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Inuit observations of a Tunicata bloom unusual for the Amundsen Gulf, western Canadian Arctic¹

Harri Pettitt-Wade, Tristan Pearce, David Kuptana, Colin P. Gallagher, Kevin Scharffenberg, Ellen V. Lea, Nigel E. Hussey, and Lisa L. Loseto

Abstract: Inuit are at the forefront of ecosystem change in the Arctic, yet their observations and interpretations are rarely reported in the literature. Climate change impacts are rapidly unfolding in the Arctic and there is a need for monitoring and reporting unique observations. In this short communication, we draw upon observations and experiential knowledge from western Canadian Inuit (Inuvialuit) harvesters combined with a scientific assessment to describe and interpret an unusual account of gelatinous organisms at high densities during summer 2019 in eastern Amundsen Gulf, near Ulukhaktok, Northwest Territories. The gelatinous organisms were identified as primarily appendicularian larvaceans (*Oikopleura* spp., pelagic tunicates) and their gelatinous “houses”. The organisms were observed within 3–5 km of the marine coast, from ~1–2 m below the surface and to depths of ~30 m with an underwater camera. Pelagic tunicates have rarely been documented in the eastern Amundsen Gulf and, to our knowledge, this was the first time these organisms had been noted by the people of Ulukhaktok. The pelagic tunicates clogged subsistence fishing nets and Inuvialuit harvesters were concerned about negative impacts to marine mammals and fishes, which they depend on for food security. These interpretations highlight major knowledge gaps for appendicularians in the Arctic.

Inuit Ukiuktaktumi nunamingni tautukpaktut nunaktik aalangnujuhanik, taimaa tautukpaktait ilihimaliktait titiraqtauyuitut titiqani. Nunam aallangujuhia tautuktauyuk kayumikhipluni Ukiuktaktun nunanni, taimatun munariyauyukhak titiraqhimayukhat aallangujuhiit. Uvani tittiqani Inuit tautukpaktait ilihimaliktait titiraqhimayut Inuvialuit anguniaqtiinnit attauttimut iliblugit qablunaat tittiratainnutitritiarumaplugitumayuuti-gut tamainnut auyanani 2019mi, tahamani Admundson Gulfmi Ulukhaktuum haniani North west Territoriesmi. Tahapkuat uumayut hauniittut imangmi attauttimiitpaktut. Uumayut tahapkuat tautuktauvaktut pingahunikluunniin tallimanitulluunniin kilometres-mik ungahiktilanganik tariukmitalvattaauk atauhikmikluunniin, malguknikluunniin

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metresnik ititigiyumi. Ilaani ititqiyami 30 metresmi takunnaqpaktun ajiliurunmun. Tahapkuninga tautuyittugaluat taja kihimi tautukpaliktait. Ulukhaktuunmiutat taja tautukpaliktait. Tahapkuat uumayut nuvaktut inmate kuvyanut himiutkpiapaktut, kuvyallu iqaluguikhutik. Inuit iqalukhiuktullu anguniaqtullu ihumaalugiliktait anguyamngnik niqiqaramik. Tahapkuat ilituriliktavut ilihimattaitnaptigit nunaptingni ukiuktaktumi ilitturrinahuaqqaqhaluavut.

Key words: appendicularian, Amundsen Gulf, Inuit observation, climate change, knowledge co-production. Uumayut hauniitut, Admundsen Gulfmi, Inuit tautukpaktait, Nunam aalangujuhia, ilihimaliktavut attauttitun havakluta.

Résumé : Les Inuits sont aux premières lignes des changements des écosystèmes de l'Arctique, mais leurs observations et leurs interprétations sont rarement rapportées dans la littérature. Les impacts des changements climatiques se révèlent rapidement dans l'Arctique et il est nécessaire de suivre et rapporter des observations uniques. Dans cette courte communication, les auteurs font appel aux observations et aux connaissances expérimentelles des chasseurs/pêcheurs inuits de l'ouest du Canada (Inuvialuits) combinées à une évaluation scientifique pour décrire et interpréter le témoignage inhabituel de la présence d'organismes gélatineux à forte densité au cours de l'été 2019 dans l'est du golfe d'Amundsen, près d'Ulukhaktok, dans les Territoires du Nord-Ouest. Les organismes gélatineux ont été identifiés comme étant essentiellement des appendiculaires larvacs (*Oikopleura* spp., tuniciers pélagiques) et leurs « maisons » gélatineuses. Les organismes ont été observés dans un rayon de 3 à 5 kilomètres de la côte marine, à environ 1 à 2 mètres sous la surface jusqu'à des profondeurs d'environ 30 mètres, à l'aide d'une caméra sous-marine. Les tuniciers pélagiques ont rarement été documentés dans l'est du golfe d'Amundsen et, à la connaissance des auteurs, ces organismes étaient observés pour la première fois par les habitants d'Ulukhaktok. Les tuniciers pélagiques bouchaient les filets de pêche de subsistance et les chasseurs/pêcheurs inuvialuits s'inquiétaient des impacts négatifs sur les mammifères marins et les poissons, dont ils dépendent pour leur sécurité alimentaire. Ces interprétations mettent en lumière les lacunes importantes des connaissances des appendiculaires de l'Arctique. [Traduit par la Rédaction]

