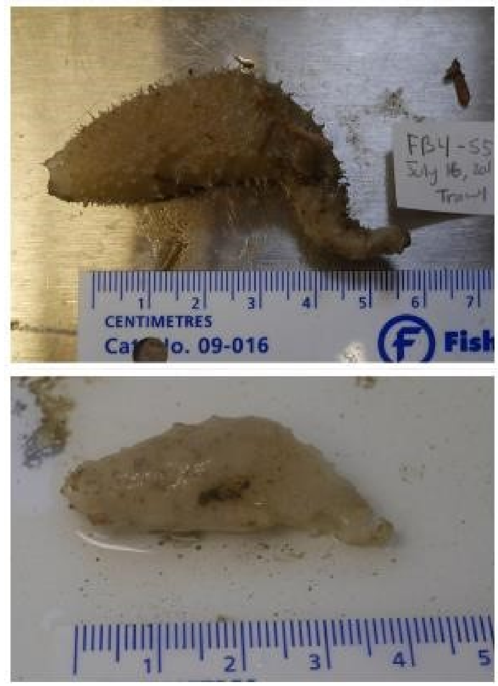


Shown whole growing on *Mycale lingua.*

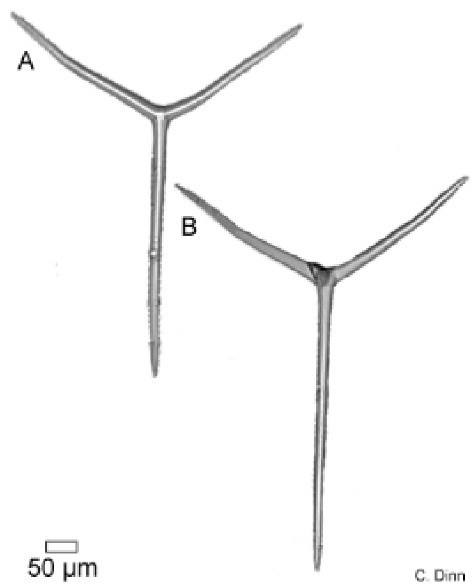
Sample	CMNI 2018-0129
Family	TETILLIDAE
Synonyms	*Craniellopsis* Topsent, 1913 *Polyurella* Gray, 1870 *Tethyopsilla* Lendenfeld, 1888
Collection Details	Northern Labrador Sea (SE Baffin shelf) 63.004° N, -60.643° W, Depth 457 m
Form	Small, round, with long protruding spicules.
Size	1 cm in dimeter.
Colour	Pink.
Consistency	Firm.
Surface	Very hispid.
Spicules	Spicules are protriaenes 1932 (1478-2318) x 18.6 (15.8-22.2) µm N=7 with clads 125 (108-144) µm in length N=19, long oxeas which are narrower on one end 1515 (865-1930) x 29 (17-38.3) µm N = 14, and stout oxeas which are quite variable in size 426 (269-520) x 28 (19.6-32.8) µm. Sigmaspire spicules were not measured as they were very rare, their rarity may be a distinguishing character.
Habitat	Unknown. Found growing on *Mycale lingua*.
Remarks	This sponge is genetically distinct from other *Craniella* specimens collected. The only discernable morphological difference is the long spicules projecting from the surface appear more pronounced in this specimen.
References	Arndt (1935)

Sycon cf. *lambei* Dendy & Row, 1913

Sample	CMNI 2018-0054, CMNI 2018-0057
Family	SYCETTIDAE
Synonyms	*Sycon asperum* Lambe, 1896
Collection Details	Frobisher Bay 63.558° N, -68.249° W, Depth 118 m 63.557° N, -68.247° W, Depth 104 m
Form	Tubular or barrel shaped.
Size	Up tp 8 cm long
Colour	Grey to off white
Consistency	Firm.
Surface	Large papillae along the outer surface.
Spicules	Calcareous. Triactines (A) with apical rays 211 (95-337) x 15.6 (6.5-25) µm, basal ray length 308 (158-487) µm. Tetractines (B) with apical ray length 219 (128-293) x 18 (13-24) µm, basal ray length 347 (189-460) x 19.7 (13-26) µm. Oxeas were not seen as apical tufts were not present.
Habitat	Unknown. Likely in softer sediments.
Distribution (WPD)	Canadian Exclusive Economic Zone, Gulf of St. Lawrence, North Labrador Sea.
Remarks	A taxonomically difficult family of sponges. Both specimens lacked a tuft of spicules surrounding the osculum. This was likely due to damage from collection as these specimens were collected using an Agassiz trawl. No oxeas were seen in spicule preparations which raises doubt about the species assignment. However, *Sycon lambei* has a well established Canadian distribution, therefore assignment to this species is suggested.
References	Lambe (1896)

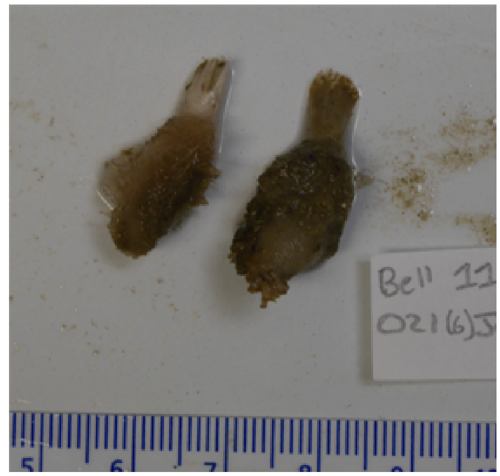


Top: shown whole. Bottom: collected as a piece.



Sycon sp.1 Risso, 1827

Sample	CMNI 2018-0185
Family	SYCETTIDAE
Synonyms	*Dunstervillia* Bowerbank, 1845 *Homoderma* Lendenfeld, 1885 *Leuckartea* Haeckel, 1872 *Scypha* Gray, 1821 *Streptoconus* Jenkin, 1908 *Sycarium* Haeckel, 1869 *Sycocystis* Haeckel, 1870 *Sycodendron* Haeckel, 1870 *Sycodendrum* Haeckel, 1869 *Syconella* Schmidt, 1868 *Sycortis* Haeckel, 1872 *Sycum* Agassiz, 1846 *Tenthrenodes* Jenkin, 1908



Shown whole.

Collection Details	Frobisher Bay 63.639° N, -68.627° W, Depth 141 m
Form	Barrel shaped with a long tuft of spicules at the apex.
Size	3-4 cm long, 1 cm wide.
Colour	Grey to off-white. Covered in a layer of sediment.
Consistency	Slightly firm.
Surface	Hispid.
Spicules	Triactines, tetractines, and very long oxeas. Measurements are highly variable, and spicules were often broken.
Habitat	Unknown.
Distribution (WPD)	Unknown
Remarks	Due to the variable nature of the spicules, this species could not reasonably be identified. Triactines have a similar form to descriptions of *S. ciliatum,* though the apical oxeas are very long in this specimen.
References	Ackers *et al.* (1992)

Calcarea unknown

Shown whole.

Sample	CMNI 2018-0187, CMNI 2018-0198
Collection Details	Frobisher Bay 63.359° N, -68.182° W, Depth 119m Northern Baffin Bay 76.317° N, -75.770, ° W, Depth 333m
Form	Tubular.
Size	Less than 2 cm
Colour	White.
Consistency	Firm.
Surface	Hispid due to protruding spicules.
Spicules	Triactines, tetractines, oxeas.
Habitat	On hard substrates.
Distribution (WPD)	Unknown.
Remarks	Specimens were very tiny, and spicules were difficult to isolate without destroying whole specimen. It is unknown whether these are juvenile *Sycon* spp. or another genus of calcareous sponge. The northern Baffin Bay specimen appears similar to Frobisher Bay specimen, but after preservation, spicules were impossible to isolate. Since this specimen appears to be more encrusting than stalked and upright, it is difficult to tell if they are the same species, therefore the distribution remains unclear.

Asconema spp. Kent, 1870

Sample	CMNI 2018-0069, CMNI 2018-0106, CMNI 2018-0113, CMNI 2018-0120, CMNI 2018-0137
Family	ROSSELLIDAE
Collection Details	North Labrador Sea (NE Hatton Basin) 61.440° N, -60.665° W, Depth 632 m North Labrador Sea (Saglek Bank) 60.463° N, -61.280° W, Depth 427 m 60.469° N, -61.289° W, Depth 401 m North Labrador Sea (SE Baffin shelf) 62.987° N, -60.629° W, Depth 500 m western Greenland shelf (Disko Fan) 67.967° N, -59.484° W, Depth 877 m
Form	Large, ill-defined funnel shaped with individual tubes forming a large bush-like structure.
Size	Variable, bushes can be greater than30 cm in diameter.
Colour	White.
Consistency	Soft, easily torn.
Surface	Smooth.
Spicules	More measurements are required
Habitat	Hard substrates.
Distribution (WPD)	Amphi-Atlantic.
Remarks	Large, bush-like glass sponges are assumed to be *A. foliatum* (Fristedt, 1887), though species affinities cannot easily be confirmed by DNA as amplification of COI did not amplify. Multiple species in the region may be assumed to be *Asconema*, but more work is required.
References	Tabachnick and Menshenina (2007)

Top: *in situ.* Bottom: collected as pieces.

Chapter 4. Discussion

4.1 Overview

Sponges are sessile filter feeding animals that pump water through their bodies to obtain food and to excrete wastes. The role of sponges as ecosystem engineers by filtering the surrounding water column and by providing biogenic habitat for other organisms underscores their importance in benthic marine ecosystems. Despite their known ecological importance, the knowledge of sponge biodiversity in the eastern Canadian Arctic and Subarctic is fragmentary, both in terms of described species and distributions.

This thesis describes the diversity of sponges species along the eastern Canadian shelf. Chapter 2 reveals how opportunistic collection of sponges within a single bay can provide an understanding of sponge community structure in a limited geographic area, Frobisher Bay. Chapter 3 presents a field guide to sponge species of deep-water habitats in the Canadian Arctic and SubArctic. These two chapters represent an exploratory goal: to describe the unknown. The objectives were to investigate the hidden biodiversity, and to begin to catalogue the sponge fauna of hard-bottom and biogenic (coral/sponge-based) habitat types in the Canadian Arctic.

4.2 The biodiversity of sponges in Eastern Canada is higher than previously reported

From 162 specimens collected on three cruises of the *CCGS Amundsen* I identified 61 distinct sponge species. I identified 42 of them based on published descriptions, but 19 I could only identify to genus level. These sponges were found over a wide geographic area, which traverses three marine ecoregions of the world (MEOWs): Northern Labrador, Baffin Bay/Davis Strait, and Lancaster Sound. In the Northern Labrador MEOW, 115 sponges were collected, and 36 distinct species were described. In Baffin Bay/Davis Strait, 43 sponges were collected, with 23 distinct species identified. In the Lancaster Sound marine ecoregion, only three sponges were collected, representing two species.

The major reference for sponges globally is the World Porifera Database, kept up-to-date by Rob Van Soest of Naturalis Biodiversity Center, formerly the Zoologisch Museum of Amsterdam and a suite of specialist editors (Van Soest *et al.*, 2018). Before this work, the World Porifera Database reported that there were 19 species of sponge in the Northern Labrador marine ecoregion. In the Baffin Bay/Davis Strait MEOW, twenty-three sponge species were previously described. No sponges were described from Lancaster Sound. Although the WPD does not list sponges that are identified to genus, for the purpose of this discussion, sponges that were identified to genus but could not be narrowed to a specific taxon were considered distinct species from the other sponges collected.

There is minimal overlap between the species recorded in the WPD and the species I identified in this thesis (Table 4-1): three species identified from Northern Labrador in the present collections were listed in the WPD; five species in Baffin Bay/Davis Strait that were identified here were listed in the WPD; and the two species identified in Lancaster Sound were the first sponges described from that ecoregion. This work therefore increases the identified number of species (excluding unresolved species) reported from Northern Labrador to 48, in Baffin Bay/Davis Strait to 33 (six of which also occur in Northern Labrador), and Lancaster Sound to two (one of which also occurs in Baffin Bay/Davis Strait). This shows that 76 separate named species have been identified in the region, with another 19 species that could only be identified to genus. Therefore, a total of 95 sponge species have been shown to live in the study region.

Eastern Canada has low diversity sponges compared to regions in the NE Atlantic and the Caribbean. In a 2012 review of global sponge biodiversity based on records in the WPD, Van Soest *et al.* (2012) reported that fewer than 16 species were reported in the three eastern Canadian Arctic and Subarctic ecoregions combined, compared to 458, 461, and 275 species in the Azores, Mediterranean, and Greater Antilles marine ecoregions respectively. It is unknown whether the rate of species discovery in other areas is as high as it is currently in Eastern Canada since that 2012 survey. In Eastern Canada about 16 species of sponges have been described each year since 2012, and it would be interesting to know if with continued collections numbers would increase to rival the diversity known from those other geographical areas. However, because we used a number of different methods for collecting sponges, and neither trawls nor ROV collections were intended to be quantifiable, a species accumulation curve cannot be properly used to estimate the number of species expected to be found in the region. Future work identifying sponges collected in DFO annual survey trawls or through fisheries bycatch may give a better understanding of the number of species expected to be found along the eastern Canadian shelf.

Table 4-1. Number of sponge taxa found in each marine ecoregion. Sponges identified during this thesis work that were previously listed in the WPD are shown in bold. Species and genera found in overlapping ecoregions are noted in parentheses.

	Number of Taxa previously known (WPD)	Number of sponges identified to species	Number of sponges identified to genus	Number of distinct sponge species described from the ecoregion
Northern Labrador	19 **(3)**	32	14	62
Baffin Bay/Davis Strait	23 **(5)**	15 (6)	8 (3)	41(9)
Lancaster Sound	0	2 (1)	0	2(1)

Species numbers are not the whole story, however. The sponges collected in this work are species that are mostly found below the littoral zone and so must be collected either by Agassiz trawl, by box core or by submersible. These collections are therefore not equivalent to species collected primarily by SCUBA or using near-shore dredges (Ackers *et al.*, 1992; Santín Muriel *et al.*, 2018). No SCUBA or dredge collections of sponges from shallow near-shore regions of the eastern Canadian Arctic have been done and so the species that may occur there remain unknown. Only six specimens were collected shallower than 100 m during the three-year sampling program discussed in this thesis. This suggests that sponge species within the SCUBA zone (<60 m) have yet to be identified in Eastern Canada, especially in the Arctic and Subarctic ecoregions. Although survey trawls are the primary means for assessing benthic biodiversity in Eastern Canada, they cannot assess benthic biodiversity in fjords and bays where large trawl nets are impractical (Kenchington, Link*, et al.*, 2011).

4.3 Sponge communities are similar at similar latitudes.

Many of the sponges identified to species during the course of this work are species that are known to occur in the Northeast Atlantic and high Arctic. This was not entirely expected. When this work began, recent literature on sponge species distributions in the eastern Canadian Arctic and Subarctic focused on large sponge ground forming species such as *Geodia* spp. (Fuller *et al.*, 2008; Murillo *et al.*, 2012; Beazley *et al.*, 2013; Knudby *et al.*, 2013), and a single field guide for the eastern Canadian shelf region only identified 16 sponges to species and additional 17 sponges to genus (Kenchington *et al.*, 2015). Some of the sponge species in that guide do not have documented distributions in Eastern Canada listed in the WPD, suggesting that no published records of these sponges exist for the area. The purpose of this guide was to be a visual field identification tool for fishers and fisheries observers as well as for those studying conservation and biodiversity, and thus does not provide in-depth taxonomic advice to identify specimens. Because of this, for my work it became necessary first to identify sponges to family based on spicule complements found in literature such as Systema Porifera (Hooper & Van Soest, 2002), and then to compare spicule measurements with guides describing large collections of sponges from elsewhere in the Atlantic (Boury-Esnault *et al.;* Boury-Esnault, 1971; Pansini, 1987; Ackers *et al.*, 1992; Boury-Esnault *et al.*, 1994; Picton & Goodwin, 2007). It became clear that based on spicule measurements alone many species collected in Eastern Canada appeared to fit the descriptions of European species and several species could be identified to species using

European guides and recent species descriptions from the NE Atlantic. A few species were particularly difficult to identify and required help from experts. *Tetilla sibirica*, for example, has rarely been collected, is only known from the high Arctic and the Kuril Islands, and the most recent account of the species was in the mid 20th century (Fristedt, 1887; Koltun, 1966). Overall, however, the species composition of the region seems quite similar to that described from European waters.

