Epibenthic community structure in the Chukchi Sea (RUSALCA 2009,2012)

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Abstract

Epibenthic community structure and potential environmental drivers were investigated in the Chukchi Sea in 2009 and 2012. In 2009 epibenthic abundance and biomass was dominated by echinoderms. In 2012 the highest contribution to epibenthic biomass was by echinoderms while arthropods contributed most to abundance. Community composition differed between the northwestern and southern Chukchi Sea, with water depth and latitude explaining about half the variability in the community composition in both years.

Introduction

The Russian-American Long-term Census of the Arctic (RUSALCA) is an international, interdisciplinary program aimed at building a time-series of biological and environmental data in Russian and US waters of the Chukchi Sea. Benthic communities in the Arctic serve as potential indicators of ecological responses to climate change due to their tight benthic-pelagic coupling. Epibenthic community composition reflects a combination of the processes of the overlying water column , properties and patterns of advected waters, and complex physical and biological interactions on the sea floor. With increasing realization of climate change and its impact on ecological systems, this study aims at providing valuable information for detecting an ecological response to climate shifts.

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Objectives

1. Document epibenthic community composition, abundance and biomass on the Chukchi Sea shelf separately for 2009 and 2012 RUSALCA collections.

2. Identify primary environmental drivers influencing epibenthic community structure in the Chukchi Sea separately for 2009 and 2012.

Methods

- 15 stations each were sampled in 2009 and 2012 using plumb-staff beam trawls in the Chukchi Sea (Figures 1,4).
- Abundance data were calculated at number of individuals 1000 m^{-2} and biomass was calculated as grams wet weight 1000 m^{-2}.
- Multidimensional scaling based on a Bray-Curtis similarity matrix was used to group stations
- Environmental data were collected (2009: Temperature, salinity, oxygen concentration, latitude, depth, sediment chlorophyll a, sediment grain size, sediment organic carbon, and infaunal biomass. 2012: Temperature, salinity, oxygen concentration, latitude and depth).
- Environmental data were compared to biological data (biomass) using the BIOENV suite (PRIMER v6) and principal component analyses were run to assess relationships between environmental variables at sampling locations.