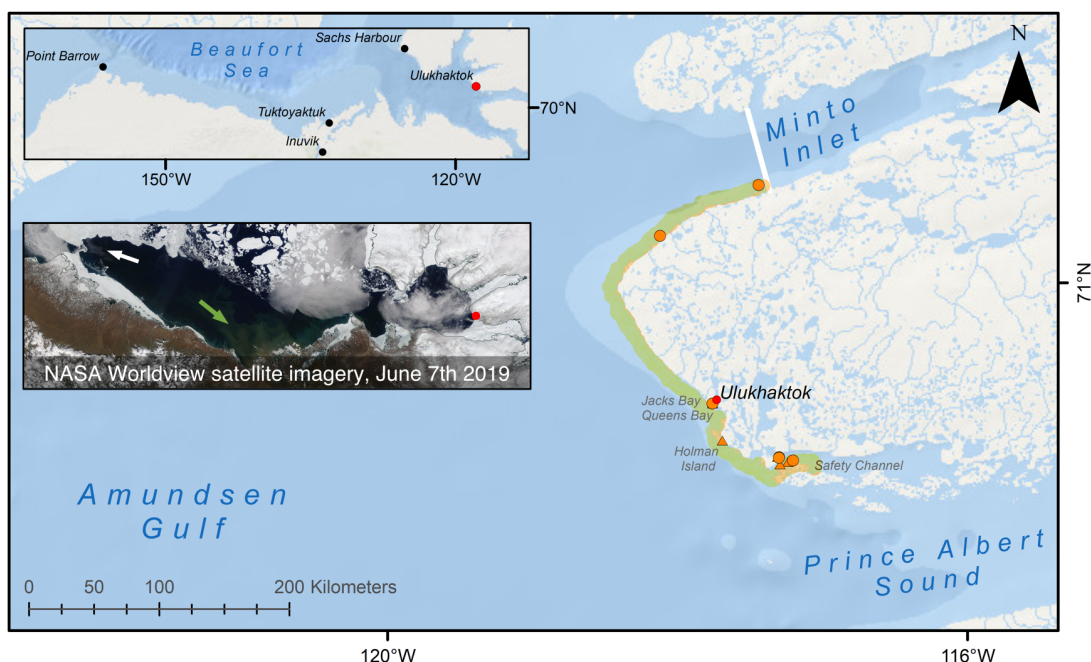
Mots-clés : appendiculaires, golfe d'Amundsen, observation des Inuits, changements climatiques, coproduction des connaissances

Introduction

Climate change impacts are being experienced across Arctic marine ecosystems, the documentation and analysis of which requires transdisciplinary approaches and the collaboration of local knowledge holders (Falardeau and Bennett 2019). Inuit are astute and highly skilled observers of the environment and are often at the forefront of observing climate change effects (Kokelj et al. 2012; Pearce et al. 2015). In the Inuvialuit Settlement Region (ISR), wildlife is managed using both traditional and scientific knowledge (IRC 2016). In this short communication, we draw upon observations from Western Canadian Inuit (Inuvialuit) and scientific understanding to describe and interpret an unusual account of gelatinous organisms at high densities in eastern Amundsen Gulf, off the west coast of Victoria Island, near Ulukhaktok, Northwest Territories, Canada. On 23 February 2020, two highly regarded elder hunters from Ulukhaktok, Northwest Territories (co-author David Kuptana and wife Bella), were interviewed by H.P.W. regarding their unusual observations using an open-ended question format (Supplementary Video S1¹). The interviewees provided informed consent for the information to be collected and distributed herein. Complete Inuinnaqtun translation of this article is available (Supplementary File S1¹).