Community structure, irrespective of species composition, is also similar to sites elsewhere in the North Atlantic, as well as similar to high latitude environments in the southern hemisphere. A study of the sponge communities of the Antarctic Peninsula shows the sponge community to be quite similar to communities in Frobisher Bay and the North Labrador Sea (Kersken *et al.*, 2016). Genera such as *Iophon, Asbestopluma, Biemna, Hymedesmia, Haliclona, Lissodendoryx, Mycale, Phorbas, Plocamionida, Polymastia, Tedania, Tentorium,* and *Tetilla,* are common between these two geographically distant locations, though many sponge genera are indeed cosmopolitan. Guides of sponges from the NE Atlantic show communities dominated by pocilosclerid sponges (Ackers *et al.*, 1992), and although the species described from these regions are not entirely congruent with the communities encountered in Eastern Canada, genus-level trends are apparent. Due to the vast geographic area covered for this thesis, it is not entirely possible to directly compare species richness and diversity to other works which focus on small geographic areas with extensive collections. However, even within Frobisher Bay, sponge communities appear to vary based on depth and substrate type. To compare sponge communities globally, it would be necessary to take habitat and environmental parameters into account, avoiding assumptions based on latitude alone.

4.4 Amphi-Atlantic range extensions

Geographic range extensions for sponges that occur in Frobisher Bay were described in detail in Chapter Two. The five sponges reported were species that were not recorded from the Northern Labrador ecoregion previously but were known from other sites in the Atlantic. Other sponges were not able to be narrowed to species without analysis of DNA. Species such as *Tethya* cf. *norvegica* and *Mycale (Anomomycale) titubans* were not initially considered to fit current species descriptions based on spicule morphology, but DNA analysis showed a strong affinity with those species, so they are now considered to be geographic range extensions as well. Several species remain unresolved in the current collections and it unclear based on morphology and DNA if they are species new to science, or if they may be poorly known species. Specimens like *Iophon* cf. *nigricans, Phorbas* sp. and *Haliclona (Reniera)* sp. *1* do not fit descriptions I could find, and so these could potentially be new species. Further comparative work is required to resolve those species identifications. It seems likely that future collections particularly in under-sampled regions above the Arctic circle, or identifications of previously collected sponges from Eastern Canada will add to the number of geographic range extensions.

4.5 Discovering hidden biodiversity

4.5.1 Cryptic species

This work underscores the need for in-depth, integrative taxonomic work to identify the sponge fauna of a region. Video-based identifications are insufficient as many species may be cryptic and impossible to identify *in situ* (Hooper, 2000; Hooper & Van Soest, 2002). For example, a number of quite similar looking 'fan-shaped' sponges collected represent different species, and yet some species of sponge have a fan shape in one place and a vase shape in another. I identified a fan-shaped, stalked sponge in the North Labrador Sea on a rocky bottom habitat to be *Axinella arctica.* A similar fan shaped sponge on the Western Greenland shelf that is found in association with *Keratosis* coral is *Plicatellopsis* sp. However, in Pond Inlet *Plicatellopsis* sp. has a different form. Initially I thought these were different species, but DNA barcoding confirmed they were the same species, and so clearly that sponge has two morphologies which are habitat dependent. To further complicate the identification of fan shaped sponges, *Axinella arctica* and *Plicatellopsis* sp. both have styles, monaxon spicules with one pointed end and one rounded end. However, oxeas (diactinal spicules pointed at both ends) are only found in *Axinella arctica* specimens. Both styles and oxeas have similar sizes in both species, and therefore without careful study of spicule measurements and without DNA analysis these species are quite difficult to differentiate.

Other species are equally difficult to distinguish from images. All members of the genus *Polymastia* were not clearly distinguishable *in situ* and required careful spicule measurements or molecular identification. *Polymastia* is a group of distinctive, mostly cushion-shaped sponges that have large characteristic papillae on the surface. The ROV video imagery showed there were *Polymastia* species in most habitats, but to separate the two sympatric species *P. uberrima* and *P. thielei* needed both spicule and DNA work. These species can be distinguished by the body shape (ovoid vs. spherical) and the placement of the papillae (on the upper portion only vs. over the entire surface), but these gross markers are incredibly difficult to distinguish *in situ* and in most cases even after collection on the ship. It remains unknown whether *P. uberrima* also occurs as far north as *P. thielei*, because we didn't collect it at the northern sites and it cannot be identified from video imagery. This example underscores the limitations of imagery-based assessments of biodiversity over wide geographic areas.

4.5.2 Cryptofauna

Not only are cryptic species that look similar to others a concern when assessing biodiversity, but cryptofauna - species that are difficult to see at all - should also be considered. When I received a grab or trawl sample, I meticulously removed sponges from rocks, scraped off coral skeletons, and found some specimens growing even within other sponges. Several species of encrusting sponge were collected: *Janulum spinispiculum*, a bone-white species, *Plocamionida ambigua,* a pink/red sponge, and *Hymedesmia (Hymedesmia) paupertas*, a blue/green sponge were crusts found on rocks, hardly visible to a casual observer. Although some species like *H. paupertas* have a distinctive colour *in situ*, after collection the specimens become dull and can easily be missed in large trawl or core collections. Several species, like *P. ambigua* have been considered to be "troublesome 'red crust' clathriids" which also include species of *Antho* (Ackers et al., 1992) which are notoriously difficult to separate without careful spicule comparisons, but appear as thin rust coloured patches on rocks. Other species such as *Pseudosuberites* sp. were found only encrusting dead branches of *Keratosis* coral along the western Greenland shelf (Neves *et al.*, 2015). A specimen of *Janulum spinispiculum,* a thin, bone-white encrusting sponge, was collected by chance in the North Labrador Sea as it was encrusting a rock with more characteristic sponges of interest also attached. *J. spinispiculum* is not commonly encountered (Calcinai *et al.*, 2013; Kelly *et al.*, 2015), and is not reported in the WPD as occurring in the area (Ríos *et al.*, 2016). The rarity of deep-water cryptofauna like the encrusting sponge *Janulum* may be due to a general ignorance to identify the unexpected. Collection and identification of these difficult to distinguish, and difficult to recognize specimens requires a keen eye and careful taxonomic comparisons to realize actual biodiversity of an area.

4.6 Assessing benthic biodiversity requires a multifaceted approach

Collecting specimens from deep sea habitats comes with a unique set of challenges. Suitable vessels, reliable sampling equipment, experienced operators, and time on a research vessel are limiting factors when it comes to sampling the benthos (Jamieson *et al.*, 2013). The Canadian Arctic is also difficult to reach. Few research vessels are equipped to navigate the thick ice of the region. Ice cover can also be detrimental to sampling operations, as benthic sampling cannot occur if ice floes may come into contact with the research vessel and potentially damage trawl or box core cables. Ice conditions can also unpredictably halt ROV operations which can have disruptive effects on cruise planning and logistics. All of these factors lead to a reliance on opportunistic sampling. Planned ROV transects may have to change location if ice cover prevents diving and box core deployments may not reach the bottom planned for sampling if sea swell is heavy.

Over a three-year sampling program, 162 sponge specimens were collected for the purposes of this thesis. However, sponges from the region are collected annually, mostly through trawls carried out by government agencies (Archambault *et al.*, 2010; Kenchington *et al.*, 2010; Kenchington, Link*, et al.*, 2011; Roy *et al.*, 2015). The sponges collected in those trawls are weighed, which provides important information about overall benthic biogenic structure, but currently only a select few species groups have been identified and reported from these trawls (Hestetun *et al.*, 2017; Plotkin *et al.*, 2017; Tompkins *et al.*, 2017; Baker *et al.*, 2018). It is unknown what proportion of sponges are retained and preserved for species level identifications. The collections are carried out using large Campelen or Cosmos shrimp trawls which are also used to assess fish stocks and other benthic faunal biodiversity, but which cannot be used nearshore and on rocky habitats, unlike the gear which was used in my work.

Reliance on multi-species trawl surveys alone may not be representative of the whole benthic sponge fauna of a region. In a recent report from the Sea of Okhotsk, Downey *et al.* (2018) show that small Agassiz trawls were the most successful method for specimen collections, where over 90% of species morphotypes identified in the region were collected by this type of net. This was not the case in this thesis work. Trawls were not effective in the collection of species encrusting rocks, as large rocks and boulders led to ripping of the trawl mesh and were ultimately not collected. Trawls could also not be deployed in steep or overly rocky habitats, therefore in sites such as Pond Inlet where sponges were collected along a submarine cliff, only the ROV was effective for sponge collection.

Sponge 'catchability' is also a factor. Overall sponge catchability is likely low in trawls, mainly due to the fragile and small nature of many species which may lead to disintegration before reaching the deck (Wassenberg *et al.*, 2002; Knudby *et al.*, 2013). Accounts of catchability of sponges using a trawl net and camera suggest that sponges less than 30 cm in size have catchability of less than 20%, and overall sponge catchability for all size classes was about 14% (Wassenberg *et al.*, 2002). Large sponges that pass into the net are also often broken into pieces as well (Wassenberg *et al.*, 2002; Kenchington, Murillo*, et al.*, 2011) which can give a biased account of true sponge abundance and biomass. Sponge catchability is also understandably low in box cores due to the limited area sampled by a single core and the likelihood of a particular core landing in a patch of sponge (Kenchington, Murillo*, et al.*, 2011).

The sampling in this study was opportunistic. Trawl and box core sets were not always successful in collecting sponges, and ROV collections are restrained by the amount of dive time available for sponge collections. Of the 162 specimens collected, 36% of sponges were collected by Agassiz trawl, 39% of sponges were collected by box core, and 25% of sponges were collected by ROV. Box cores were used in all ecoregions, but sponges were only collected in cores from the Northern Labrador ecoregion. This is likely because substrates in the North Labrador Sea were rocky, while in Baffin Bay substrates were mainly soft, with less hard structures on which sponges can settle. Box cores also only sample a small (0.5 m^2) area, and the lack of sponges collected in box cores in Baffin Bay may have been simply by chance. Many encrusting species were only collected in box cores in this study. *Halichondira panicea, Plocamionida ambigua, Plocamionida* sp.*, Hymedesmia (Hymedesmia) paupertas, Tedania (Tedania) suctoria, Melonanchora elliptica,* and *Biemna variantia* were never collected by trawl, which strongly suggests that alternative methods of sponge biodiversity assessment are required in rocky habitats.

From the collections described in this thesis, it is not possible to accurately assess catchability of sponge species. Standardized methodology such as consistent stratified trawl tows (Kenchington *et al.*, 2010; Kenchington, Link*, et al.*, 2011; Roy *et al.*, 2014, 2015), camera-coupled trawls (Wassenberg *et al.*, 2002) or box core transects verified by visual surveys (Kenchington, Murillo*, et al.*, 2011) could give a better indication of which sponge species are able to be collected by a particular method. A synthesis of collection methods is desirable to better understand overall benthic biodiversity, as well as to quantify any ecological interactions which may occur on the benthos of a given region.

4.7 Sponge communities throughout eastern Canada vary based on habitat

Although this work relied on opportunistic sampling over a wide geographic area, it was clear that particular sponge species were only found in certain sites, while some species were found at most sites. Sites in the North Labrador Sea (NE Hatton Basin, Saglek Bank, SE Baffin shelf) are consistently rocky, Frobisher Bay is mostly sandy with some bedrock outcrops, Disko Fan on the western Greenland shelf has a muddy bottom with dense *Keratoisis* coral forests, Pond Inlet has steep bedrock walls with patches of flat sand, and Lancaster Sound has a homogeneous sandy habitat. Each of these habitat types had distinct sponge communities. It is possible that the local environmental factors (tides, current and food availability) shapes these communities, but substrate type is likely a major factor since sponge larvae require firm substrates for settlement. For example, *Polymastia* species were found at most sites and were quite often seen in ROV video. *Tentorium semisuberites* was also collected throughout the whole study area, and was collected on rocks and dead coral skeletons, although this species is quite small and is difficult to see during an ROV dive. However, some species appeared to be more specialized for particular habitats. *Chondrocladia grandis* was only collected in sandy/muddy habitats in Pond Inlet and Lancaster Sound. *C. grandis* is a peculiar sponge, not only because it is carnivorous thus has particular food requirements, but it also has extensive root tufts to anchor it into the sediment. *Pseudosuberites sp*., and *Haliclona (Reniera)* sp. *1* were only found growing among *Keratoisis* coral forests and on dead coral branches, which could suggest specialization to this particular habitat. Because these specimens collected along the western Greenland shelf could not be narrowed to a specific taxon, they may represent endemic species unique to this particular geographic region.

Habitat type can be coarsely identified from eight ROV dives which occurred over a wide geographic area. Four of these dives were carried out in nearby sites in the North Labrador Sea (dives 50-53), two dives occurred in the West Greenland shelf site (dives 54 and 55), one in Pond Inlet, and one in Lancaster Sound. From these dives it is apparent that bottom type varies along the eastern Canadian exclusive economic zone, but it is not clear where transition areas between these habitat types occur. More information on bottom types, whether it be from additional ROV dives or from drop camera surveys in other sites in the Canadian Arctic would help determine whether these sites are representative of the region as a whole.

4.8 Future directions

Quantification of the sponge fauna of eastern Canada is not complete. This work relied solely on the identification of sponges collected during three field seasons on board the *CCGS Amundsen*. Sponges have been collected in the region for several years (Kenchington, Link*, et al.*, 2011), thus the true sponge fauna of the region can be further described from preserved specimens. Sharing of specimens and expertise among researchers in the region will only serve to improve our knowledge of the benthic fauna of the region.

4.9 Concluding statements

This work used an integrative taxonomic approach to identify sponges in the eastern Canadian Arctic and Subarctic. By using varied benthic sampling methods and through collection of underwater video, sponge communities in several sites in eastern Canada were described. Using only freshly collected specimens, the first inventory of the sponge fauna of Frobisher Bay was created, and a guide to sponges of the North Labrador Sea, Baffin Bay/Davis Strait, and Lancaster Sound was presented to allow quantification of seafloor habitats during future work in the Canadian Arctic.