2009

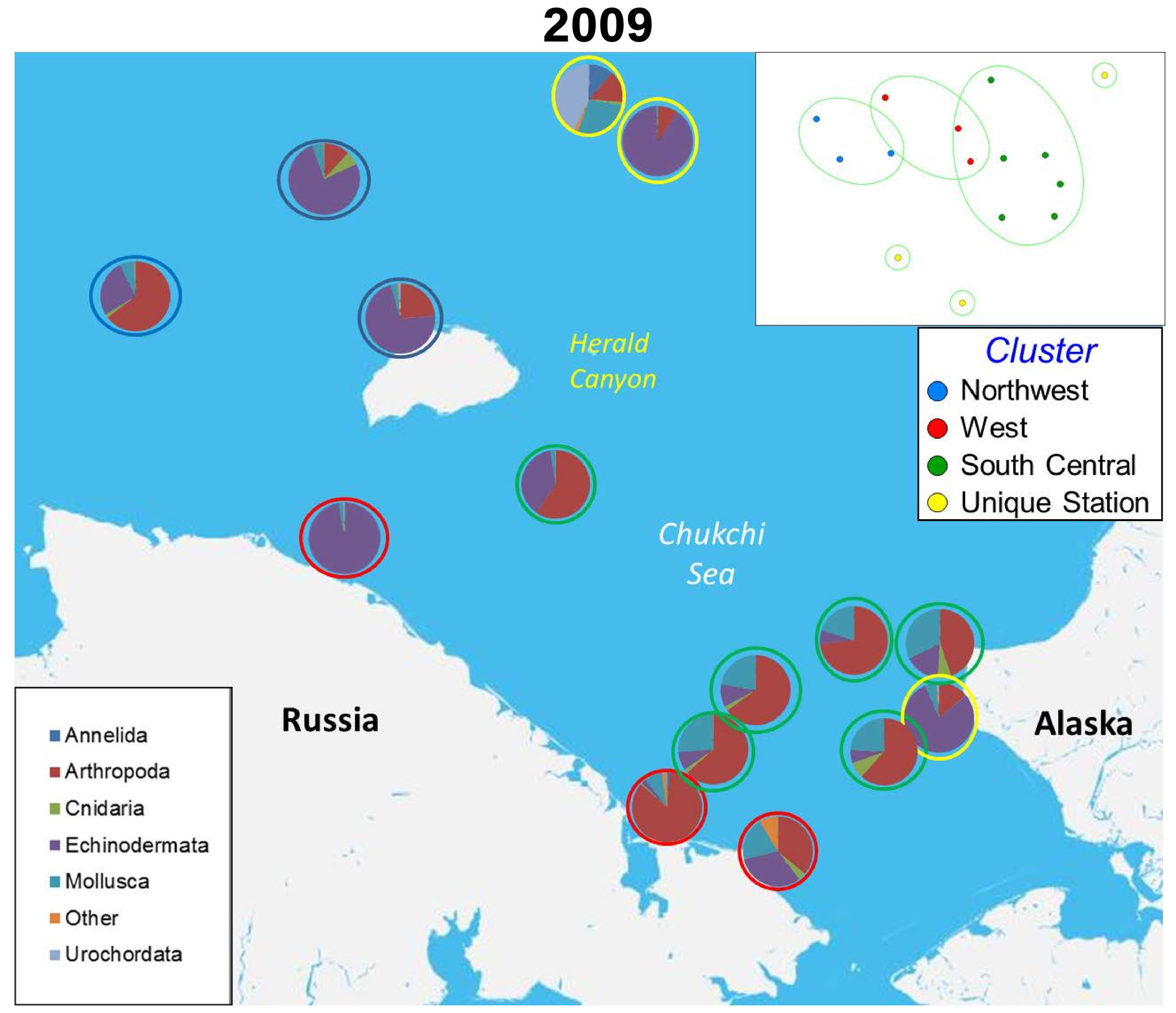

Figure 1. Relative taxanomic composition (biomass, 2009) at sample stations with clusters identified by MDS. **Inset:** Ordination of sample stations (biomass) with clusters at 43% similarity.