¹Supplementary material is available with the article through the journal Web site at <http://nrcresearchpress.com/doi/suppl/10.1139/as-2020-0018>.

Fig. 1. Map showing the extent of observations of gelatinous organisms near Ulukhaktok, Northwest Territories, during summer 2019. The general region of sightings and sampling collections along the marine coast is marked in green. The white line in Minto Inlet marks the land-fast ice edge at the time of first sampling and underwater video (11 July 2019). Points indicate video and sampling locations (orange circle) or sampling only (orange triangle). Inset map (upper left) shows the region in context; Ulukhaktok is marked by a red dot. Satellite imagery inset map (middle left) shows the southern Beaufort region ice-free on 7 June 2019, opening up to the Chukchi Sea (white arrow) and productive plumes rising from the Mackenzie Delta (green arrow). Ulukhaktok is marked by a red dot; note the ice edge to the north and south of the community. Inuvialuit place names are available at <https://www.pwnhc.ca/cultural-places/geographic-names/traditional-ulukhaktok-place-names/> (accessed 19 June 2020). Basemap service layer credits: Esri, Garmin, General Bathymetric Chart of the Oceans (GEBCO), National Oceanic and Atmospheric Administration (NOAA), and National Geophysical Data Center (NGDC). Satellite imagery was obtained from National Aeronautics and Space Administration (NASA) Worldview (<https://worldview.earthdata.nasa.gov>, accessed 5 May 2020).

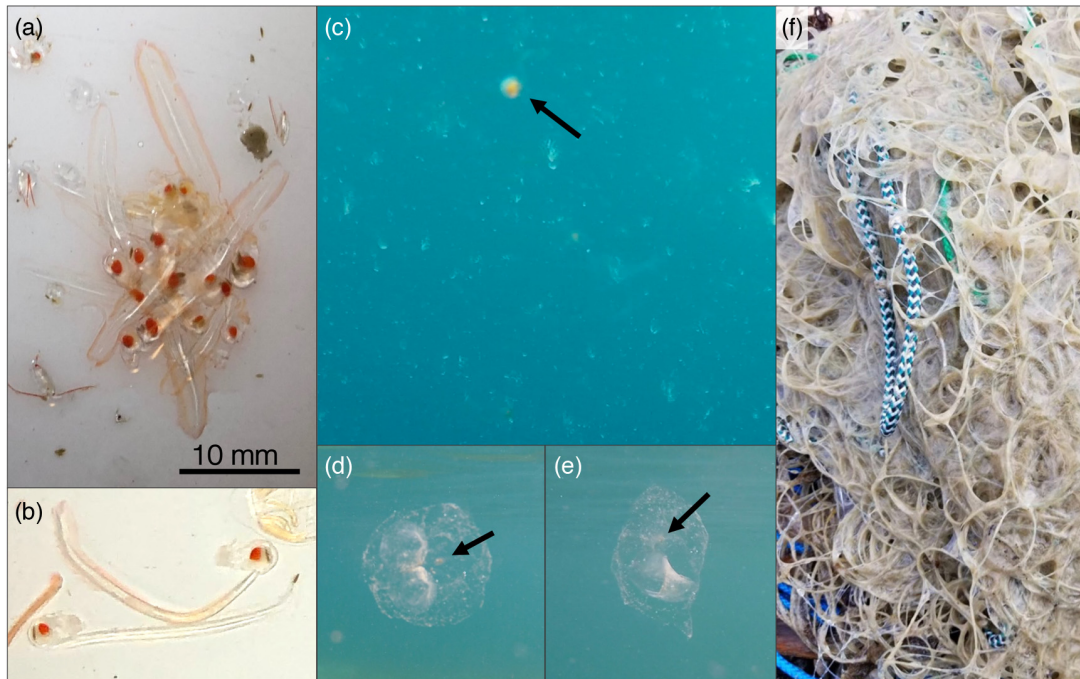


Inuit observations

In late June 2019, while hunting *nattiq* (ringed seal (*Pusa hispida*)) in Tahuyak (Safety Channel) in Kangiryuak (Prince Albert Sound) off Victoria Island in the Amundsen Gulf, western Canadian Arctic (Fig. 1), Ulukhaktomiut² elder hunters David and Bella Kuptana observed many small white but translucent organisms at high densities in the upper water column. David and Bella were hunting from their 5.5 m aluminum boat by the ice edge when they observed several *nattiq* on top of the ice, but very few in the water. Consequently, Bella suggested fishing. When Bella dropped her fishing line into the water and tried to sink it to the bottom, she observed large quantities of white translucent organisms about 1–2 m below the surface. Upon closer observation, David and Bella saw the organisms all around the boat moving slowly just below the water surface. They looked like snow in appearance and some of them appeared to have lights emanating from inside (Fig. 2).