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Appendix 1. Tables of DNA sequences using COI and 28S from Chapter 2

Table A1.1. COI sequences for select sponges from Frobisher Bay

Taxon	GenBank Accession Number	CMN Catalogue Number	Trimmed Contig Sequence
Craniella cf. *cranium*	MH394252	CMNI 2018-0168	GTTAGTTTGCTTATTAGATTAGAACTATCCACTCCCG GACTAATGTTGGGTGACGACCATTTATATAATGTTAT GGTCACGGCCCACGGCCTTATAATGATCTTTTTCTTA GTTATGCCGGTTATGATAGGGGGGTTCGGTAATTGA ATGGTTCCCCTTTATATAGGGGCACCGGATATGGCTT TTCCAAGATTAAACAATATTAGTTTTTGAGTTTTACC CCCTTCCTTAATACTACTGTTAGGTTCTGCTTTTGTTG AACAAGGGGTTGGGGCAGGATGAACCCTTTATCCCC CCTTATCTAGTATACAAGCTCATTTTGGGGGTTCAGT CGACGCGGCAATCTTTAGTCTTCATTTGGCCGGTATT TCTTCAATTTTAGGGGCAATGAATTTTATAACTACTA TCTTTAATATGCGGGCACCGGGGATTACCATGGATC GGTTGCCTTTATTTGTTTGATCTATTTTAGTAACAACT TATTTGTTATTATTAGCTTTACCAGTATTGGCGGGCG CAATCACTATGCTTTTAACAGATAGAAATTTCAATAC
Craniella cf. *cranium*	MH394253	CMNI 2018-0175	GATTTAGTTTGCTTATTAGATTAGAACTATCCACTCC CGGACTAATGTTGGGTGACGACCATTTATATAATGTT ATGGTCACGGCCCACGGCCTTATAATGATCTTTTTCT TAGTTATGCCGGTTATGATAGGGGGGTTCGGTAATT GAATGGTTCCCCTTTATATAGGGGCACCGGATATGG CTTTTCCAAGATTAAACAATATTAGTTTTTGAGTTTT ACCCCCTTCCTTAATACTACTGTTAGGTTCTGCTTTTG TTGAACAAGGGGTTGGGGCAGGATGAACCCTTTATC CCCCCTTATCTAGTATACAAGCTCATTTTGGGGGTTC AGTCGACGCGGCAATCTTTAGTCTTCATTTGGCCGGT ATTTCTTCAATTTTAGGGGCAATGAATTTTATAACTA CTATCTTTAATATGCGGGCACCGGGGATTACCATGG ATCGGTTGCCTTTATTTGTTTGATCTATTTTAGTAACA

			ACTTATTTGTTATTATTAGCTTTACCAGTATTGGCGG GCGCAATCACTATGCTTTTAACAGATAGAAATTTCA AT
Polymastia thielei	MH394254	CMNI 2018-0169	TGCGCCGGGGGCAATGTTAGGGGATGATCATTTGTA TAATGTTATAGTAACGGCCCATGCATTTGTGATGATA TTTTTTTTAGTTATGCCGGTAATGATAGGGGGATTTG GAAATTGACTTGTTCCTTTATATATAGGGGCGCCAGA TATGGCGTTTCCAAGGTTAAATAATATTAGTTTTTGG CTTTTACCTCCTTCTCTAACTTTATTATTGGGTTCAGC TTTTGTTGAGCAAGGGGCTGGGACAGGGTGAACGGT TTATCCCCCCCTGTCTAGTATACAAACACACTCAGGA GGGTCAGTAGATATGGTGATATTTAGTTTGCATTTAG CAGGGATTTCGTCGATATTGGGTGCAATGAATTTCAT TACAACCATTTTTAATATGAGAGCACCTGGGATTAC AATGGATAGAATGCCGTTATTTGTGTGATCTATTTTA ATTACTGCGTTTTTATTATTACTATCTTTGCC
Haliclona (Reniera) sp.	MH394255	CMNI 2018-0176	AGATTGGAACTATCTGATCCGGGGTCTATGTTAGGG GATGATCATTTATATAATGTTATAGTAACAGCTCATG CATTTGTAATGATATTTTTTTTAGTTATGCCAGTAAT GATCGGGGGGTTTGGTAATTGGTTAGTTCCATTATAT ATTGGTGCTCCTGATATGGCTTTCCCTAGATTAAACA ATATTAGTTTCTGGTTGTTACCCCCGGCGCTTACCTT ATTATTAGGTTCTGCTTTTGTGGAACAAGGGGCTGGG ACAGGTTGAACAGTGTATCCGCCTTTATCTAGTATTC AAACTCATTCTGGGGGATCTGTGGACATGGTGATAT TTAGTCTTCATTTAGCAGGTATATCTTCAATATTGGG TGCTATGAATTTTATAACTACAATATTTAATATGAGG GCACCAGGGATAACTATGGATAGAATGCCTTTATTT GTTTGATCTGTTTTAGTGACTGCCTTTTTATTATTATT ATCCTTGCCAGTATTAGCCGGTGCGATAACAATGCTT TTAACCGACCGAAACTTTAAT

Table A1.1. 28S D3-D5 sequences for select sponges from Frobisher Bay

Taxon	GenBank Accession Number	CMN Catalogue Number	Trimmed Contig Sequence
Iophon cf. *nigricans*	MH394248	CMNI 2018-0180	GGTGGCAAACCCGTCGGCGCAATGAAAGTGAA GGCAGCTCTTTTGCTGCTGTGGCGAGAGCCTCC TTGCGAGGCGCATCGTCGACCGATCCCAAGCT ACGCTGTGGCGGGATTTGAGTGAGAGCGTGCC TGTTGCGACCCGAAAGATGGTGAACTATGCCT GAATAGGGTGAAGCCAGACGAAAGTCTGGTG GAAGCTCGTAGCGATTCTGACGTGCAAATCGA TCGTCAAATTTGGGTATAGGGGCGAAAGACTA ATCGAACCGTCTAGTAGCTGGTTCCCTCCGAA GTTTCCCTCAGGATAGCTGGAGCCCGGTGCAG TTTTATCAGGTAAAGCGAATGATTAGAGGTCT TGGGGCTGAAACGGCTTCAACCTATTCTCAAA CTTTAAATGGGTAAGAAGCCCGGCTTGCTCGG TTGAAGTCGGGCGTTAGAATGCCGGGGCTCCC AGTGGGCCATTTTTGGTAAGCAGAACTGGCGA TGTGGGATGAACCAAATGCCGGGTTAAGGTGC CGGAATCGACGCTCATCAGATCCCATGAAAGG TGTTGGTTGATACAGACAGCAGGAC
Tetilla sibirica	MH394249	CMNI 2018-0183	GTGGTAGAAACCCCGCGAGCGCAATGAAGGTG AAGGTGAGACTTGTGCTCACTGAGGCGAGAGC CGCCCTCGTGGCGGCGCATCGTCGCCCGATCC AACGCCACGCCGTGGCGGGATTCGAGTGAGAG CGTTGCTGTTGCGACCCGAAAGATGGTGAACT ATGCCTGAGCAGGGTGAAGCCAGAGGAAACTC TGGTGGAAGCCCGCAGCGGTTCTGACGTGCAA ATCGATCGTCAAACTTGGGTATAGGGGCGAAA GACTAATCGAACCATCTAGTAGCTGGTTCCCTC CGAAGTTTCCCTCAGGATAGCTGGAGCCCTCG ATGCAGTTTTATCAGGTAAAGCGAATGATTAG AGGTCTTGGGGTCGAAACGATCTCAACCTATT CTCAAACTTTAAATGGGTAAGACGTCCGGCTT GCTTAAGTGAAGCCGGGCCACGAATGCCGGGG

			CTCCCAGTGGGCCATTTTTGGTAAGCAGAACT GGCGATGCGGGATGAACCGAACGCTGAGTTAA GGTGCCCGAATCGACGCTCATCAGATCCCATG AAAGGTGTTGGTTGATCTAGACAGCAGGACGG TGGCC
Craniella cf. *polyura*	MH394250	CMNI 2018-0184	AACCCCGCGAGCGCAATGAAGGTGAAGGCGA GACTTGGGCTCGCCGAGGCGAGAGCCGCCCTC GTGGTGGCGCATCGTCGCCCGATCCAATGCCA CGTCGTGGCGGGATTCGAGTGGGAGCGTTGCT GTTGCGACCCGAAAGATGGTGAACTATGCCTG AGCAGGGTGAAGCCAGAGGAAACTCTGGTGG AAGCCCGCAGCGGTTCTGACGTGCAAATCGAT CGTCAAACTTGGGTATAGGGGCGAAAGACTAA TCGAACCATCTAGTAGCTGGTTCCCTCCGAAGT TTCCCTCAGGATAGCTGGAGCCCTCGATGCAG TTTTATCAGGTAAAGCGAATGATTAGAGGTCT TGGGGTCGAAACGACTTCAACCTATTCTCAAA CTTTAAATGGGTAAGACGCCCGGCTTGCTTAA GCGAAGCCGGGCCACGAATGCCGGGGCTCCCA GTGGGCCATTTTTGGTAAGCAGAACTGGCGAT GCGGGATGAACCGAACGCCGAGTTAAGGTGCC CGAATCGACGCTCATCAGATCCCATGAAAGGT GTTGGTTGATCTAGACAGCAGGACGGTGGCC

Table A1.2. 28S D6-D8 sequences for select sponges from Frobisher Bay

Taxon	GenBank Accession Number	Catalogue Number	Trimmed Contig Sequence
Iophon cf. *nigricans*	MH394251	CMNI 2018-0180	GTGTCGTACCCATACCCGGCCGTCGGGTCGAGCGGC GTGACCCGATGTGTAGGAGGGCGCGGTGGTGGCCGT GCAGCCTCTGGCGCGAGCCTGGGTGAAGCCGCCACC GGTGCAGATCTTGGTGGTAGTAGCAAATATTCAAAC GAGAACTTTGAAGACTGAAGTGGAGAAGGGTTCCAT GTGAACAGCAGTTGGACATGGGTTAGTCGATCCTAA GGGAAAGGAGAGGTCCCTCTGGAAGGCGCAACATC

	GCTTCGGCGACCCGCGCCATTCCCCGAAAGGGAATC GGGTTAACATTCCCGAACCGGGATGCGGATAGGGCC TCAACGCCCGCAGCGGCGACGCAAGCGAACTCGGAG ACGTCGGCGGGAGCCCCGGGAAGAGTTCTCTTTTCTT CTTAACGGACTGGCACCCTGGAATCAGATTGGCTGG AGATAGGGTCGAATGTCCGGTAAAGCACCACACTTG TGGTGGTGTCCGGTGCGCTCTCGACGGCCCGTGAAA ATCCGAGGGAGCGAGTTATTCACGCGCCCGGTCGTA CCGATAACCGCATCAGGTCTCCAAGGTGAACAGCCT CTAGT

A1.1. Alignment of 28S D3-D5 sequences for CMNI 2018-0180 Iophon cf. nigricans with KF018114.1 Iophon nigricans and KF018107.1 Iophon hyndmani.

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2018-0180('17)1 GG--------------------------------------TGGCAAACCCGTCGGCGCAA
2018-0180('18)1 GT--------------------------------------------------CGGCGCAA
KF018114.1    1 ACACGGACCAAGGAGTGCAACATGCGTGCGAGTCTCTGGGTGGCAAACCCGTCGGCGCAA
KF018107.1    1 ACG--AACCAAGGAGTGCAACATGCGTGCGAGTCTCTGGGTGGCAAACCCGTCGGCGCAA
MC4296        1 TC--------------------------------TCTGGGTGGCAAACCCGTCGGCGCAA
MC3646        1 CG----------------------------------------------------GCGCAA
MC5341        1 CG----------------------------AGTCTCTGGGTGGCAAACCCGTCGGCGCAA

2018-0180('1723 TGAAAGTGAAGGCAGCTCTTTTGCTGCTGTGGCGAGAGCCTCCTTGCGAGG---CGCATC
2018-0180('1811 TGAAAGTGAAGGCAGCTCTTTTGCTGCTGTGGCGAGAGCCTCCTTGCGAGG---CGCATC
KF018114.1   61 TGAAAGTGAAGGCAGCTCTTTTGCTGCTGTGGCGAGAGCCTCCTCGCGAGG---CGCATC
KF018107.1   59 TGAAAGTGAAGGCAGCTCTTTTGCTGCTGTGGCGAGAGCCTCGGTAACACGAGGKGCATC
MC4296       29 TGAAAGTGAAGGCAGCTCTTTTGCTGCTGTGGCGAGAGCCTCCTCGCGAGG---CGCATC
MC3646        9 TGAAAGTGAAGGCAGCTCTTTTGCTGCTGTGGCGAGAGCCTCCTCGCGAGG---CGCATC
MC5341       33 TGAAAGTGAAGGCAGCTCTTTTGCTGCTGTGGCGAGAGCCTCCTCGCGAGG---CGCATC

2018-0180('1780 GTCGACCGATCCCAAGCTACGCTGTGGCGGGATTTGAGTGAGAGCGTGCCTGTTGCGACC
2018-0180('1868 GTCGACCGATCCCAAGCTACGCTGTGGCGGGATTTGAGTGAGAGCGTGCCTGTTGCGACC
KF018114.1  118 GTCGACCGATCCCAAGCTACGCTGTGGCGGGATTTGAGTGAGAGCGTGCCTGTTGCGACC
KF018107.1  119 GTCGACCGATCCCAAGCTACGCTGTAGCGGGATTTGAGTGAGAGCGTGCCTGTTGCGACC
MC4296       86 GTCGACCGATCCCAAGCTACGCTGTGGCGGGATTTGAGTGAGAGCGTGCCTGTTGCGACC
MC3646       66 GTCGACCGATCCCAAGCTACGCTGTGGCGGGATTTGAGTGAGAGCGTGCCTGTTGCGACC
MC5341       90 GTCGACCGATCCCAAGCTACGCTGTGGCGGGATTTGAGTGAGAGCGTGCCTGTTGCGACC

2018-0180('1140 CGAAAGATGGTGAACTATGCCTGAATAGGGTGAAGCCAGACGAAAGTCTGGTGGAAGCTC
2018-0180('1128 CGAAAGATGGTGAACTATGCCTGAATAGGGTGAAGCCAGACGAAAGTCTGGTGGAAGCTC
KF018114.1  178 CGAAAGATGGTGAACTATGCCTGAATAGGGTGAAGCCAGACGAAAGTCTGGTGGAAGCTC
KF018107.1  179 CGAAAGATGGTGAACTATGCCTGAATAGGGTGAAGCCAGACGAAAGTCTGGTGGAAGCTC
MC4296      146 CGAAAGATGGTGAACTATGCCTGAATAGGGTGAAGCCAGACGAAAGTCTGGTGGAAGCTC
MC3646      126 CGAAAGATGGTGAACTATGCCTGAATAGGGTGAAGCCAGACGAAAGTCTGGTGGAAGCTC
MC5341      150 CGAAAGATGGTGAACTATGCCTGAATAGGGTGAAGCCAGACGAAAGTCTGGTGGAAGCTC

2018-0180('1200 GTAGCGATTCTGACGTGCAAATCGATCGTCAAATTTGGGTATAGGGGCGAAAGACTAATC
2018-0180('1188 GTAGCGATTCTGACGTGCAAATCGATCGTCAAATTTGGGTATAGGGGCGAAAGACTAATC
KF018114.1  238 GTAGCGATTCTGACGTGCAAATCGATCGTCAAATTTGGGTATAGGGGCGAAAGACTAATC
KF018107.1  239 GTAGCGATTCTGACGTGCAAATCGATCGTCAAATTTGGGTATAGGGGCGAAAGACTAATC
MC4296      206 GTAGCGATTCTGACGTGCAAATCGATCGTCAAATTTGGGTATAGGGGCGAAAGACTAATC
MC3646      186 GTAGCGATTCTGACGTGCAAATCGATCGTCAAATTTGGGTATAGGGGCGAAAGACTAATC
MC5341      210 GTAGCGATTCTGACGTGCAAATCGATCGTCAAATTTGGGTATAGGGGCGAAAGACTAATC

2018-0180('1260 GAACCGTCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTCAGGATAGCTGGAGCCCGGTGCA
2018-0180('1248 GAACCGTCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTCAGGATAGCTGGAGCCCGGTGCA
KF018114.1  298 GAACCGTCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTCAGGATAGCTGGAGCCCGGTGCA
KF018107.1  299 GAACCGTCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTCAGGATAGCTGGAGCCCGGTGCA
MC4296      266 GAACCGTCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTCAGGATAGCTGGAGCCCGGTGCA
MC3646      246 GAACCGTCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTCAGGATAGCTGGAGCCCGGTGCA
MC5341      270 GAACCGTCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTCAGGATAGCTGGAGCCCGGTGCA
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2018-0180('1320 GTTTTATCAGGTAAAGCGAATGATTAGAGGTCTTGGGGCTGAAACGGCTTCAACCTATTC
2018-0180('1308 GTTTTATCAGGTAAAGCGAATGATTAGAGGTCTTGGGGCTGAAACGGCTTCAACCTATTC
KF018114.1  358 GTTTTATCAGGTAAAGCGAATGATTAGAGGTCTTGGGGCTGAAACGGCTTCAACCTATTC
KF018107.1  359 GTTTTATCAGGTAAAGCGAATGATTAGAGGTCTTGGGGCTGAAACGGCTTCAACCTATTC
MC4296      326 GTTTTATCAGGTAAAGCGAATGATTAGAGGTCTTGGGGCTGAAACGGCTTCAACCTATTC
MC3646      306 GTTTTATCAGGTAAAGCGAATGATTAGAGGTCTTGGGGCTGAAACGGCTTCAACCTATTC
MC5341      330 GTTTTATCAGGTAAAGCGAATGATTAGAGGTCTTGGGGCTGAAACGGCTTCAACCTATTC

