Size distribution and abundance of the dominant Arctic shelf brittle stars: *Ophiura sarsii* and *Ophiocten sericeum*

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Background: Why care about brittle stars?

Brittle stars are the most abundant megabenthic taxon throughout the Arctic shelves. On the Alaskan Arctic shelves, *Ophiura sarsii* and *Ophiocten sericeum* are the dominant brittle star species. Both have boreal Arctic distribution and can be found in high densities on many Arctic shelves. In the Chukchi Sea, for example, *O. sarsii* densities reach up to several hundred individuals per square meter (Ambrose et al., 2001).

These high density brittle star beds exist in the Arctic due to:

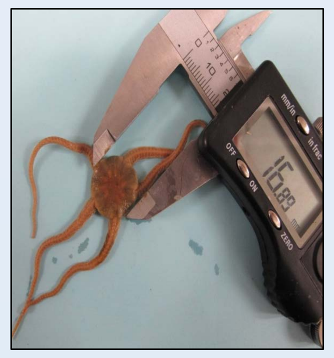
- High seasonal primary production, fed to the benthos through tight benthic-pelagic coupling.
- Advection of food from water masses with high nutrient concentration.
- Low predation pressure, particularly from fish.

Despite their dominance of Arctic epibenthic communities, to date we have no knowledge of the population structure, the time it takes for these dense brittle star assemblages to form or how long they may persist in time or space. With the accelerated environmental changes occurring in the Arctic, knowledge of the population parameters of these two species will contribute to an integrated understanding of the Arctic marine ecosystem.

Questions

- What is the population size structure of *Ophiura sarsii* and *Ophiocten sericeum*?
- How do the distribution and density patterns of *O. sarsii* and *O. sericeum* differ through the Chukchi and Beaufort Sea shelves?

Methods



Size frequency analysis. Body size of ophiuroids was measured as disc diameter (illustrated to the left). Both species were collected during the ice-free seasons of 2013. *Ophiura sarsii* (n=6,478) were found in the Hanna Shoal region at 20 stations and *Ophiocten sericeum* (n=3,622) were found in the central Beaufort Sea at 14 stations. Station depth in both regions ranged from 35 to 200 m.

Distribution and density analyses. Presence/Absence data were determined from 244 stations sampled during various research cruises, spanning from 1976 to 2013. Due to gear discrepancies or final data availability, not all data sets were included in the density analysis. Samples for density analysis were collected with a 3.05 m plumb-staff beam trawl, with a 7 mm mesh and a 4 mm codend liner (left image). Trawl time varied from 1.5 to 5 minutes on the seafloor. Densities were standardized to ind.1000 m^{-2}.

Results

Size frequency analysis

Size frequency analysis for *O. sarsii* shows three distinct size groups (Fig. 1). Disc diameter ranged from 1.8 to 30.9 mm. The mode (8.2 mm) fell in the first and highest frequency size group.