²Ulukhaktomiut is the Inuinnaqtun term used to identify Inuit from the community of Ulukhaktok, Northwest Territories, Canada.

Fig. 2. Pelagic tunicate appendicularian larvaceans collected from the marine coast near Ulukhaktok, Northwest Territories in July 2019. (a) Multiple individuals pooled together (13 July), (b) close-up of two individuals (13 July), (c) underwater video screen capture of dense clouds of gelatinous zooplankton, dominated by larvaceans (11 July). Gelatinous structures (“houses”) and one individual without a house (arrow in (c)). (d–e) One individual captured close to shore (<1 m deep) inside its house (22 July). This house was roughly the size of a small chicken egg. (f) Image of a gill net clogged with gelatinous substances after being set perpendicular to the marine shoreline by Ulukhaktok for two days (14 July). The 10 mm scale is for (a) and (b), scale not available for (c–f). Credit to H. Pettitt-Wade (a–e) and J. Ogina (f).



Some of the organisms floated to the surface and when they emerged, David described that the outer part of the organism popped, turned into powder and vanished. The organisms were unfamiliar to them, so they refrained from touching them and continued hunting. They travelled northwest and every time they stopped, they looked into the water and observed large quantities of the same organisms at different locations: *Tahuyak*, outside *Tahuyak*, in front of *Qikiktakyoak* (Holman Island) and towards *Kagiyotihok* (Minto Inlet) (Fig. 1). Observations of the organisms were also made approximately 3 km from the shore, after the drop-off to the deeper ocean, noting that not many were present in the shallower water closer to shore.

David explained that *nattiq* behaviour appeared different than usual in the presence of these organisms. He observed that there were many *nattiq* on top of the ice, but few in the water, and those that were on the ice were reluctant to enter the water even when approached by the boat. When they pursued *nattiq* that were in the water with their boat, the *nattiq* swam near the surface for long distances. They would pop up quickly and then continue swimming. It seemed to them as though the *nattiq* were trying to avoid the organisms by limiting their diving. These observations of *nattiq* differ markedly from their expected natural behavior. Usually they dive deep and do not travel far when approached by a boat, emerging in the same area and remaining at the surface for a period of time, a movement behavior that leaves them exposed to the hunter.

These white translucent organisms were observed by David and Bella and other *Ulukhaktomiut* continually until early August (~40 d) when it is believed that west winds moved the organisms out of the Ulukhaktok area. David stated that there were fewer animals in the water during the time in which these organisms were present, in particular *nattiq* and *qilalugaq* (beluga whales, *Delphinapterus leucas*). Drawing on his observation of unusual *nattiq* behaviour, David commented that he believed the organisms might affect the eyes of *nattiq* and *qilalugaq*, explaining why few individuals were seen when the organisms were present. These organisms also accumulated in fishing nets intended for *iqalukpik* (Arctic char, *Salvelinus alpinus*) rendering them less effective for fishing and requiring the nets to be removed from the water for drying and cleaning (Fig. 2, Supplementary Video S1¹). This made fishing an arduous process due to the weight of the fishing nets covered in the gelatinous organisms and the need to dry and clean them several times throughout July. Earlier in 2019, David had also noted that the marine coast near Ulukhaktok did not freeze all winter, which is unusual compared with previous years (D. Kuptana, Personal Communication with E.V. Lea on “ice conditions”, 16 May 2019).

David and Bella reported their observations to fisheries researchers, who had arrived in Ulukhaktok in early July 2019 to undertake field research on fish diet and movement behaviour. *Ulukhaktomiut* wished to know what these organisms were, as they had never seen them before, and wondered if they should be concerned about their potential impacts on the marine ecosystem. The researchers took samples, photos, and videos of the organisms. An analysis of these video/samples follows with a discussion about what is known about these organisms, their impacts on the marine environment, gaps in knowledge, and research opportunities (Table 1).