2018-0180('1380 TCAAACTTTAAATGGGTAAGAAGCCCGGCTTGCTCGGTTGAAGTCGGGCGTTAGAATGCC
2018-0180('1368 TCAAACTTTAAATGGGTAAGAAGCCCGGCTTGCTCGGTTGAAGTCGGGCGTTAGAATGCC
KF018114.1  418 TCAAACTTTAAATGGGTAAGAAGCCCGGCTTGCTCGGTTGAAGTCGGGCGTTAGAATGCC
KF018107.1  419 TCAAACTTTAAATGGGTAAGAAGCTCGGCTTGCTTGGTTGAAGTCGGGCGTTAGAATGCC
MC4296      386 TCAAACTTTAAATGGGTAAGAAGCCCGGCTTGCTCGGTTGAAGTCGGGCGTTAGAATGCC
MC3646      366 TCAAACTTTAAATGGGTAAGAAGCCCGGCTTGCTCGGTTGAAGTCGGGCGTTAGAATGCC
MC5341      390 TCAAACTTTAAATGGGTAAGAAGCCCGGCTTGCTCGGTTGAAGTCGGGCGTTAGAATGCC
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A1.2. Alignment of 28S D6-D8 sequences for CMNI 2018-0180 Iophon cf. *nigricans with KF018114.1 (AKA 4296), MC3646, & MC5341 Iophon nigricans, and KF018107.1 Iophon hyndmani.*

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2018-0180(’11 T-----CAAGTGTCGTACCCATACCCGGCCGTCGGGTCGAGCGGCGTGACCCGATGTGTA
2018-0180(’11 G---------TGTCGTACCCATACCCGGCCGTCGGGTCGAGCGGCGTGACCCGATGTGTA
MC3646      1 CG--CTCAAGTGTCGTACCCATACCCGGCCGTCGGGTCGAGCGGCGTGACCCGATGTGTA
MC4296      1 GGCGCTCAAGTGTCGTACCCATACCCGGCCGTCGGGTCGAGCGGCGTGACCCGATGTGTA
MC5341      1 A-------AGTGTCGTACCCATACCCGGCCGTCGGGTCGAGCGGCGTGACCCGATGTGTA

2018-0180(’56 GGAGGGCGCGGTGGTGGCCGTGCAGCCTCTGGCGCGAGCCTGGGTGAAGCCGCCACCGGT
2018-0180(’52 GGAGGGCGCGGTGGTGGCCGTGCAGCCTCTGGCGCGAGCCTGGGTGAAGCCGCCACCGGT
MC3646     59 GGAGGGCGCGGTGGTGGCCGTGCAGCCTCTGGCGCGAGCCTGGGTGAAGCCGCCACCGGT
MC4296     61 GGAGGGCGCGGTGGTGGCCGTGCAGCCTCTGGCGCGAGCCTGGGTGAAGCCGCCACCGGT
MC5341     54 GGAGGGCGCGGTGGTGGCCGTGCAGCCTCTGGCGCGAGCCTGGGTGAAGCCGCCACCGGT

2018-0180(116 GCAGATCTTGGTGGTAGTAGCAAATATTCAAACGAGAACTTTGAAGACTGAAGTGGAGAA
2018-0180(112 GCAGATCTTGGTGGTAGTAGCAAATATTCAAACGAGAACTTTGAAGACTGAAGTGGAGAA
MC3646    119 GCAGATCTTGGTGGTAGTAGCAAATATTCAAACGAGAACTTTGAAGACTGAAGTGGAGAA
MC4296    121 GCAGATCTTGGTGGTAGTAGCAAATATTCAAACGAGAACTTTGAAGACTGAAGTGGAGAA
MC5341    114 GCAGATCTTGGTGGTAGTAGCAAATATTCAAACGAGAACTTTGAAGACTGAAGTGGAGAA

2018-0180(’76 GGGTTCCATGTGAACAGCAGTTGGACATGGGTTAGTCGATCCTAAGGGAAAGGAGAGGTC
2018-0180(172 GGGTTCCATGTGAACAGCAGTTGGACATGGGTTAGTCGATCCTAAGGGAAAGGAGAGGTC
MC3646    179 GGGTTCCATGTGAACAGCAGTTGGACATGGGTTAGTCGATCCTAAGGGAAAGGAGAGGTC
MC4296    181 GGGTTCCATGTGAACAGCAGTTGGACATGGGTTAGTCGATCCTAAGGGAAAGGAGAGGTC
MC5341    174 GGGTTCCATGTGAACAGCAGTTGGACATGGGTTAGTCGATCCTAAGGGAAAGGAGAGGTC

2018-0180(236 CCTCTGGAAGGCGCAACATCGCTTCGGCGACCCGCGCCATTCCCCGAAAGGGAATCGGGT
2018-0180(232 CCTCTGGAAGGCGCAACATCGCTTCGGCGACCCGCGCCATTCCCCGAAAGGGAATCGGGT
MC3646    239 CCTCTGGAAGGCGCAACATCGCTCCGGCGACCCGCGCCATTCCCCGAAAGGGAATCGGGT
MC4296    241 CCTCTGGAAGGCGCAACATCGCTCCGGCGACCCGCGCCATTCCCCGAAAGGGAATCGGGT
MC5341    234 CCTCTGGAAGGCGCAACATCGCTCCGGCGACCCGCGCCATTCCCCGAAAGGGAATCGGGT

2018-0180(296 TAACATTCCCGAACCGGGATGCGGATAGGGCCTCAACGCCCGCAGCGGCGACGCAAGCGA
2018-0180(292 TAACATTCCCGAACCGGGATGCGGATAGGGCCTCAACGCCCGCAGCGGCGACGCAAGCGA
MC3646    299 TAACATTCCCGAACCGGGATGCGGATAGGGCCTCAACGCCCGCAGCGGCGACGCAAGCGA
MC4296    301 TAACATTCCCGAACCGGGATGCGGATAGGGCCTCAACGCCCGCAGCGGCGACGCAAGCGA
MC5341    294 TAACATTCCCGAACCGGGATGCGGATAGGGCCTCAACGCCCGCAGCGGCGACGCAAGCGA

2018-0180(356 ACTCGGAGACGTCGGCGGGAGCCCCGGGAAGAGTTCTCTTTTCTTCTTAACGGACTGGCA
2018-0180(352 ACTCGGAGACGTCGGCGGGAGCCCCGGGAAGAGTTCTCTTTTCTTCTTAACGGACTGGCA
MC3646    359 ACTCGGAGACGTCGGCGGGAGCCCCGGGAAGAGTTCTCTTTTCTTCTTAACGGACTGGCA
MC4296    361 ACTCGGAGACGTCGGCGGGAGCCCCGGGAAGAGTTCTCTTTTCTTCTTAACGGACTGGCA
MC5341    354 ACTCGGAGACGTCGGCGGGAGCCCCGGGAAGAGTTCTCTTTTCTTCTTAACGGACTGGCA

2018-0180(416 CCCTGGAATCAGATTGGCTGGAGATAGGGTCGAATGTCCGGTAAAGCACCACACTTGTGG
2018-0180(412 CCCTGGAATCAGATTGGCTGGAGATAGGGTCGAATGTCCGGTAAAGCACCACACTTGTGG
MC3646    419 CCCTGGAATCAGATTGGCTGGAGATAGGGTCGAATGTCCGGTAAAGCACCACACTTGTGG
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MC4296     421 CCCTGGAATCAGATTGGCTGGAGATAGGGTCGAATGTCCGGTAAAGCACCACACTTGTGG
MC5341     414 CCCTGGAATCAGATTGGCTGGAGATAGGGTCGAATGTCCGGTAAAGCACCACACTTGTGG

2018-0180(476 TGGTGTCCGGTGCGCTCTCGACGGCCCGTGAAAATCCGAGGGAGCGAGTTATTCACGCGC
2018-0180(472 TGGTGTCCGGTGCGCTCTCGACGGCCCGTGAAAATCCGAGGGAGCGAGTTATTCACGCGC
MC3646     479 TGGTGTCCGGTGCGCTCTCGACGGCCCGTGAAAATCCGAGGGAGCGAGTTATTCACGCGC
MC4296     481 TGGTGTCCGGTGCGCTCTCGACGGCCCGTGAAAATCCGAGGGAGCGAGTTATTCACGCGC
MC5341     474 TGGTGTCCGGTGCGCTCTCGACGGCCCGTGAAAATCCGAGGGAGCGAGTTATTCACGCGC

2018-0180(536 CCGGTCGTACCGATAACCGCATCAGGTCTCCAAGGTGAACAGCCTCTAGTTGATAGAACA
2018-0180(532 CCGGTCGTACCGATAACCGCATCAGGTCTCCAAGGTGAACAGCCTCTAG-----------
MC3646     539 CCGGTCGTACCGATAACCGCATCAGGTCTCCAAGGTGAACAGCCTCTAGTTGATAGAACA
MC4296     541 CCGGTCGTACCGATAACCGCATCAGGTCTCCAAGGTGAACAGCCTCTAGTTGATAGAACA
MC5341     534 CCGGTCGTACCGATAACCGCATCAGGTCTCCAAGGTGAACAGCCTCTAGTTGATAGAACA
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A1.3. Alignment of 28S D3-D5 sequences for CMNI 2018-0183 Tetilla sibirica with KT124358.1 Antarctotetilla leptoderma and KT124368.1 Cinachyra Antarctica

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2018-0183     1 GT--------------------------------------GGTAGAAACCCCGCGAGCGC
KT124358.1    1 CACGGACCAAGGAGTGCAGCAGTGGCGCGAGTCGAGGGGTGGTAGAAACCCCGCGAGCGC
KT124368.1    1 CACGGACCAAGGASTGCAGCAGTGGCGCGAGTCGAGGGGTGGTAGAAACCCCGCGAGCGC

2018-0183    23 AATGAAGGTGAAGGTGAGACTTGTGCTCACTGAGGCGAGAGCCGCCCTCGTGGCGGCGCA
KT124358.1   61 AATGAAGGTGAAGGCGAGACTTGGGCTCGCTGAGGCGAGAGCCGTCCTAGTGGCGGCGCA
KT124368.1   61 AATGAAGGTGAAGGCGAGACTTGGGCTCGCTGAGGCGAGAGCCGTCCTAGTGGCGGCGCA

2018-0183    83 TCGTCGCCCGATCCAACGCCACGCCGTGGCGGGATTCGAGTGAGAGCGTTGCTGTTGCGA
KT124358.1  121 TCGTCGCCCGATCCAATGCCACGCCGTGGCGGGATTCGAGTGGGAGCGTTGCTGTTGCGA
KT124368.1  121 TCGTCGCCCGATCCAATGCCACGCCGTGGCGGGATTCGAGTGGGAGCGTTGCTGTTGCGA

2018-0183   143 CCCGAAAGATGGTGAACTATGCCTGAGCAGGGTGAAGCCAGAGGAAACTCTGGTGGAAGC
KT124358.1  181 CCCGAAAGATGGTGAACTATGCCTGAGCAGGGTGAAGCCAGAGGAAACTCTGGTGGAAGC
KT124368.1  181 CCCGAAAGATGGTGAACTATGCCTGAGCAGGGTGAAGCCAGAGGAAACTCTGGTGGAAGC

2018-0183   203 CCGCAGCGGTTCTGACGTGCAAATCGATCGTCAAACTTGGGTATAGGGGCGAAAGACTAA
KT124358.1  241 CCGCAGCGGTTCTGACGTGCAAATCGATCGTCAAACTTGGGTATAGGGGCGAAAGACTAA
KT124368.1  241 CCGCAGCGGTTCTGACGTGCAAATCGATCGTCAAACTTGGGTATAGGGGCGAAAGACTAA

2018-0183   263 TCGAACCATCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTCAGGATAGCTGGAGCCCTCGA
KT124358.1  301 TCGAACCATCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTCAGGATAGCTGGAGCCCTCGA
KT124368.1  301 TCGAACCATCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTCAGGATAGCTGGAGCCCTCGA

2018-0183   323 TGCAGTTTTATCAGGTAAAGCGAATGATTAGAGGTCTTGGGGTCGAAACGATCTCAACCT
KT124358.1  361 TGCAGTTTTATCAGGTAAAGCGAATGATTAGAGGTCTTGGGATCGAAACGATCTCAACCT
KT124368.1  361 TGCAGTTTTATCAGGTAAAGCGAATGATTAGAGGTCTTGGGATCGAAACGATCTCAACCT

2018-0183   383 ATTCTCAAACTTTAAATGGGTAAGACGTCCGGCTTGCTTAAGTGAAGCCGGGCCACGAAT
KT124358.1  421 ATTCTCAAACTTTAAATGGGTAAGACGTCCGGCTTGCTTAAGCGAAGCCGGGCCACGAAT
KT124368.1  421 ATTCTCAAACTTTAAATGGGTAAGACGTCCGGCTTGCTTGAGCGAAGCCGGGCCACGAAT

2018-0183   443 GCCGGGGCTCCCAGTGGGCCATTTTTGGTAAGCAGAACTGGCGATGCGGGATGAACCGAA
KT124358.1  481 GCCGGGGCTCCCAGTGGGCCATTTTTGGTAAGCAGAACTGGCGATGCGGGATGAACCGAA
KT124368.1  481 GCCGGGGCTCCCAGTGGGCCATTTTTGGTAAGCAGAACTGGCGATGCGGGATGAACCGAA

2018-0183   503 CGCTGAGTTAAGGTGCCCGAATCGACGCTCATCAGATCCCATGAAAGGTGTTGGTTGATC
KT124358.1  541 CGCTGAGTTAAGGTGCCCGAATCGACGCTCATCAGATCCCAGGAAAGGTGTTGGTTGATC
KT124368.1  541 CGCTGAGTTAAGGTGCCCGAATCGACGCTCATCAGATCCCAGGAAAGGTGTTGGTTGATC