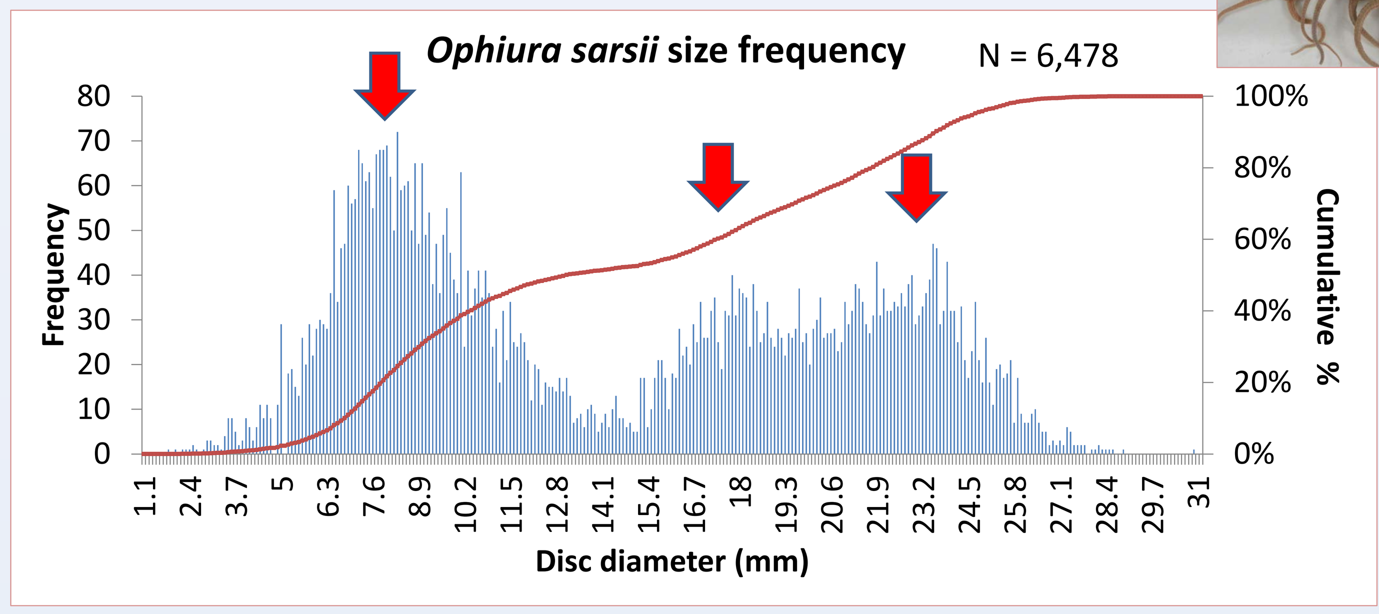


Fig. 1. Size frequency of *O. sarsii*. Arrows indicate the three size groups.

Size frequency analysis for *O. sericeum* shows three distinct size groups (Fig. 2). Disc diameter ranged from 1.1 to 14.9 mm. The mode (2.5 mm) fell in the first and highest frequency size group.

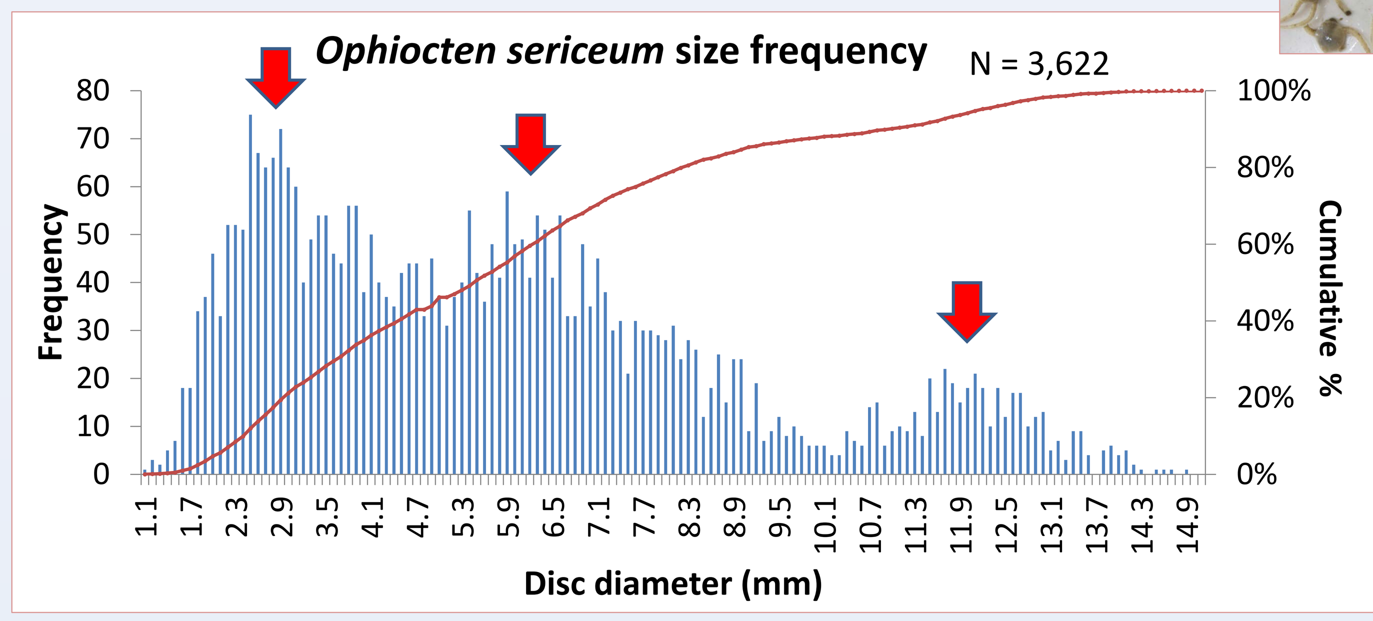


Fig 2. Size frequency of *O. sericeum*. Arrows indicate the three size groups.