Scientific analysis

Samples of the gelatinous organisms were collected from the coastal region near Ulukhaktok in July 2019 using a zooplankton net (0.5 m diameter, 500 µm mesh with cod end). The net was dropped to 5–10 m above the substrate and pulled vertically towards the surface at ~0.5 m/s to retrieve a sample representative of the full water column, while avoiding collection of sediment. Triplicate samples were collected from seven coastal sites between 11 July and 5 August 2019 at depths ranging from 18 to 50 m. Samples were either preserved frozen or in 10% formalin-salt water solution and returned to the laboratory. The organisms were initially visually identified in the field using a hand lens and confirmed in the laboratory using a stereoscopic microscope based on morphological features using the Marine Species Identification Portal (<http://species-identification.org>, last accessed 30 April 2020, Van Couwelaar 2003) and Leung et al. (1972). Samples consisted of primarily appendicularian larvaceans (*Oikopleura* spp.), commonly known as pelagic tunicates (Fig. 2). Other zooplankton present in the samples included copepods and other gelatinous organisms including cnidarian Ctenophora and micromedusae. Underwater video footage taken at each sampling event also confirmed the presence of gelatinous structures at high densities throughout the water column ~1–2 m below the surface (Supplementary Video S1¹, Fig. 1). Larvacean pelagic tunicates produce large quantities of gelatinous structures referred to as their “houses”; however, these are generally not well represented in plankton tow samples due to their fragility. David, Bella and other *Ulukhaktomiut* confirmed that the gelatinous organisms they observed in June and July 2019 matched the images of the sample collections of larvaceans and their gelatinous houses from July 2019.

Distribution and geographical bias in knowledge: is it unusual for larvaceans to occur in the Beaufort Sea and the Amundsen Gulf?

Appendicularian larvaceans are widely abundant throughout the world’s oceans, including the Arctic Ocean (Lane et al. 2008; Conley and Sutherland 2017) where they have

Table 1. Outstanding questions on larvaceans in the Beaufort Sea and Amundsen Gulf: current understanding and suggested actions.

| Current understanding | Suggested action | Relevant citations |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>What are these organisms that are unfamiliar to local Inuvialuit? Primarily pelagic tunicates. Appendicularian larvaceans. Ctenophora also potentially sighted.</p> | Informative report and identification key for communities in the Inuvialuit Settlement Region | Leung 1972 , Van Couwelaar 2003 |
| <p>Are these organisms unusual for the region? Unclear. Unusual to see in large numbers inshore. Rarely sampled in the Amundsen Gulf. First known record of observations in such high densities near Ulukhaktok, Northwest Territories.</p> | Increased zooplankton sampling close to coast at peak productivity. Distribute quick ID guides to Arctic communities and facilitate reporting of local observations. | Maekakuchi et al. 2018 , Lane et al. 2008 , Walkusz et al. 2016 |
| <p>Why were they present near Ulukhaktok in such high numbers in 2019? They feed on small plankton and grow/reproduce very rapidly at extremely high plankton densities. Likely brought to the region along with Pacific water from the west by strong winds and currents following ice-breakup. Long open-water season in 2018 and early breakup in 2019 likely contributed to the high numbers visible in surface waters due to high productivity.</p> | Models of gelatinous organism species distribution and abundance under different scenarios of ice-breakup and formation should include coastal regions and bays. | Deibel et al. 2017 , Deibel et al. 2005 , Acuña et al. 1999 , Nakano et al. 2016 , Maekakuchi et al. 2018 , Nelson et al. 2019 , Oviatt et al. 2015 |
| <p>Are they harmful to marine mammals or fishes? Aside from food web dynamics and energy transfer, current understanding of the potential physiological and behavioural influence of pelagic tunicate blooms on other species is very limited and warrants investigation. Larvaceans do not have stinging nematocysts, but their Cnidaria jellyfish predators do (e.g., <i>Aurelia</i> sp.). There is very little information on whether dense larvacean blooms induce avoidance behaviour of marine mammals or fishes. Indirect impacts include disruption to energy transfer within food webs and low lipid content.</p> | Research on the physiological and behavioural impact of large larvacean blooms on marine mammals and fishes. | Nomura and Davis 2005 , Connelly et al. 2016 , Nakano et al. 2016 , Falardeau and Bennett 2019 |
| <p>What are some other potential impacts? Larvaceans are considered to provide some major positive impacts on oceanic food webs, filtering tiny plankton into a form that is digestible by larger organisms and providing large quantities of marine snow for pelagic and benthic habitats. Species that feed on these particles and the gelatinous houses could benefit, including copepods and the keystone Arctic fish, Arctic cod. Older life stages could compete for food with other key prey, such as copepods. They could attract more larger gelatinous predators to the area (i.e., cnidarian jellyfish).</p> | An impact assessment for larvaceans dramatically increasing in abundance in the Beaufort Sea and connected water bodies, including the Amundsen Gulf and coastal regions. | Nakano et al. 2016 , Alldredge 1984 , Alldredge 2005 , Deibel et al. 2005 , Doubleday and Hopcroft 2015 , Gorsky and Fenaux 1998 , Prokopchuk 2017 |
| <p>Should we expect to see more of these in the region in the near future? General literature is mixed as to whether numbers are increasing with climate change or driven more by decadal events. The few current studies for the Beaufort Sea suggest numbers are increasing. Increasing open-water season and polynya area, wind speed, and coastal upwelling could lead to higher nearshore marine productivity and more tunicates visible near the surface and (or) close to shore.</p> | Systematic sampling and continuous monitoring programs in collaboration with Inuvialuit community research committees (e.g., Hunters and Trappers) could provide rapid accounts of presence/absence and increase the accuracy of predictive models. | Bouquet et al. 2018 , Maekakuchi et al. 2018 , Nakano et al. 2016 , Walkusz et al. 2016 , Hopcroft et al. 2008 , Roman and Pierson 2019 |