2018-0183   563 TAGACAGCAGGACGGTGGC------------------------------C
KT124358.1  601 TAGACAGCAGGACGGTGGCCATGGAAGTCGGAATCCGCTAAGGAGTGTGT
KT124368.1  601 TAGACAGCAGGACGGTGGCCATGGAAGTCGGAATCCGCTAAGGAGTGTGT
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A1.4. Alignment of 28S D3-D5 sequences for CMNI 2018-0184 Craniella cf. polyura with KT124372.1 Craniella sp., KT124371.1 Craniella sp., KT124358.1 Antarctotetilla leptoderma

```
2018-0184      1 AA-----------------------------------------------CCCCGCGAGCG
KT124372.1     1 TG----------------------GCGCGAGTCGARGG-GTGCTAGAAACCCCGCGAGCG
KT124371.1     1 CACGGACCAAGGAGTGCAGCAGTGGCGCGAGTCGA-GGGGTGCTAGAAACCCCGCGAGCG
KT124358.1     1 CACGGACCAAGGAGTGCAGCAGTGGCGCGAGTCGAG-GGGTGGTAGAAACCCCGCGAGCG

2018-0184     14 CAATGAAGGTGAAGGCGAGACTTGGGCTCGCCGAGGCGAGAGCCGCCCTCGTGGTGGCGC
KT124372.1    38 CAATGAAGGTGAAGGCGAGACTTGGGCTCGCCGAGGCGAGAGCCGTCCTAGTGGCGGCGC
KT124371.1    60 CAATGAAGGTGAAGGCGAGACTTGGGCTCGCCGAGGCGAGAGCCGTCCTAGTGGCGGCGC
KT124358.1    60 CAATGAAGGTGAAGGCGAGACTTGGGCTCGCTGAGGCGAGAGCCGTCCTAGTGGCGGCGC

2018-0184     74 ATCGTCGCCCGATCCAATGCCACGTCGTGGCGGGATTCGAGTGGGAGCGTTGCTGTTGCG
KT124372.1    98 ATCGTCGCCCGATCCAATGCCACTTGGTGGCGGGATTCGAGTGGGAGCGTTGCTGTTGCG
KT124371.1   120 ATCGTCGCCCGATCCAATGCCACWTGGTGGCGGGATTCGAGTGGGAGCGTTGCTGTTGCG
KT124358.1   120 ATCGTCGCCCGATCCAATGCCACGCCGTGGCGGGATTCGAGTGGGAGCGTTGCTGTTGCG

2018-0184    134 ACCCGAAAGATGGTGAACTATGCCTGAGCAGGGTGAAGCCAGAGGAAACTCTGGTGGAAG
KT124372.1   158 ACCCGAAAGATGGTGAACTATGCCTGAGCAGGGCGAAGCCAGAGGAAACTCTGGTGGAAG
KT124371.1   180 ACCCGAAAGATGGTGAACTATGCCTGAGCAGGGCGAAGCCAGAGGAAACTCTGGTGGAAG
KT124358.1   180 ACCCGAAAGATGGTGAACTATGCCTGAGCAGGGTGAAGCCAGAGGAAACTCTGGTGGAAG

2018-0184    194 CCCGCAGCGGTTCTGACGTGCAAATCGATCGTCAAACTTGGGTATAGGGGCGAAAGACTA
KT124372.1   218 CCCGCAGCGGTTCTGACGTGCAAATCGATCGTCAAACTTGGGTATAGGGGCGAAAGACTA
KT124371.1   240 CCCGCAGCGGTTCTGACGTGCAAATCGATCGTCAAACTTGGGTATAGGGGCGAAAGACTA
KT124358.1   240 CCCGCAGCGGTTCTGACGTGCAAATCGATCGTCAAACTTGGGTATAGGGGCGAAAGACTA

2018-0184    254 ATCGAACCATCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTCAGGATAGCTGGAGCCCTCG
KT124372.1   278 ATCGAACCATCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTCAGGATAGCTGGAGCCCTCG
KT124371.1   300 ATCGAACCATCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTCAGGATAGCTGGAGCCCTCG
KT124358.1   300 ATCGAACCATCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTCAGGATAGCTGGAGCCCTCG

2018-0184    314 ATGCAGTTTTATCAGGTAAAGCGAATGATTAGAGGTCTTGGGGTCGAAACGACTTCAACC
KT124372.1   338 ATGCAGTTTTATCAGGTAAAGCGAATGATTAGAGGTCTTGGGGTCGAAACGACCTCAACC
KT124371.1   360 ATGCAGTTTTATCAGGTAAAGCGAATGATTAGAGGTCTTGGGGTCGAAACGACCTCAACC
KT124358.1   360 ATGCAGTTTTATCAGGTAAAGCGAATGATTAGAGGTCTTGGGATCGAAACGATCTCAACC

2018-0184    374 TATTCTCAAACTTTAAATGGGTAAGACGCCCGGCTTGCTTAAGCGAAGCCGGGCCACGAA
KT124372.1   398 TATTCTCAAACTTTAAATGGGTAAGACGCCCGGCTTGCTTGAGCGAAGTCGGGCCACGAA
KT124371.1   420 TATTCTCAAACTTTAAATGGGTAAGACGCCCGGCTTGCTTGAGCGAAGTCGGGCCACGAA
KT124358.1   420 TATTCTCAAACTTTAAATGGGTAAGACGTCCGGCTTGCTTAAGCGAAGCCGGGCCACGAA

2018-0184    434 TGCCGGGGCTCCCAGTGGGCCATTTTTGGTAAGCAGAACTGGCGATGCGGGATGAACCGA
KT124372.1   458 TGCCGGGGCTCCCAGTGGGCCATTTTTGGTAAGCAGAACTGGCGATGCGGGATGAACCGA
KT124371.1   480 TGCCGGGGCTCCCAGTGGGCCATTTTTGGTAAGCAGAACTGGCGATGCGGGATGAACCGA
KT124358.1   480 TGCCGGGGCTCCCAGTGGGCCATTTTTGGTAAGCAGAACTGGCGATGCGGGATGAACCGA

2018-0184    494 ACGCCGAGTTAAGGTGCCCGAATCGACGCTCATCAGATCCCATGAAAGGTGTTGGTTGAT
KT124372.1   518 ACGCTGAGTTAAGGTGCCCGAATCGACGCTCATCAGATCCCAGGAAAGGTGTTGGTTGAT
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KT124371.1    540 ACGCTGAGTTAAGGTGCCCGAATCGACGCTCATCAGATCCCAGGAAAGGTGTTGGTTGAT
KT124358.1    540 ACGCTGAGTTAAGGTGCCCGAATCGACGCTCATCAGATCCCAGGAAAGGTGTTGGTTGAT

2018-0184     554 CTAGACAGCAGGACGGTGGC------------------------------C
KT124372.1    578 CTAGACAGCAGGACGGTGGCCATGGAAGTCGGAATCCGCTAAGGAGTGTGT
KT124371.1    600 CTAGACAGCAGGACGGTGGCCATGGAAGTCGGAATCCGCTAAGGAGTGTGT
KT124358.1    600 CTAGACAGCAGGACGGTGGCCATGGAAGTCGGAATCCGCTAAGGAGTGTGT
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A1.5. Alignment of COI sequences for CMNI 2018-0169 Polymastia thielei with LN606469.1 Polymastia thielei voucher ZMBN 98052.

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2018-0169       1 TGC---------------------------------------------------------
LN606469.1      1 GACTCTTTATTTATTATTAGGAGCTTTTGCGGGGATGATAGGAACAGCCTTTAGTATGTT

2018-0169       4 ---------------------GCCGGGGGCAATGTTAGGGGATGATCATTTGTATAATGT
LN606469.1     61 GATCCGGTTAGAATTATCTGCGCCGGGGGCAATGTTAGGGGATGATCATTTGTATAATGT

2018-0169      43 TATAGTAACGGCCCATGCATTTGTGATGATATTTTTTTAGTTATGCCGGTAATGATAGG
LN606469.1    121 TATAGTAACGGCCCATGCATTTGTGATGATATTTTTTTAGTTATGCCGGTAATGATAGG

2018-0169     103 GGGATTTGGAAATTGACTTGTTCCTTTATATATAGGGGCGCCAGATATGGCGTTTCCAAG
LN606469.1    181 GGGATTTGGAAATTGACTTGTTCCTTTATATATAGGGGCGCCAGATATGGCGTTTCCAAG

2018-0169     163 GTTAAATAATATTAGTTTTTGGCTTTTACCTCCTTCTCTAACTTTATTATTGGGTTCAGC
LN606469.1    241 GTTAAATAATATTAGTTTTTGGCTTTTACCTCCTTCTCTAACTTTATTATTGGGTTCAGC

2018-0169     223 TTTTGTTGAGCAAGGGGCTGGGACAGGGTGAACGGTTTATCCCCCCCTGTCTAGTATACA
LN606469.1    301 TTTTGTTGAGCAAGGGGCTGGGACAGGGTGAACGGTTTATCCCCCCCTGTCTAGTATACA

2018-0169     283 AACACACTCAGGAGGGTCAGTAGATATGGTGATATTTAGTTTGCATTTAGCAGGGATTTC
LN606469.1    361 AACACACTCAGGAGGGTCAGTAGATATGGTGATATTTAGTTTGCATTTAGCAGGGATTTC

2018-0169     343 GTCGATATTGGGTGCAATGAATTTCATTACAACCATTTTTAATATGAGAGCACCTGGGAT
LN606469.1    421 GTCGATATTGGGTGCAATGAATTTCATTACAACCATTTTTAATATGAGAGCACCTGGGAT

2018-0169     403 TACAATGGATAGAATGCCGTTATTTGTGTGATCTATTTTAATTACTGCGTTTTTATTATT
LN606469.1    481 TACAATGGATAGAATGCCGTTATTTGTGTGATCTATTTTAATTACTGCGTTTTTATTATT

2018-0169     463 ACTATCTTTG--------------------------------------------------
LN606469.1    541 ACTATCTTTGCCTGTATTGGCGGGGGCAATAACAATGTTGTTAACAGATAGAAATTTTAA

2018-0169     473 --------------------------------------------------------CC
LN606469.1    601 TACTACATTTTTTGATCCTGCTGGGGGTGGGGACCCAATTTTATATCAACATTTGTTT
```

A1.6. Alignment of COI sequences for CMNI 2018-0168 and CMNI 2018-0175 Craniella cf. cranium with HM032750.1 Craniella sp. AS-2010 voucher BIOICE 3659, HM592668.1 Craniella sp. PC-2011 voucher ZMBN:85240, and HM592669.1 Craniella cranium voucher ZMBN:85239

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2018-0168      1 GT-------------------------------------------------TAGTTTGCT
2018-0175      1 GA-----------------------------------------------TTTAGTTTGCT
HM032750.1     1 AC-CTTATACTTATTATTTGGTGTTTTTTCAGGTATAATAGGAACTGGATTTAGTTTGCT
HM592668.1     1 GACCTTATACTTATTATTTGGTGTTTTTTCGGGTATAATAGGAACTGGATTTAGTTTGCT
HM592669.1     1 GACCTTATACTTATTATTTGGTGTTTTTTCGGGTATGATAGGAACTGGATTTAGTTTGCT

2018-0168     12 TATTAGATTAGAACTATCCACTCCCGGACTAATGTTGGGTGACGACCATTTATATAATGT
2018-0175     14 TATTAGATTAGAACTATCCACTCCCGGACTAATGTTGGGTGACGACCATTTATATAATGT
HM032750.1    60 TATTAGATTAGAACTATCCACTCCCGGACTAATGTTGGGTGACGACCATTTATATAATGT
HM592668.1    61 TATTAGACTAGAACTATCCACTCCCGGACTAATGTTGGGTGACGATCATTTATATAATGT
HM592669.1    61 TATTAGATTAGAACTATCCGCCCCCGGATTAATGTTAGGTGACGACCATTTATATAATGT

2018-0168     72 TATGGTCACGGCCCACGGCCTTATAATGATCTTTTTCTTAGTTATGCCGGTTATGATAGG
2018-0175     74 TATGGTCACGGCCCACGGCCTTATAATGATCTTTTTCTTAGTTATGCCGGTTATGATAGG
HM032750.1   120 TATGGTCACGGCCCACGGCCTTATAATGATCTTTTTCTTAGTTATGCCGGTTATGATAGG
HM592668.1   121 TATGGTCACGGCCCACGGCCTTATAATGATCTTTTTCTTAGTTATGCCGGTTATGATAGG
HM592669.1   121 TATGGTCACGGCTCACGGTCTTATAATGATCTTTTTCTTAGTTATGCCGGTTATGATTGG

2018-0168    132 GGGGTTCGGTAATTGAATGGTTCCCCTTTATATAGGGGCACCGGATATGGCTTTTCCAAG
2018-0175    134 GGGGTTCGGTAATTGAATGGTTCCCCTTTATATAGGGGCACCGGATATGGCTTTTCCAAG
HM032750.1   180 GGGGTTCGGTAATTGAATGGTTCCCCTTTATATAGGGGCACCGGATATGGCTTTTCCAAG
HM592668.1   181 GGGGTTCGGTAATTGAATGGTACCCCTATATATAGGGGCACCGGATATGGCTTTTCCAAG
HM592669.1   181 GGGGTTCGGTAATTGAATGGTTCCTCTTTACATCGGGGCACCGGATATGGCTTTTCCAAG

2018-0168    192 ATTAAACAATATTAGTTTTTGAGTTTTACCCCCTTCCTTAATACTACTGTTAGGTTCTGC
2018-0175    194 ATTAAACAATATTAGTTTTTGAGTTTTACCCCCTTCCTTAATACTACTGTTAGGTTCTGC
HM032750.1   240 ATTAAACAATATTAGTTTTTGAGTTTTACCCCCTTCCTTAATACTACTGTTAGGTTCTGC
HM592668.1   241 ATTAAACAATATTAGTTTTTGAGTTTTACCCCCTTCCTTAATATTACTCTTAGGTTCTGC
HM592669.1   241 ATTAAACAATATTAGTTTTTGAGTTTTACCCCCCTCATTAATACTACTGTTAGGCTCTGC

2018-0168    252 TTTTGTTGAACAAGGGGTTGGGGCAGGATGAACCCTTTATCCCCCCTTATCTAGTATACA
2018-0175    254 TTTTGTTGAACAAGGGGTTGGGGCAGGATGAACCCTTTATCCCCCCTTATCTAGTATACA
HM032750.1   300 TTTTGTTGAACAAGGGGTTGGGGCAGGATGAACCCTTTATCCCCCCTTATCTAGTATACA
HM592668.1   301 TTTTGTTGAACAAGGGGTCGGGGCAGGATGAACCCTTTATCCCCCCTTATCTAGCATACA
HM592669.1   301 TTTTGTTGAACAAGGGGTTGGGGCAGGATGAACCCTGTATCCGCCATTATCTAGTATACA

2018-0168    312 AGCTCATTTTGGGGGTTCAGTCGACGCGGCAATCTTTAGTCTTCATTTGGCCGGTATTTC
2018-0175    314 AGCTCATTTTGGGGGTTCAGTCGACGCGGCAATCTTTAGTCTTCATTTGGCCGGTATTTC
HM032750.1   360 AGCTCATTTTGGGGGTTCAGTCGACGCGGCAATCTTTAGTCTTCATTTGGCCGGTATTTC
HM592668.1   361 AGCTCATTTTGGGGGTTCAGTCGATGCGGCAATCTTTAGTCTTCATTTGGCTGGGATTTC
HM592669.1   361 AGCTCATTTTGGGGGTTCAGTCGATGCGGCAATCTTTAGTCTTCATTTGGCCGGGATTTC

2018-0168    372 TTCAATTTTAGGGGCAATGAATTTTATAACTACTATCTTTAATATGCGGGCACCGGGGAT
2018-0175    374 TTCAATTTTAGGGGCAATGAATTTTATAACTACTATCTTTAATATGCGGGCACCGGGGAT
HM032750.1   420 TTCAATTTTAGGGGCAATGAATTTTATAACTACTATCTTTAATATGCGGGCACCGGGGAT
HM592668.1   421 TTCAATTTTAGGGGCAATGAATTTTATAACTACTATCTTTAATATGCGGGCACCGGGTAT
HM592669.1   421 TTCAATTTTAGGGGCAATGAATTTTATAACTACTATCTTTAATATGCGGGCACCGGGGAT

2018-0168    432 TACCATGGATCGGTTGCCTTTATTTGTTTGATCTATTTTAGTAACAACTTATTTGTTATT
2018-0175    434 TACCATGGATCGGTTGCCTTTATTTGTTTGATCTATTTTAGTAACAACTTATTTGTTATT
HM032750.1   480 TACCATGGATCGGTTGCCTTTATTTGTTTGATCTATTTTAGTAACAACTTATTTGTTATT
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HM592668.1    481 TACCATGGACCGGTTGCCTTTATTTGTTTGATCTATTTTAGTAACAACTTATTTGTTATT
HM592669.1    481 TACCATGGATAGGTTGCCTTTATTTGTTTGATCTATTTTAGTAACAACTTATTTGTTATT

2018-0168     492 ATTAGCTTTACCAGTATTGGCGGGCGCAATCACTATGCTTTTAACAGATAGAAATTTCAA
2018-0175     494 ATTAGCTTTACCAGTATTGGCGGGCGCAATCACTATGCTTTTAACAGATAGAAATTTCA-
HM032750.1    540 ATTAGCTTTACCAGTATTGGCGGGCGCAATCACTATGCTTTTAACAGATAGAAATTTCAA
HM592668.1    541 ATTAGCTTTACCAGTATTGGCGGGGGCAATAACTATGCTTTTAACAGATAGAAATTTCAA
HM592669.1    541 ATTAGCTTTACCAGTATTGGCGGAGCCATAACTATGCTTTTAACAGATAGAAATTTCAA
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A1.7. Alignment of COI sequences for CMNI 2018-0176 Haliclona (Reniera) sp. with JN242198.1 Haliclona cinerea voucher POR14138.