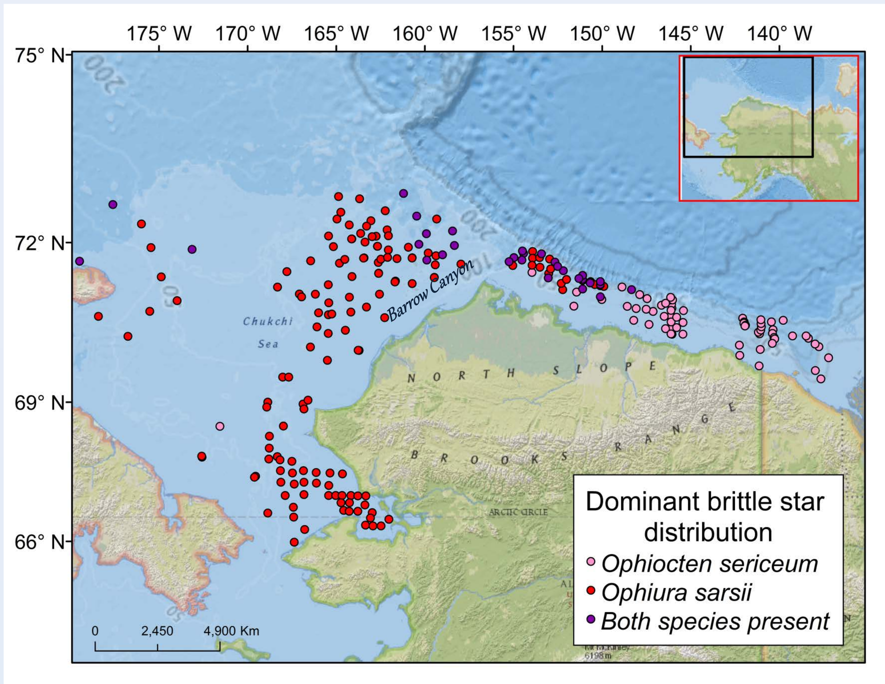


Fig. 3. Distribution of *O. sarsii* and *O. sericeum* from 244 stations.

Species Distribution

O. sericeum was present at less stations (40%, 97 of all stations) compared to *O. sarsii* (74%, 180 of all stations) and was mostly limited to the Beaufort Sea, NE and NW Chukchi Sea. (Fig. 3)

O. sarsii dominated the Chukchi Sea shelf with a clear eastern boundary at 148°W.

The distribution of both species overlapped in two small areas, where the Chukchi and Beaufort Seas meet and in the northwestern Chukchi Sea (33 stations).

Species Density

Throughout the Alaskan Arctic the abundance of *O. sarsii* was an order of magnitude higher than the abundance of *O. sericeum* (Fig. 4).

O. sarsii had high densities in the vicinity of Barrow Canyon (NE Chukchi Sea) and along the western Beaufort Sea slope.

O. sericeum had a much more variable abundance. The area with the highest density was located along the western Beaufort Sea slope.