been observed at high densities throughout the water column from surface waters to depths of ~4000 m (Raskoff et al. 2005). The currently reported observations of larvaceans at high densities close to shore at <100 m depth in the Amundsen Gulf region could relate to the increasing persistence of polynyas in the Beaufort Region and associated blooms of diatoms (Deibel et al. 2017, Fig. 1 — inset map). Larvaceans often occur at high densities and are among the highest biomass of non-copepod zooplankton taxa in Arctic polynyas and at the ice edge during periods of high primary productivity (Acuña et al. 1999; Deibel et al. 2005, 2017). These gelatinous organisms have been observed at high densities in offshore sampling collections and fish stomach contents in the Beaufort, Chukchi, and Bering seas (Nakano et al. 2016; Maekakuchi et al. 2018; Nelson et al. 2019), the Canadian Arctic deep-sea basin (Kosobokova and Hopcroft 2010; Kosobokova et al. 2011) and Baffin Bay (Deibel et al. 2005, 2017). Variation in distribution and abundance often relate to physical water structure with highest densities occurring in locations where water motion creates “shear” due to different water densities (i.e., fronts, halo-/or thermoclines, Raskoff et al. 2005). Different species and life stages of larvaceans also have variable temperature and salinity thresholds and feed on different size plankton particles, which influence their distribution in the water column and drive regional biases in distribution (Raskoff et al. 2005; Deibel et al. 2017). High densities have been documented in waters close to the coast of the Baltic and Chukchi seas when offshore winds cause upwelling of cold water to the surface (López-Urrutia et al. 2005, Fig. 1 — inset map; Choe and Deibel 2008). However, sampling is most often conducted far offshore and might not accurately reflect their distribution closer to shore, in bays and inlets. Given the challenges of capturing gelatinous organisms with conventional zooplankton sampling techniques, they remain understudied and even basic regional abundance estimates are not available for the Canadian Arctic. Moreover, limited historic observations in the Canadian Arctic restrict the capacity to infer long-term trends in occurrence and abundance (Raskoff et al. 2005).

What role do larvaceans have in Arctic marine food webs?