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2018-0176       1 AG---------------------------ATTGGAACTATCTGATCCGGGGTCTATGTTA
JN242198.1      1 ATAGGAACAGCGTTTAGTATGCTTATTAGATTGGAACTATCTGCTCCGGGGGCTATGTTG

2018-0176      34 GGGGATGATCATTTATATAATGTTATAGTAACAGCTCATGCATTTGTAATGATATTTTTT
JN242198.1     61 GGGGATGATCATTTATATAATGTTATAGTAACAGCTCATGCATTTGTAATGATATTTTTT

2018-0176      94 TTAGTTATGCCAGTAATGATCGGGGGGTTTGGTAATTGGTTAGTTCCATTATATATTGGT
JN242198.1    121 TTAGTTATGCCAGTAATGATAGGGGGTTTTGGTAATTGGTTAGTTCCATTATATATTGGT

2018-0176     154 GCTCCTGATATGGCTTTCCCTAGATTAAACAATATTAGTTTCTGGTTGTTACCCCCGGCG
JN242198.1    181 GCTCCTGATATGGCTTTCCCTAGATTAAACAATATTAGTTTTTGGTTGTTACCCCCGGCG

2018-0176     214 CTTACCTTATTATTAGGTTCTGCTTTTGTGGAACAAGGGGCTGGGACAGGTTGAACAGTG
JN242198.1    241 CTTACTTTATTGTTAGGTTCTGCTTTTGTGGAACAAGGTGCTGGGACAGGTTGAACAGTG

2018-0176     274 TATCCGCCTTTATCTAGTATTCAAACTCATTCTGGGGGATCTGTGGACATGGTGATATTT
JN242198.1    301 TATCCGCCTTTATCTAGTATTCAAACTCATTCTGGGGGATCTGTGGATATGGTGATATTT

2018-0176     334 AGTCTTCATTTAGCAGGTATATCTTCAATATTGGGTGCTATGAATTTTATAACTACAATA
JN242198.1    361 AGTCTTCATTTAGCAGGGATATCCTCAATATTGGGGGCTATGAATTTTATAACTACAATA

2018-0176     394 TTTAATATGAGGGCACCAGGGATAACTATGGATAGAATGCCTTTATTTGTTTGATCTGTT
JN242198.1    421 TTTAATATGAGGGCACCGGGGATAACTATGGATAGAATGCCTTTATTCGTTTGATCCGTT

2018-0176     454 TTAGTGACTGCCTTTTTATTATTATTATCCTTGCCAGTATTAGCCGGTGCGATAACAATG
JN242198.1    481 TTAGTGACTGCCTTTTTATTATTATTATCTTTGCCAGTATTAGCTGGTGCGATAACAATG

2018-0176     514 CTTTTAACCGACCGAAACTTTAA------------T
JN242198.1    541 CTTTTAACCGACCGAAATTTTAATACTACTTTTTTT
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Appendix 2. Sponge Collections by Ecoregion

Table A.2.1. Inventory of sponge taxa identified from 2015-2017 aboard *CCGS Amundsen* cruises in the Northern Labrador Marine Ecoregion.Sample numbers missing from this list represent unidentified specimens.

Date	**Site**	**Sample Method**	**Depth (m)**	**Catalogue Number**	**Species ID**
October 25, 2015		ROV	65	CMNI 2018-0165	*Tetilla sibirica*
		ROV	95.5	CMNI 2018-0166	*Iophon* spp.
July 15, 2016	FB6-1	Box Core	459	CMNI 2018-0053	*Mycale lingua*
July 16, 2016	FB4	Box Core	118	CMNI 2018-0054	*Sycon* cf. *lambei*
		Agassiz Trawl	104	CMNI 2018-0055	*Halichondira (Eumastia) sitiens*
	FB4	Agassiz Trawl	104	CMNI 2018-0057	*Sycon* cf. *lambei*
	FB2-1	Box Core	80	CMNI 2018-0058	*Thenea* sp. *1*
July 17, 2016	FB7-1	Agassiz Trawl	443	CMNI 2018-0060	*Lycopodina lycopodium*
		Agassiz Trawl	443	CMNI 2018-0061	*Lycopodina cupressiformis*
July 18, 2016	NE Hatton Basin Dive 50	Box Core	562	CMNI 2018-0065	*Haliclona (Haliclona) urceolus*
July 19, 2016	Hatton Basin Dive 51	ROV	631.8	CMNI 2018-0067	*Geodia macandrewii*
		ROV	631.6	CMNI 2018-0069	*Asconema* sp.
		ROV	631.7	CMNI 2018-0070	*Geodia barretti*
		ROV	631.3	CMNI 2018-0071	*Mycale lingua*
		Box Core	620	CMNI 2018-0072	*Tentorium semisuberites*
		Box Core	615	CMNI 2018-0076	*Quasillina brevis*
		Box Core	615	CMNI 2018-0078	*Spinularia* cf. *sarsii*
		Box Core	615	CMNI 2018-0079	*Antho (Acarnia) signata*
July 20, 2016	NE Saglek Bank Cold Seep	Box Core	286	CMNI 2018-0083	*Tentorium semisuberites*
		Box Core	286	CMNI 2018-0084	*Tedania (Tedania) suctoria*
		Box Core	286	CMNI 2018-0085	*Tedania (Tedania) suctoria*
		Box Core	286	CMNI 2018-0086	*Hymedesmia paupertas*
		Box Core	279	CMNI 2018-0088	*Plocamionida* sp.
		Box Core	279	CMNI 2018-0090	*Plocamionida ambigua*
		Box Core	279	CMNI 2018-0091	*Halichondira panicea*
July 21, 2016	Saglek Bank Dive 52	ROV	411.8	CMNI 2018-0093	*Polymasita uberrima*
		ROV	411.9	CMNI 2018-0094	*Axinella arctica*
		ROV	411.9	CMNI 2018-0095	*Janulum spinispiculum*
		Box Core	452	CMNI 2018-0096	*Polymasita uberrima*
		Box Core	452	CMNI 2018-0097	*Tedania (Tedania) suctoria*
		Box Core	452	CMNI 2018-0099	*Axinella arctica*
		Box Core	452	CMNI 2018-0101	*Tentorium semisuberites*

Table A2.1 Continued

Date	**Site**	**Sample Method**	**Depth (m)**	**Catalogue Number**	**Species ID**
		Box Core	452	CMNI 2018-0103	*Polymasita uberrima*
		Box Core	427	CMNI 2018-0104	*Tentorium semisuberites*
		Box Core	427	CMNI 2018-0106	*Asconema* spp.
		Box Core	427	CMNI 2018-0107	*Melonanchora elliptica*
		Box Core	401	CMNI 2018-0109	*Anomomycale titubans*
		Box Core	401	CMNI 2018-0110	*Biemna variantia*
		Box Core	401	CMNI 2018-0113	*Asconema sp.*
		Box Core	401	CMNI 2018-0115	*Biemna variantia*
		Box Core	401	CMNI 2018-0119	*Tethya norvegica*
		Box Core	401	CMNI 2018-0120	*Asconema sp.*
		Box Core	401	CMNI 2018-0121	*Polymastia thelei*
		Box Core	458	CMNI 2018-0123	*Hymeniacidon* sp.
		Agassiz Trawl	457	CMNI 2018-0125	*Polymastia thelei*
		Agassiz Trawl	457	CMNI 2018-0126	*Geodia barretti*
		Agassiz Trawl	457	CMNI 2018-0127	*Hymeniacidon* sp.
		Agassiz Trawl	457	CMNI 2018-0128	*Thenea* sp. *2*
		Agassiz Trawl	457	CMNI 2018-0129	*Craniella* sp.
		Agassiz Trawl	457	CMNI 2018-0131	*Phorbas* sp..
		Agassiz Trawl	457	CMNI 2018-0133	*Biemna variantia*
		Box Core	456	CMNI 2018-0164	*Hymeniacidon sp*
July 14, 2017	OF-S-25 (OF B2)	Agassiz Trawl	402	CMNI 2018-0167	*Mycale Lingua*
		Agassiz Trawl	402	CMNI 2018-0168	*Craniella* cf. *cranium*
		Agassiz Trawl	402	CMNI 2018-0169	*Polymastia thielei*
		Agassiz Trawl	402	CMNI 2018-0170	*Craniella* cf. *cranium*
		Agassiz Trawl	402	CMNI 2018-0171	*Cladorhiza oxeata*
		Agassiz Trawl	402	CMNI 2018-0172	*Thenea* sp. *2*
		Agassiz Trawl	402	CMNI 2018-0173	*Craniella* cf. *cranium*
		Agassiz Trawl	402	CMNI 2018-0174	*Forcepia (Forcepia) fabricans*
		Agassiz Trawl	402	CMNI 2018-0175	*Craniella* cf. *cranium*
		Agassiz Trawl	402	CMNI 2018-0176	*Haliclona (Reniera)* sp. *2*
		Box Core	507	CMNI 2018-0177	*Iophon piceum*
July 15, 2017	FB 2-2 5G	Box Core	84	CMNI 2018-0178	*Polymastia grimaldii*
		Agassiz Trawl	87	CMNI 2018-0179	*Halichondria sitiens*
	A16	Agassiz Trawl	141	CMNI 2018-0180	*Iophon* cf. *nigricans*
		Agassiz Trawl	141	CMNI 2018-0181	*Halichondria sitiens*
		Agassiz Trawl	141	CMNI 2018-0182	*Lissodendoryx (Lissodendoryx) indistincta*
		Agassiz Trawl	141	CMNI 2018-0183	*Tetilla sibirica*
		Agassiz Trawl	141	CMNI 2018-0184	*Craniella polyura*
		Agassiz Trawl	141	CMNI 2018-0185	*Sycon* sp. *1*
		Agassiz Trawl	141	CMNI 2018-0186	*Lissodendoryx* sp.
	Bell 11	Box Core	119	CMNI 2018-0187	*Calcarea unknown*
		Box Core	119	CMNI 2018-0188	*Halichondria sitiens*
July 16, 2017	OF-S-22	Agassiz Trawl	288	CMNI 2018-0191	*Halichondria* sp.
		Agassiz Trawl	288	CMNI 2018-0192	*Lissodendoryx (Lissodendoryx) indistincta*
		Agassiz Trawl	288	CMNI 2018-0193	*Hymedesmia* sp.
	OF - B9	Box Core	377	CMNI 2018-0194	*Polymastia thielei*
		Box Core	377	CMNI 2018-0195	*Tentorium semisuberites*

Table A.2. 2. Inventory of sponge taxa identified from 2015-2017 aboard *CCGS Amundsen* cruises in the Baffin Bay/Davis Strait Marine Ecoregion.Sample numbers missing from this list represent unidentified specimens

Date	**Site**	**Sample Method**	**Depth (m)**	**Catalogue Number**	**Species ID**
July 25, 2016	Disko Fan Dive 55	ROV	877.6	CMNI 2018-0135	*Plicatellopsis* sp.
		ROV	876.7	CMNI 2018-0136	*Plicatellopsis* sp.
		ROV	876.6	CMNI 2018-0137	*Asconema* spp.
		ROV	877.6	CMNI 2018-0138	*Phorbas microchelifer*
		ROV	877.6	CMNI 2018-0139	*Haliclona (Haliclona) urceolus*
		ROV	876.7	CMNI 2018-0140	*Lissodendoryx (Lissodendoryx) complicata*
		ROV	876.6	CMNI 2018-0142	*Haliclona* sp.1
		ROV	876.6	CMNI 2018-0143	*Pseudosuberites* sp.
		ROV	876.6	CMNI 2018-0144	*Tentorium semisuberites*
		ROV	876.6	CMNI 2018-0145	*Plicatellopsis* sp
		ROV	876.6	CMNI 2018-0146	*Axinella arctica*
		ROV	876.6	CMNI 2018-0147	*Iotroata affinis*
		ROV	876.6	CMNI 2018-0149	*Crella (Yvesia) pyrula*
		ROV	876.6	CMNI 2018-0150	*Axinella arctica*
		ROV	876.6	CMNI 2018-0151	*Iotroata affinis*
		ROV	876.6	CMNI 2018-0152	*Mycale lingua*
July 26, 2016	Black Coral Site	Agassiz Trawl	1148	CMNI 2018-0154	*Polymastia thelei*
		Agassiz Trawl	1148	CMNI 2018-0155	*Thenea* sp. 2
		Agassiz Trawl	1148	CMNI 2018-0156	*Thenea* sp. 2
		Agassiz Trawl	1148	CMNI 2018-0157	*Lycopodina* sp. 1
		Agassiz Trawl	1148	CMNI 2018-0158	*Thenea* sp. 2
		Agassiz Trawl	1148	CMNI 2018-0159	*Thenea* sp. 2
		Agassiz Trawl	1148	CMNI 2018-0160	*Thenea muricata*
		Agassiz Trawl	1148	CMNI 2018-0161	*Lycopodina* sp. 2
		Agassiz Trawl	1148	CMNI 2018-0162	*Thenea muricata*
		Agassiz Trawl	1148	CMNI 2018-0163	*Tentorium semisuberites*
July 25, 2017	Stn. 105	Agassiz Trawl	333	CMNI 2018-0196	*Mycale lingua*
		Agassiz Trawl	333	CMNI 2018-0197	*Haliclona (Flagellia) porosa*
		Agassiz Trawl	333	CMNI 2018-0198	Calcarea unknown
July 28, 2017	Trinity Glacier TS 233	Agassiz Trawl	400	CMNI 2018-0199	*Tentorium semisuberites*
August 1, 2017	Pond Inlet Dive 59	ROV	874.8	CMNI 2018-0201	*Cladorhiza oxeata*
		ROV	855.5	CMNI 2018-0202	*Semisuberites cribosa*
		ROV	767.4	CMNI 2018-0207	*Lissodendoryx (Lissodendoryx) lundbecki*
		ROV	415.7	CMNI 2018-0209	*Chondrocladia grandis*

Table A.2.3. Inventory of sponge taxa identified from 2015-2017 aboard *CCGS Amundsen* cruises in the Lancaster Sound Marine Ecoregion.