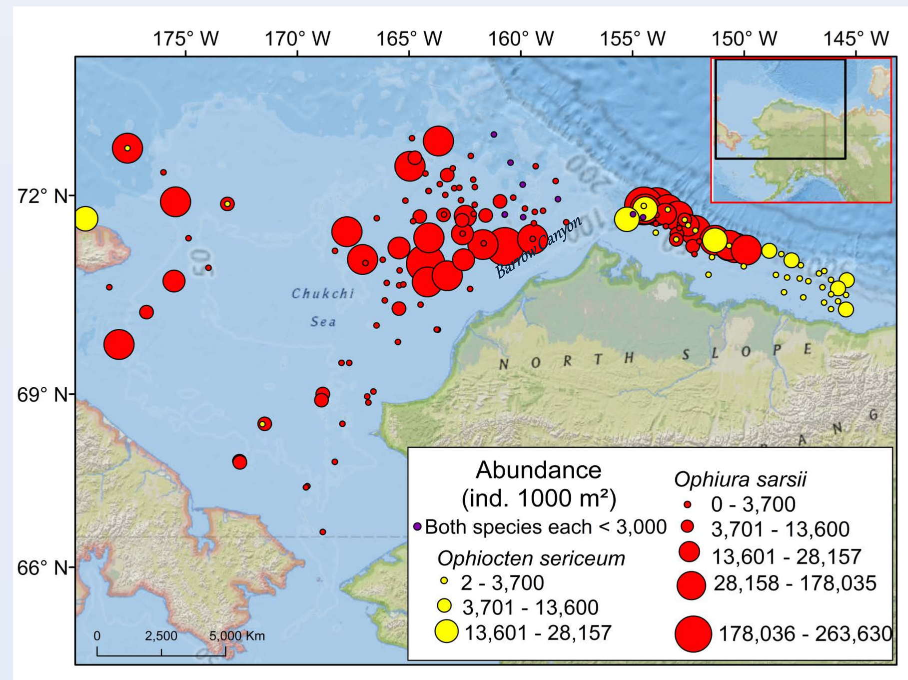


Fig. 4. Density of *O. sarsii* and *O. sericeum* from 156 stations (RUSALCA, COMIDA-CAB and Beau-Fish cruises).

Conclusions and Implications

Overall, *O. sericeum* is a smaller species than *O. sarsii* (in both maximum size and mode).

Typical size frequency distributions have a high frequency of small individuals that diminishes with increasing size. This trend was much more apparent for *O. sericeum*. The smallest size groups may not have been captured qualitatively because of the trawls mesh size, poor recruitment the year sampled, or limited geographic coverage.

It is unlikely that each of the size modes observed for both species are only composed of one cohort (specimens of the Arctic species *Ophiura ophiura* were determined to be 9 years old at a disc diameter of 15 mm; Dahm, 1993). Aging analysis of these species will shed light on the real size-at-age distribution of these populations, see Next Steps.

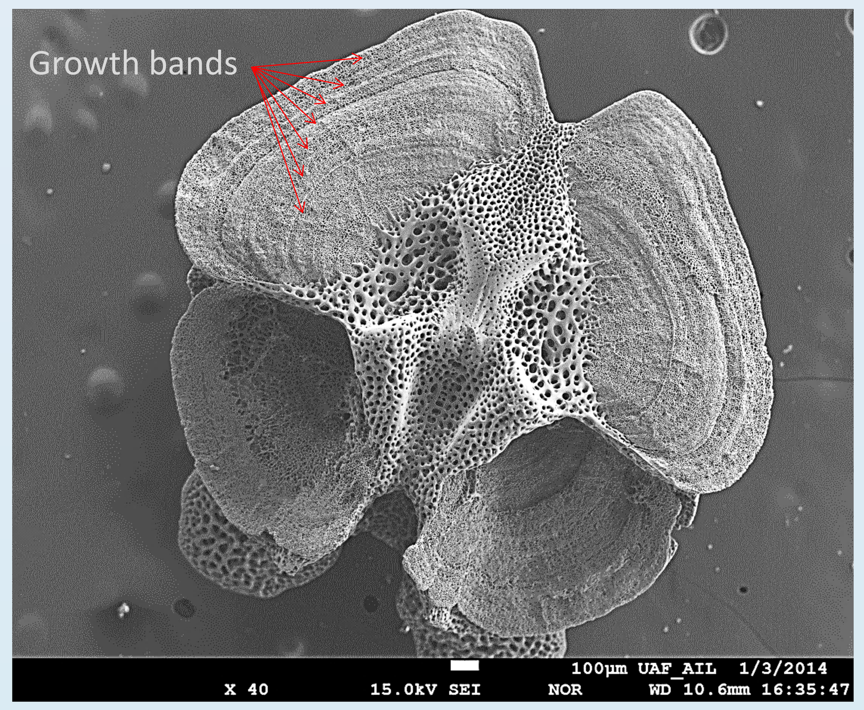
These species share a relatively small area that overlaps in their distribution. This area also appears to delineate a distribution limit on the Alaskan shelves for each species.

Areas of high density were located in the vicinity of Barrow Canyon and along the western Beaufort Sea slope. Life history traits, such as longevity and secondary production rates, can help make the connection between organisms' distribution and the environment, as well as help explain the species composition in biological hot spots, see Next Steps.

Next Steps

Age analysis
Will allow the determination of growth rates and longevity for both species.

Secondary Production
Production/ Biomass (P/B) is highly affected by population age and size structure.
These metrics are essential to understand the energy flow and organic matter cycling in the environment.



Brittle star arm ossicles have growth bands that can be used for aging (like tree rings).

Why can't they be friends?
The segregated distribution of the two species may stem from differences in their biogeographic origin or be maintained by differences in their biological characteristics. Expanding our knowledge on the biological characteristics of the two species will help us answer this question.

Acknowledgments

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