Larvaceans are key species in ocean food webs, for example, providing a critical trophic linkage to microbes and nanophytoplankton and picophytoplankton that are too small for crustacean zooplankton to consume (Gorsky and Fenaux 1998). Often during or soon after phytoplankton bloom events, pelagic tunicates and ctenophores have been found to sporadically occur at very high relative abundances in the stomachs of keystone Arctic fish species including salmonids (Doubleday and Hopcroft 2015), gadids (Johnson et al. 2009), snailfish in the Beaufort Sea (Walkusz et al. 2016), Arctic cod (*Boreogadus saida*) in the Bering and Chukchi seas (Nakano et al. 2016), and even when copepods, a potential alternative prey item, are concurrently high in abundance (Kara Sea, Prokopchuk 2017). As such, gelatinous zooplankton can be a primary source of energy that is transferred higher up in the food chain to fishes, marine mammals, and birds throughout the Arctic (Sommer et al. 2002). Larvaceans are also common prey of many other gelatinous organisms, including the cnidarian Ctenophora that were present in sample collections and were likely the colourful light emitting organisms simultaneously observed by *Uluksaktomiut*. Pelagic tunicates are also major contributors to the “biological pump” of nutrients from the euphotic zone to deeper waters and benthic zones (Alldredge 1984, 2005). Using their gelatinous structures (called houses, Figs. 2c–2e), high densities of larvaceans filter large quantities of sea water for microorganisms and phytoplankton. Once houses are clogged and discarded, other zooplankton (copepods, krill, polychaete larvae) will feed on trapped diatoms and flagellates while the structures sink to deeper waters (Alldredge 1972). Several structures are created and discarded by each individual every day (1–6/day in Newfoundland, Gorsky and Fenaux 1998), providing a considerable contribution to marine snow, particles of organic matter

that are consumed by many species throughout the water column and at the bottom of the ocean (Alldredge 1972).

What are the potential ecological, societal and economic impacts of larvacean blooms?

Predicting potential impacts of larvacean blooms in the Amundsen Gulf is challenging due to the limited documented accounts in the region (Lane et al. 2008) and recognized complexities driving their occurrence elsewhere (López-Urrutia et al. 2005; Maekakuchi et al. 2018, Table 1). However, larvaceans are generally considered to provide an important and potentially unique functional role at very high and fluctuating diatom densities, such as at ice edges and polynyas, providing rapid transfer of energy into a form that zooplanktivores are able to consume (Acuña et al. 2002; Deibel et al. 2017). Larvaceans are able to graze at much higher concentrations of diatoms than other common zooplankton taxa (Deibel et al. 2017). For example, *Oikopleura vanhoeffeni*, the most cold-water tolerant larvacean (Choe and Deibel 2008), was found to graze at a rate that equaled all copepod species combined (North Water Polynya, Baffin Bay; Deibel et al. 2017). This functional role, coupled with their resilience to ocean acidification and deoxygenation, is particularly crucial to consider as Arctic ecosystems and species are increasingly impacted by climate change (Roman and Pierson 2019). Conversely, larvaceans have been found to have lower lipid content than other common prey species, including copepods, which could incur a physiological cost for Arctic predators that depend on a high lipid diet and Inuit that depend on sustainable subsistence harvest of marine mammals and fishes (Nomura and Davis 2005; Connelly et al. 2016).

A potential indirect impact of increasing larvacean abundance is the increasing abundance of their predators, such as Ctenophora and large cnidarian jellyfish. Increasing frequency and abundance of jellyfish blooms in the Bering Sea, and subsequent population crashes whereby large numbers are washed up on shore, has been attributed to climate change (Brodeur et al. 2002). Local observations of "...jellyfish piled up several feet deep along large expanses of Barrow, Alaska, shorelines..." suggest these boom and bust cycles are also taking place in the Chukchi–Beaufort region (Hopcroft et al. 2008). Subsequent blooms in gelatinous predators (i.e., large jellyfish) of tunicates and micromedusae (i.e., small-growing jellyfish) can incur substantial ecological, economic and societal impacts, including clogging fishing nets and piping, killing fish in aquaculture pens, stinging swimmers (Purcell et al. 2007) and altered distribution of Arctic cod (Lions mane jellyfish *Cyanea capillata*, Crawford 2016). Solitary and colonial tunicates that settle on structures are a common fouling nuisance (including fishing nets), and multiple species are invasive along the North Pacific and Atlantic coasts (Therriault and Herborg 2008).

This is the first published account, to our knowledge, of pelagic tunicates (or their houses) clogging subsistence gill nets, typically <55 m in length (114 mm stretch mesh) set perpendicular from shore. Although samples were not obtained from gill nets to confirm if these were pelagic tunicates, the timing coincides with observations and sample collections and photographs of nets matched their general appearance (Fig. 2f). Catch Per Unit Effort of Arctic char from the Ulukhaktok annual harvest monitoring program were not notably different than previous summers, although several harvesters noted they had to pull their nets to clean heavy gelatinous substance from them (Ellen Lea, DFO Inuvik, unpublished data, 2019). This likely resulted in both reduced efficiency of the fishing gear and increased effort required to clean nets and coincide with community reports (including D. Kuptana's) that clogged nets reduced potential catches during summer 2019.