Date	Site	Sample Method	Depth (m)	Catalogue Number	Species ID
July 31, 2017	Stn. 323	Agassiz Trawl	786	CMNI 2018-0200	*Polymastia andrica*
August 3, 2017	Lancaster Sound Dive 61	Agassiz Trawl	719	CMNI 2018-0210	*Chondrocladia grandis*
		Agassiz Trawl	719	CMNI 2018-0211	*Chondrocladia grandis*

Appendix 3. DNA sequences for select sponges from Chapter 3

Total DNA was extracted using the Qiagen DNeasy Blood and Tissue kit following the manufacturer's instructions, using approximately 0.5 cm2 of sponge tissue to account for spicule weight. Spicules were allowed to settle in the post-lysis mixture for 10 minutes before being applied to the spin column. DNA purity was assessed on a NanoDrop ND-1000.
The 5' end region of COI was amplified using M13F/M13R-tailed dgLCO1490: 5' – (GTA AAA CGA CGG CCA GTG) GGT CAA CAA ATC ATA AAG AYA TYG G and dgHCO2198: 5' – (GGA AAC AGC TAT GAC CAT G) TAA ACT TCA GGG TGA CCA AAR AAY CA degenerate Folmer fragment primers (Folmer et al., 1994; Meyer, 2003). Amplification of 28S rDNA was performed using three pairs of primers designed by Morrow et al. (Morrow et al., 2012): Por28S-15F/878R for region D1-D2, Por28S-830F/1520R for region D3-D5, and Por28S-1490F/2170R for region D6-D8. For COI and 28S amplifications, reactions using Invitrogen Platinum Taq Polymerase were run on an Eppendorf Mastercycler Ep Gradient using a standard protocol of 94.0° for 5 min; (95.0° for 30 s; 48.0° for 30 s; 72.0°for 30 s) × 40 cycles; 72.0° for 10 min. The amplification of 28S produced better results at an annealing temperature of 50°. PCR products were visualized on 2% agarose gels and purified using the Qiagen MinElute PCR purification kit. Tailed primers were used to improve sequencing, using only the M13F/R tail primer in the final sequencing mixture. The sequencing reaction was run on an Applied Biosystems 3730 Genetic Analyzer at the Molecular Biology Service Unit (MSBU) at the University of Alberta. Contigs were assembled in BioEdit version 7.2 and manually checked for sequencing errors. The consensus sequences of the contigs were trimmed to remove primer residuals. Consensus sequences were aligned in MEGA (v.7.02) and species affinities were confirmed by BLAST (Altschul et al., 1990).

Table A.3.1. COI contig sequences for select sponges collected during 2015-2017 *CCGS Amundsen* cruises.

Sample	Sequence
CMNI 2018-0088 *Plocamionida sp. Topsent, 1927*	> CMNI 2018-0088COI GGCTAGAGTTATCCGCCCCTGGGTCAATGTTAGGGGATGACCATTTATATAA TGTAATTGTAACTGCTCATGCCTTTGTCATGATTTTTTTTTAGTTATGCCAGT AATGATTGGGGGATTTGGAAATTGGCTTGTGCCTTTATACATCGGTGCCCCTG ATATGGCTTTTCCAAAATTAAATAATATAAGTTTTTGATTACTGCCCCCGGCC TTAAGTCTATTATTGGCCTCTGCTTTTGTGGAACAAGGGGCGGGAACGGGAT GGACAGTTTATCCCCCTTTGTCCGGTATTCAGGCCCATTCCGGGGGTTCAGTG GATTTAGTAATATTTAGTTTACACTTGGCGGGGATTTCTTCTATATTGGGTGC TATGAATTTTATAACTACAATAATAAACATGAGGGCATTGGGGATAACTATG GATAGAATGCCATTATTCGTTTGATCAATTTTAGTAACTGCGGTTTTATTATT ATTGTCTTTACCAGTTTTAGCGGGGGCCATTACTATGCTATTAACGGATAGAA ATTTTAATA
CMNI 2018-0096 *Polymastia uberrima* (Schmidt, 1870)	> CMNI 2018-0096COI AGGAACAGCCTTTAGTATGTTGATCCGGTTAGAATTATCTGCGCCGGGGGCA ATGTTAGGGGATGACCATTTGTATAATGTTATAGTAACGGCCCATGCATTTGT GATGATATTTTTTTTAGTTATGCCGGTAATGATAGGGGGATTTGGAAATTGAC TTGTCCCTCTATATATAGGAGCACCGGATATGGCGTTTCCAAGGCTAAATAA TATTAGTTTTTGGCTTTTACCTCCTTCTTTAACTTTATTATTGGGTTCAGCTTTT GTTGAGCAAGGGGCTGGGACAGGGTGAACGGTCTATCCGCCCCTGTCTAGTA TACAAACACACTCAGGGGGATCAGTCGATATGGTGATATTTAGTTTGCATTT AGCAGGGATTTCGTCGATATTGGGTGCAATGAATTTCATTACAACAATTTTTA ATATGAGAGCACCTGGAATTACAATGGATAGAATGCCGTTATTTGTGTGATC TATTTTAACTACTGCGTTTTTATTATTATTATCTTTGCCTGTATTGGCGGGGGC AATAACAATGCTGCTAACAGATAGAAATTTTAATACTACATTTTTTGACCCTG CTGGGGGTGGG
CMNI 2018-0099 *Axinella arctica* (Vosmaer, 1885)	> CMNI 2018-0099COI TTAGAACTATCAGCTCCCGGTACAATGCTAGGTGATGATCATTTATATAATGT TATAGTAACAGCCCATGCTTTTGTGATGATATTTTTCTTAGTTATGCCAGTAA TGATAGGGGGGTTTGGGAATTGATTTGTACCGTTATATATAGGTGCACCTGA TATGGCTTTCCCAAGATTAAATAATCTTAGTTTTTGAGTATTACCCCCTTCAA TTACTTTATTATTAGGTTCTGCTTTTGTAGAGCAAGGAGCTGGAACAGGGTG AACAGTCTATCCACCCTTAGCAGGCATACAAACACATTCAGGTGGATCCGTA GATATGGCAATATTTAGTCTTCATTTAGCTGGTTTATCTTCTATATTAGGGTC AATGAACTTTATTACAACTATTTTAAATATGAGGGCACCAGGTATCACAATG GATAGATTGCCATTATTTGTGTGATCTATTTTAATTACAACTTTTTTATTAATA TTAGCTTTGCCAGTATTGGCAGGTGCGATTACAATGCTTCTTACAGATAGAA ATTTTAATACAAC
CMNI 2018-0119 *Tethya* cf. *norvegica* Bowerbank, 1872	> CMNI 2018-0119COI GAATTGTCGGCTCCTGGTTCAATGTTAGGAGATGACCATTTGTACAATGTAA TTGTGACAGCTCATGCCTTTGTAATGATATTTTTCTTAGTAATGCCAGTAATG ATCGGGGGGTTTGGAAATTGGTTTGTGCCATTATATATTGGGGCACCGGACA TGGCTTTTCCTAGGTTAAATAACATAAGTTTTTGGTTATTACCTCCTTCGCTA ACTTTATTACTGGGTTCAGCTTTTGTGGAACAAGGAGCTGGGACAGGGTGGA CAGTTTATCCGCCTTTAGCAAGTATACAAGCTCACTCAGGTGGGTCAGTGGA TATGGCAATTTTCAGTTTACATTTAGCCGGGATTTCTTCAATATTAAGTACAA

TTAATTTTATAACAACAATTCTAAATATGAGGGCACCGGGGATAACAATGGA
TCGAATGCCATTATTTGTTTGATCTATTTTAGTGACAGCTATTTTATTGTTATT
ATCTTTACCGGTTTTAGCAGGGGCAATTACAATGCTTCTTACGGACAGGAAT
TTTAATACAGCTTTTTTTGATCCTGCGGG

CMNI 2018-0123
Hymeniacidon sp.
Bowerbank, 1858

> CMNI 2018-0123COI
GGAACTCTTTATTTATTGTTTGGGGCTTTTGCTGGAATGATCGGGACAGCTTT
TAGCATGTTAATAAGATTAGAGCTATCAGCTCCTGGTTCAATGCTTGGCGAT
GATCATTTATATAACGTAATAGTAACTGCTCACGCCTTTGTAATGATTTTCTT
TTTGGTTATGCCTGTGATGATAGGAGGTTTTGGGAATTGATTTGTTCCTTTAT
ATATAGGTGCACCTGATATGGCTTTCCCTAGATTAAATAATCTTAGCTTTTGA
TTATTACCTCCCGCTTTAACTTTATTATTGGGTTCAGCGTTTGTAGAACAAGG
AGCTGGGACTGGTTGAACGGTATACCCTCCTTTATCAAGTATACAAGCTCAC
TCAGGGGGATCAGTAGATTTGGCAATTTTTAGTCTTCATTTAGCTGGGATATC
TTCAATATTAGGGGCGATGAATTTTATTACAACCATTATAAATATGAGAGCG
CCAGGAATTACAATGGATAGAATGCCTTTATTTGTGTGATCTGTTTTAGTAAC
TGCCATTTTGTTATTGTTATCTTTACCAGTATTGGCAGGAGCTATAACAATGC
TTTTGACAGATCGAAACTTTAATACCGCGTTTTTTG

CMNI 2018-0129
Craniella sp.
Schmidt, 1870

> CMNI 2018-0129COI
GGGACCTTATACTTATTATTTGGTGTGTTTTCGGGTATAATAGGAACTGGATT
TAGTTTGCTTATTAGATTAGAATTATCCACTCCCGGACTAATGTTGGGTGACG
ACCATTTATATAATGTTATGGTCACGGCCCACGGCCTTATAATGATCTTTTTC
TTAGTTATGCCGGTTATGATAGGGGGGTTCGGTAATTGAATGGTTCCCCTTTA
TATCGGGGCACCGGATATGGCTTTTCCAAGATTAAACAATATTAGTTTTTGA
GTTTTACCCCCTTCCTTAATACTATTGTTAGGTTCAGCTTTTGTTGAACAAGG
GGTTGGGGCAGGATGAACTCTTTACCCCCCCTTATCTAGCATACAAGCTCATT
TTGGGGGTTCAGTTGACGCGGCAATCTTTAGTCTTCATTTGGCCGGTATTTCT
TCAATTTTAGGGGCAATGAATTTTATAACTACTATCTTTAATATGCGGGCGCC
GGGGATTACCATGGATCGGTTGCCTTTATTTGTTTGATCTATTTTAGTAACAA
CTTATTTGTTATTATTAGCCTTACCAGTATTGGCGGGCGCAATCACTATGCTT
TTAACAGATAGAAATTTCAATACAACGTTTTTTGATCCCGCTGGCGGTGGTG
ATCCAA

CMNI 2018-0131
Phorbas sp.
Duchassaing &
Michelotti, 1864

> CMNI 2018-0131COI
TTAGAGTTGTCTGCGCCAGGGTCAATGTTGGGGGATGATCATTTATATAATG
TTATAGTAACTGCTCATGCTTTTGTCATGATTTTTTTTTTAGTTATGCCGGTAA
TGATCGGGGGATTTGGAAATTGGTTTGTGCCGTTATATATCGGTGCGCCGGA
CATGGCTTTTCCCCGGTTAAATAATATAAGTTTTTGATTATTGCCTCCGGCCC
TAAGTTTATTATTGGCCTCTGCTTTTGTGGAGCAAGGGGCAGGAACCGGGTG
GACAGTTTATCCGCCATTATCGGGTATACAGGCCCATTCGGGGGGGTCAGTT
GATTTAGTAATATTTAGTTTACACTTGGCGGGGATTTCTTCTATATTGGGGGC
TATGAATTTTATAACTACAATAATCAATATGAGGGCATTGGGGGTAACTTTG
GATAGAATGCCATTATTCGTTTGATCTATTCTAGTAACTGCGGTTTTATTATT
ATTGTCTTTACCTGTATTAGCTGGGGCTATTACTATGTTATTAACGGATAGAA
ACTTTA

CMNI 2018-0136
Plicatellopsis sp.
Burton, 1932

> CMNI 2018-0136COI
TGTTAATAAGATTAGAGCTTTCAGCCCCTGGCTCAATGCTCGGTGATGATCAT
CTATATAACGTAATAGTAACCGCTCACGCCTTTGTAATGATCTTCTTTTTGGT
TATGCCTGTGCTGATAGGGGGCTTCGGGAATTGATTTGTGCCTTTATATATTG
GTGCACCGGATATGGCTTTCCCTAGATTGAATAATCTTAGTTTTTGATTATTG
CCTCCTGCTTTAACCTTATTACTAGGCTCAGCATTTGTAGAACAAGGGGCTGG
GACGGGTTGAACTGTATATCCGCCCCTATCAAGCATACAAGCCCACTCGGGG
GGATCGGTAGATATGGTTATATTTAGTCTCCATTTAGCCGGAATATCCTCAAT

	ACTGGGTGCTATGAATTTTATTACAACAATTCTAAATATGAGAGCCCCAGGA ATTACAATGGACCGAATGCCTTTATTTGTGTGATCTGTTTTAGTTACTGCCAT ATTGTTGTTGCTATCGTTGCCGGTATTGGCGGGAGCTATAACAATGCTTTTGA CAGATCGTAACTTTAATACTGCGTTCTTTGATCCAGCGGGTGGAGGGGATCC AA
CMNI 2018-0140 *Lissodendoryx (Lissodendoryx) complicata* (Hansen, 1885)	> CMNI 2018-0140COI TGGGGGATTCGCAGGTATGATTGGGACCGGTTTTAGTTTATTGATTAGGTTA GAATTATCGGGGCCCGGTAGTATGTTAGGAGATGATCAATTGTATAATGTGA TAGTGACTGGACACGCGTTAGTGATGATATTTATGTTGGTAATGCCTGTGAT GATAGGCGGTTTTGGAAATTGAATGGTGCCACTGTATATCGGTGCGCCAGAT ATGGCATTTCCGCGGTTGAATAATATAAGTTTTTGGTTGTTGCCCCCTGCATT GACGATGTTATTATTGTCGAGTTTTGTAGAACAAGGGGCAGGTACTGGTTGA ACGGTATATCCGCCGTTATCCGGCATATCAGCGCATTCAGGAGGGGCAGTAG ACTTAGTAATATTTAGTTTACATTTAGCGGGAATATCCTCAATATTAGGGGCA ATGAACTTTATTACAACTATTGGTAATATGCGTACGCCAGGGTTGGGGTTTG ATAGATTGCCATTATTTGTGTGATCTATATTGGTGACCGTGGTATTATTGTTA TTGGCGTTGCCAGTATTAGCGGGTGCAATAACAATGTTATTAACGGACAGGA ATTTCAATACAACATTCTTTGATCCAGCCGGCGG
CMNI 2018-0145 *Plicatellopsis* sp. Burton, 1932	> CMNI 2018-0145COI TGATCGGGACAGCTTTTAGCATGTTAATAAGATTAGAGCTTTCAGCCCCTGG CTCAATGCTCGGTGATGATCATCTATATAACGTAATAGTAACCGCTCACGCC TTTGTAATGATCTTCTTTTTGGTTATGCCTGTGCTGATAGGGGGCTTCGGGAA TTGATTTGTGCCTTTATATATTGGTGCACCGGATATGGCTTTCCCTAGATTGA ATAATCTTAGTTTTTGATTATTGCCTCCTGCTTTAACCTTATTACTAGGCTCAG CATTTGTAGAACAAGGGGCTGGGACGGGTTGAACTGTATATCCGCCCCTATC AAGCATACAAGCCCACTCGGGGGGATCGGTAGATATGGTTATATTTAGTCTC CATTTAGCCGGAATATCCTCAATACTGGGTGCTATGAATTTTATTACAACAAT TCTAAATATGAGAGCCCCAGGAATTACAATGGACCGAATGCCTTTATTTGTG TGATCTGTTTTAGTTACTGCCATATTGTTGTTGCTATCGTTGCCGGTATTGGC GGGAGCTATAACAATGCTTTTGACAGATCGTAACTTTAATACTGCGTTCTT
CMNI 2018-0153 *Craniella* cf. *cranium* (Müller, 1776)	> CMNI 2018-0153COI GTTAGTTTGCTTATTAGATTAGAACTATCCACTCCCGGACTAATGTTGGGTGA CGACCATTTATATAATGTTATGGTCACGGCCCACGGCCTTATAATGATCTTTT TCTTAGTTATGCCGGTTATGATAGGGGGGTTCGGTAATTGAATGGTTCCCCTT TATATAGGGGCACCGGATATGGCTTTTCCAAGATTAAACAATATTAGTTTTTG AGTTTTACCCCCTTCCTTAATACTACTGTTAGGTTCTGCTTTTGTTGAACAAG GGGTTGGGGCAGGATGAACCCTTTATCCCCCCTTATCTAGTATACAAGCTCA TTTTGGGGGTTCAGTCGACGCGGCAATCTTTAGTCTTCATTTGGCCGGTATTT CTTCAATTTTAGGGGCAATGAATTTTATAACTACTATCTTTAATATGCGGGCA CCGGGGATTACCATGGATCGGTTGCCTTTATTTGTTTGATCTATTTTAGTAAC AACTTATTTGTTATTATTAGCTTTACCAGTATTGGCGGGCGCAATCACTATGC TTTTAACAGATAGAAATTTCAATAC
CMNI 2018-0169 *Polymastia thielei* Koltun, 1964	> CMNI 2018-0169COI TGCGCCGGGGGCAATGTTAGGGGATGATCATTTGTATAATGTTATAGTAACG GCCCATGCATTTGTGATGATATTTTTTTAGTTATGCCGGTAATGATAGGGGG ATTTGGAAATTGACTTGTTCCTTTATATATAGGGGCGCCAGATATGGCGTTTC CAAGGTTAAATAATATTAGTTTTTGGCTTTTACCTCCTTCTCTAACTTTATTAT TGGGTTCAGCTTTTGTTGAGCAAGGGGCTGGGACAGGGTGAACGGTTTATCC CCCCCTGTCTAGTATACAAACACACTCAGGAGGGTCAGTAGATATGGTGATA TTTAGTTTGCATTTAGCAGGGATTTCGTCGATATTGGGTGCAATGAATTTCAT TACAACCATTTTTAATATGAGAGCACCTGGGATTACAATGGATAGAATGCCG TTATTTGTGTGATCTATTTTAATTACTGCGTTTTTATTATTACTATCTTTGCC

CMNI 2018-0175 *Craniella* cf. *cranium* (Müller, 1776)	> CMNI 2018-0175COI GATTTAGTTTGCTTATTAGATTAGAACTATCCACTCCCGGACTAATGTTGGGT GACGACCATTTATATAATGTTATGGTCACGGCCCACGGCCTTATAATGATCTT TTTCTTAGTTATGCCGGTTATGATAGGGGGGTTCGGTAATTGAATGGTTCCCC TTTATATAGGGGCACCGGATATGGCTTTTCCAAGATTAAACAATATTAGTTTT TGAGTTTTACCCCCTTCCTTAATACTACTGTTAGGTTCTGCTTTTGTTGAACAA GGGGTTGGGGCAGGATGAACCCTTTATCCCCCCTTATCTAGTATACAAGCTC ATTTTGGGGGTTCAGTCGACGCGGCAATCTTTAGTCTTCATTTGGCCGGTATT TCTTCAATTTTAGGGGCAATGAATTTTATAACTACTATCTTTAATATGCGGGC ACCGGGGATTACCATGGATCGGTTGCCTTTATTTGTTTGATCTATTTTAGTAA CAACTTATTTGTTATTATTAGCTTTACCAGTATTGGCGGGCGCAATCACTATG CTTTTAACAGATAGAAATTTCAAT
CMNI 2018-0176 *Haliclona (Reniera)* sp. *2* Schmidt, 1862	> CMNI 2018-0176COI AGATTGGAACTATCTGATCCGGGGTCTATGTTAGGGGATGATCATTTATATA ATGTTATAGTAACAGCTCATGCATTTGTAATGATATTTTTTTAGTTATGCCA GTAATGATCGGGGGGTTTGGTAATTGGTTAGTTCCATTATATATTGGTGCTCC TGATATGGCTTTCCCTAGATTAAACAATATTAGTTTCTGGTTGTTACCCCCGG CGCTTACCTTATTATTAGGTTCTGCTTTTGTGGAACAAGGGGCTGGGACAGGT TGAACAGTGTATCCGCCTTTATCTAGTATTCAAACTCATTCTGGGGGATCTGT GGACATGGTGATATTTAGTCTTCATTTAGCAGGTATATCTTCAATATTGGGTG CTATGAATTTTATAACTACAATATTTAATATGAGGGCACCAGGGATAACTAT GGATAGAATGCCTTTATTTGTTTGATCTGTTTTAGTGACTGCCTTTTTATTATT ATTATCCTTGCCAGTATTAGCCGGTGCGATAACAATGCTTTTAACCGACCGA AACTTTAAT

Table A.3.2. 28S contig sequences for select sponges collected during 2015-2017 *CCGS Amundsen* cruises.

Sample	**Sequence**
CMNI 2018-0076 *Quasillina brevis* (Bowerbank, 1861)	> CMNI 2018-0076 28S D1-D2 GAGCTCGAGCCTGAAATCTCTGGCAGTCGCTGTCAGCGAATTGTGGCCGGGA GAGACAGCCTAAGCTCCGACCGGCGCTGTCGAAGTTGACCTGGAAAGGCAC GTCGCAGAGGGTGAGAGCCCCGTGTGCGGCACCGCCGGGCGGAGTTGCTAC TGTCTTCGGAGAGTCGGGTTGTTTGGGAATGCAGCCCAAAGTGGGTGGTAAA CTCCATCTAAAGCTAAATACTGGCACGAGACCGATAGCAAACAAGTACCATG AGGGAAAGGTGAAAAGCACTTTGAAAAGAGAGTCAAAAAGACCGCGAAAC CGTTAGGAGGGAAACGAATGCGGCTGAATCGGCACTCCGTCAGGCTCAGGA GACGTTGGTGGCCATTCCCTGGCGGCGACAGCTTCGGCGTCGTCGTCGGGAT ACGTCGCCATCTCCTCTGCATTCCTGCGGAGCGCCGGCCAACGACGGTCGAT CCTGGCTCAGAAGGGTGCGTCGGGTAGGTGGCCCTCTCCGGAGGGAACTTAT AGCCGGCCGCCTGGCCAGTCCGGGGCCGACCGAGGAGAGTCGTGAAGTTTC ACGCGTGCAGTGCAAGCCCCGTCCGCGGGGCCGCGTCACTTCTGTTCGTTCG GGCATCGCACCGTGGACTGCGTGCAGTGTCCGGTGTAGGCTGTCTGTTCGTG > CMNI 2018-0076 28S_D3-D5 TGGGTGACAAACCCGCCGGCGCAATGAAAGTGAAGGCAGACGTGGGTCTGC CGAGGTGAGAACCCCCGTCCGTGGGGGCGCATCATCGACCGATCCCAGGCTA CGCTGTAGCGGGATTTGAGTGAGAGCGTGCCTGTTGCGACCCGAAAGATGGT

GAACTATGCCTGAATAGGGTGAAGCCAGAGGAAACTCTGGTGGAAGCTCGT
AGCGATTCTGACGTGCAAATCGATCGTCAAATTTGGGTATAGGGGCGAAAGA
CTAATCGAACCATCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTTAGGATAGCT
GGAGCCCGGTGCAGTTTTATCAGGTAAAGCGAATGATTAGAGGTCTTGGGGT
TGAAACAACCTCAACCTATTCTCAAACTTTAAATGGGTAAGAAGCCCGGCTT
GCTTGGTTGAAGTCGGGCATGGAATGCCGGGGCTCTTAGTGGGCCATTTTTG
GTAAGCAGAACTGGCGATGCGGGATGAACCGAATGCCGGGCTAAGGTGCCC
GAGTCGACGCTCATCAGATACCATGAAAGGTGTTGGTTGATCTAGACAGCAG
GACGGTGGCCATGGAA

> CMNI 2018-0076 28S _D6-D8
AGCGTCGCACCCATACCCGGCCGTCGGACCGAGAGGCATGGTCCGACGAGT
AGGAGGGCGCGGTGGTGGCCGTGCAGCCTCTGGCGCGAGCCTGGGTGAAGC
CGCCACCGGTGCAGATCTTGGTGGTAGTAGCAAATATTCAAACGAGAGCTTT
GAAGACTGAAGTGGAGAAGGGTTCCATGTGAACAGCAGTTGGACATGGGTT
AGTCGATCCTAAGAGAAGGGAGAGGTCCTTCTGGAAGGTGCAATCGCTCTGG
CGACCGCGCCGTTCCTCGAAAGGGAATCGGGTTAACATTCCCGAACCGGGAT
GCGGATAGGCCCCTGGCCGTCAGCGGCAACGCAAGCGAACTCGGAGACGTC
GGCAGGAGCCCCGGGAAGAGTTCTCTTTTCTTCTTAACGGACTGGCACCCTG
GAATCAGATTGGCTGGAGATAGGGTTGAATGTCCGGTAAAGCACCACACTTG
TTGTGGTGTCCGGTGCGCTCTTGACGGCCCGTGAAAATCCGAGGGAGCGTTT
GATTCTCGCGCCCGGTCGTACCGATAACCGCATCAGGTCTCCAAGGTGAACA
GCCTCTAGT

CMNI 2018-0109
Mycale (Anomomycale) titubans (Schmidt, 1870)

> CMNI 2018-0109 28S_ D3-D5
GAATAGGGTGAAGCCAGAGGAAACTCTGGTGGAAGCTCGCAGCGATTCTGA
CGTGCAAATCGATCGTCAAATTTGGGTATAGGGGCGAAAGACTAATCGAACC
GTCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTCAGGATAGCTGGAGCCCGGT
GCAGTTTTATCAGGTAAAGCGAATGAT

> CMNI 2018-0109 28S_D3-D5
GTGTCGTACCCATACCCGGCCGTCGGGTCGAGTGGCATGACTCGACGTGTAG
GAGGGCGCGGCGGTGGCTGTGCAGCCTCTGGCGCGAGCCTGGGTGAAGCCG
CCGCTGGTGCAGATCTTGGTGGTAGTAGCAAATATTCAAACGAGAACTTTGA
AGACTGAAGTGGAGAAGGGTTCCATGTGAACAGCAGTTGGACATGGGTTAG
TCGATCCTAAGAGAAGGGAGAGGTCCTTCTGGAAGGCACAATGCACCATCCC
CCGGTGCCCGTGCCATTCCTCGAAAGGGAATCGGGTTAACATTCCCGAACCG
GGATGCGGACAGGGCCTCCGTGCCCACGGCGGCAACGCAAGCGAACTCGGA
GACGTCGGCGGGAGCCCTGGGAAGAGTTCTCTTTTCTTCTTAACGGACTGGC
ACCCTGGAATCAGATTGGCTGGAGATAGGGTTGAATGTCCGGTAAAGCACCA
CACTTGTGGTGGTGTCCGGTGCGCTCTCGACGGCCCGTGAAAATCCGAGGGA
GCGACTGACTCTCGCGCCCGGTCGTACCGATAACCGCATCAGGTCTCCAAGG
TGAACAGCCTCTAGTTGATGGAACAATGTAG

CMNI 2018-0180
Iophon cf. nigricans. Gray, 1867

> CMNI 2018-0180 28S_D3-D5
GGTGGCAAACCCGTCGGCGCAATGAAAGTGAAGGCAGCTCTTTTGCTGCTGT
GGCGAGAGCCTCCTTGCGAGGCGCATCGTCGACCGATCCCAAGCTACGCTGT
GGCGGGATTTGAGTGAGAGCGTGCCTGTTGCGACCCGAAAGATGGTGAACT
ATGCCTGAATAGGGTGAAGCCAGACGAAAGTCTGGTGGAAGCTCGTAGCGA
TTCTGACGTGCAAATCGATCGTCAAATTTGGGTATAGGGGCGAAAGACTAAT
CGAACCGTCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTCAGGATAGCTGGAG
CCCGGTGCAGTTTTATCAGGTAAAGCGAATGATTAGAGGTCTTGGGGCTGAA
ACGGCTTCAACCTATTCTCAAACTTTAAATGGGTAAGAAGCCCGGCTTGCTC
GGTTGAAGTCGGGCGTTAGAATGCCGGGGCTCCCAGTGGGCCATTTTTGGTA
AGCAGAACTGGCGATGTGGGATGAACCAAATGCCGGGTTAAGGTGCCGGAA
TCGACGCTCATCAGATCCCATGAAAGGTGTTGGTTGATACAGACAGCAGGAC

	> CMNI 2018-0180 28S_D6-D8 GTGTCGTACCCATACCCGGCCGTCGGGTCGAGCGGCGTGACCCGATGTGTAG GAGGGCGCGGTGGTGGCCGTGCAGCCTCTGGCGCGAGCCTGGGTGAAGCCG CCACCGGTGCAGATCTTGGTGGTAGTAGCAAATATTCAAACGAGAACTTTGA AGACTGAAGTGGAGAAGGGTTCCATGTGAACAGCAGTTGGACATGGGTTAG TCGATCCTAAGGGAAAGGAGAGGTCCCTCTGGAAGGCGCAACATCGCTTCG GCGACCCGCGCCATTCCCCGAAAGGGAATCGGGTTAACATTCCCGAACCGGG ATGCGGATAGGGCCTCAACGCCCGCAGCGGCGACGCAAGCGAACTCGGAGA CGTCGGCGGGAGCCCCGGGAAGAGTTCTCTTTTCTTCTTAACGGACTGGCAC CCTGGAATCAGATTGGCTGGAGATAGGGTCGAATGTCCGGTAAAGCACCAC ACTTGTGGTGGTGTCCGGTGCGCTCTCGACGGCCCGTGAAAATCCGAGGGAG CGAGTTATTCACGCGCCCGGTCGTACCGATAACCGCATCAGGTCTCCAAGGT GAACAGCCTCTAGT
CMNI 2018-0183 *Tetilla sibirica* (Fristedt, 1887)	CMNI 2018-0183 28S_D3-D5 GTGGTAGAAACCCCGCGAGCGCAATGAAGGTGAAGGTGAGACTTGTGCTCA CTGAGGCGAGAGCCGCCCTCGTGGCGGCGCATCGTCGCCCGATCCAACGCCA CGCCGTGGCGGGATTCGAGTGAGAGCGTTGCTGTTGCGACCCGAAAGATGGT GAACTATGCCTGAGCAGGGTGAAGCCAGAGGAAACTCTGGTGGAAGCCCGC AGCGGTTCTGACGTGCAAATCGATCGTCAAACTTGGGTATAGGGGCGAAAG ACTAATCGAACCATCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTCAGGATAG CTGGAGCCCTCGATGCAGTTTTATCAGGTAAAGCGAATGATTAGAGGTCTTG GGGTCGAAACGATCTCAACCTATTCTCAAACTTTAAATGGGTAAGACGTCCG GCTTGCTTAAGTGAAGCCGGGCCACGAATGCCGGGGCTCCCAGTGGGCCATT TTTGGTAAGCAGAACTGGCGATGCGGGATGAACCGAACGCTGAGTTAAGGT GCCCGAATCGACGCTCATCAGATCCCATGAAAGGTGTTGGTTGATCTAGACA GCAGGACGGTGGCC
CMNI 2018-0184 *Craniella* cf. *polyura* (Schmidt, 1870)	CMNI 2018-0184 28S_D3-D5 AACCCCGCGAGCGCAATGAAGGTGAAGGCGAGACTTGGGCTCGCCGAGGCG AGAGCCGCCCTCGTGGTGGCGCATCGTCGCCCGATCCAATGCCACGTCGTGG CGGGATTCGAGTGGGAGCGTTGCTGTTGCGACCCGAAAGATGGTGAACTATG CCTGAGCAGGGTGAAGCCAGAGGAAACTCTGGTGGAAGCCCGCAGCGGTTC TGACGTGCAAATCGATCGTCAAACTTGGGTATAGGGGCGAAAGACTAATCG AACCATCTAGTAGCTGGTTCCCTCCGAAGTTTCCCTCAGGATAGCTGGAGCC CTCGATGCAGTTTTATCAGGTAAAGCGAATGATTAGAGGTCTTGGGGTCGAA ACGACTTCAACCTATTCTCAAACTTTAAATGGGTAAGACGCCCGGCTTGCTT AAGCGAAGCCGGGCCACGAATGCCGGGGCTCCCAGTGGGCCATTTTTGGTAA GCAGAACTGGCGATGCGGGATGAACCGAACGCCGAGTTAAGGTGCCCGAAT CGACGCTCATCAGATCCCATGAAAGGTGTTGGTTGATCTAGACAGCAGGACG GTGGCC