Should we expect to see more larvacean bloom events in the region in the near future?

Environmental changes have a disproportionate impact on different zooplankton and the potential for gelatinous zooplankton to prevail over crustaceans with climate change is the subject of ongoing discussion (Saint-Béat et al. 2018). Ocean acidification and associated deoxygenation is generally projected to negatively impact crustaceans and fishes and positively impact gelatinous organisms (AMAP 2018; Roman and Pierson 2019), including larvaceans (Bouquet et al. 2018). Within the Arctic, studies suggest that the densities of pelagic tunicates in the Arctic are increasing over time (Acuña et al. 1999; Deibel et al. 2005; Hopcroft et al. 2005; Lane et al. 2008), though there are limited accounts for the Amundsen Gulf. Given the physiological thresholds and distribution of different larvacean species, two species (*Oikopleura labrodensis* and *Fritillaria borealis*) were predicted to increase in abundance in the Arctic with climate change (Choe and Deibel 2008). In the Bering and Chukchi seas, these species spawned earlier in 2007 compared with 1983–1996 and had higher abundance of newly recruited small individuals, possibly attributed to higher and more frequent peaks in productivity in more recent years (Maekakuchi et al. 2018). However, peaks in abundance in the Pacific and Atlantic have also coincided with decadal trends in warming, cooling, winds and ocean currents (Oviatt et al. 2015; Maekakuchi et al. 2018). Given the considerable tropical and temperate regional bias in the current understanding of the abundance, distribution and physiology of gelatinous organisms, and pelagic tunicates in particular, the contribution of decadal-scale events relative to recent climate change is currently unknown for the Arctic.

Conclusions and research directions

Inuit operate on the forefront of climate change effects in the Arctic. Western Canadian Inuit (Inuvialuit) requested that scientists investigate observations of high densities of gelatinous organisms in the Arctic marine ecosystem. *Ulukhaktomiut* shared that these organisms were unfamiliar to them and wanted to know more about what the organisms were and their potential impacts on the marine ecosystem (Table 1). The organisms were confirmed to be primarily larvaceans, but samples also contained Ctenophora, which are common predators of larvaceans. Further research is required to determine if this unusual sighting is a result of longer open water seasons that are increasing productivity and phytoplankton abundance to levels that can sustain reproduction and rapid growth of larvaceans at high densities in the western Canadian Arctic (Maekakuchi et al. 2018). High winds and upwelling could also force productive water masses, nutrients, and larvaceans inshore and closer to the surface, as suggested in the Chukchi and Bering seas (Choe and Deibel 2008), but this has yet to be examined in the eastern Amundsen Gulf (Table 1).

These organisms have been observed previously at high densities in the Beaufort Sea, and sporadic occurrences are common for the species in general. However, given that the sighting was entirely novel among *Ulukhaktomiut*, who continuously observe the marine environment throughout their lives, it is highly likely that this was the first Tunicata bloom near Ulukhaktok, Northwest Territories, in recent history. In July 2020, David noticed the organisms again from the surface at high densities near Ulukhaktok, but samples were not obtained to confirm they were pelagic tunicates (D. Kuptana, Personal Communication with H. Pettitt-Wade, July 2020). Zooplankton sampling is rarely conducted close to shore and information on these species and gelatinous organisms in general is scarce for the region and across the Arctic. Systematic and repeated sampling for gelatinous organisms close to shore, in bays and inlets that coincides with expected bloom events and at other times for comparison could help fill a major knowledge gap. Moreover, aside from occurrence in fish diets, little is known regarding the interaction between pelagic tunicates and larger animals, which was alluded to by Inuvialuit interpretation of observations.

It is unclear whether tunicates were responsible for the perceived changes in marine mammal and fish behavior observed by Inuvialuit and (or) reduced/alterd fishing effort during summer 2019. Increasing densities of predatory large-growing jellyfish and Ctenophora could cause considerable ecological and societal impact, whether drawn to the region by tunicate blooms or favourable environmental conditions (Gorsky and Fenaux 1998; Purcell et al. 2007; Crawford 2016). We demonstrate how local Inuit observations grounded in a long history of ecological knowledge of the area can provide valuable first-hand information on understudied species and highlight potential knowledge gaps. Inuit interpretations of observations are rarely reported in the scientific literature yet are crucial to document during this period of rapid environmental change.

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