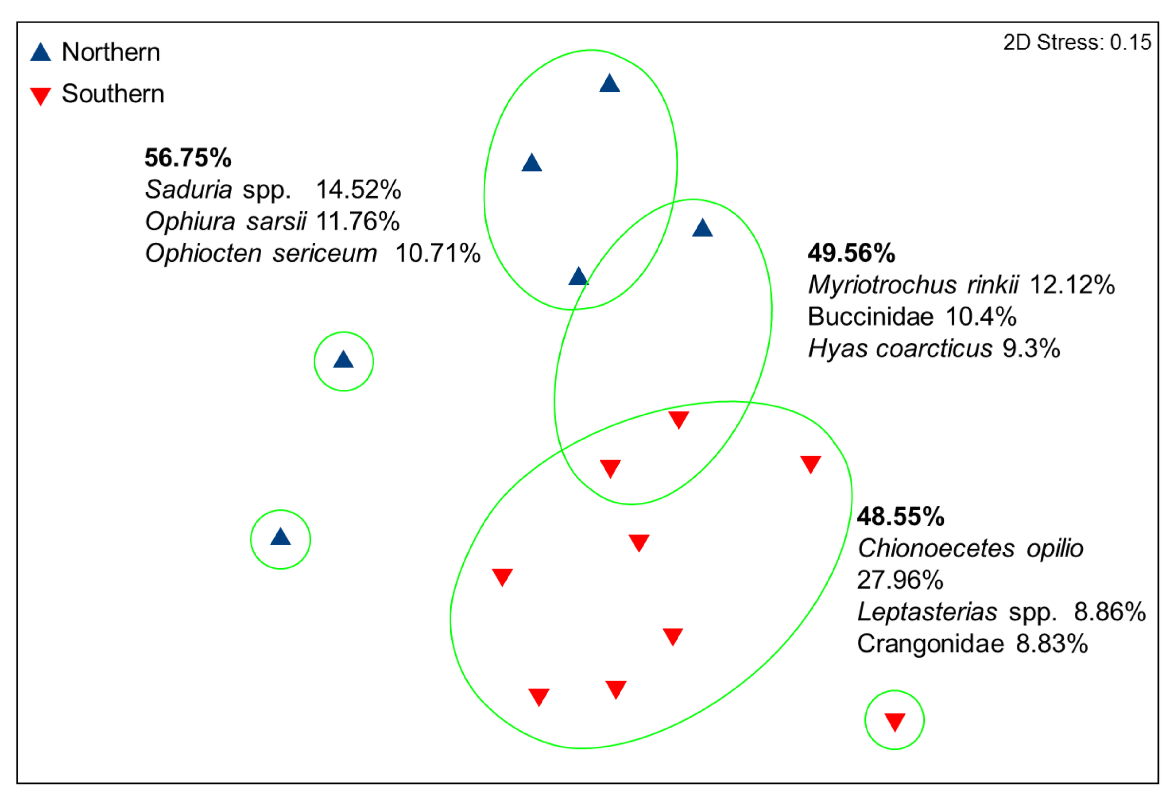

Figure 2. Ordination of sample stations (biomass 2009) with average similarity within clusters and taxa contributing the most to similarity.

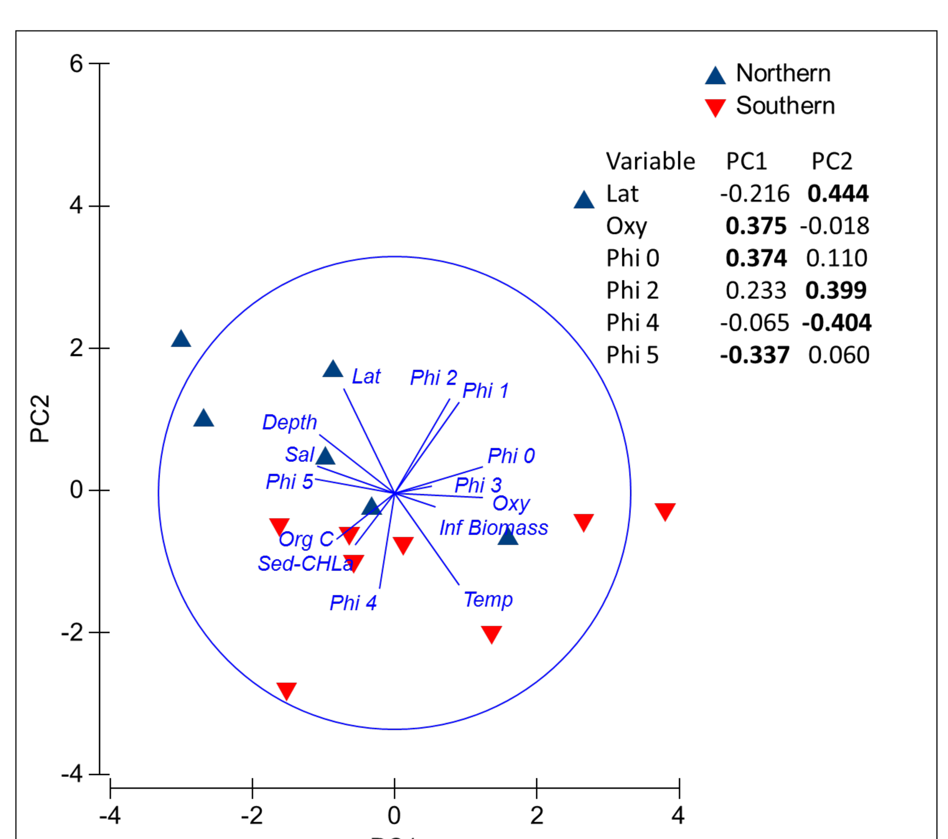

Figure 3. PCA of environmental variables (2009) and sampling stations. Table lists the three variables most correlated to PC1 and PC2. PC1 explains 29% of variability, PC2 explains 20.2%.

2012

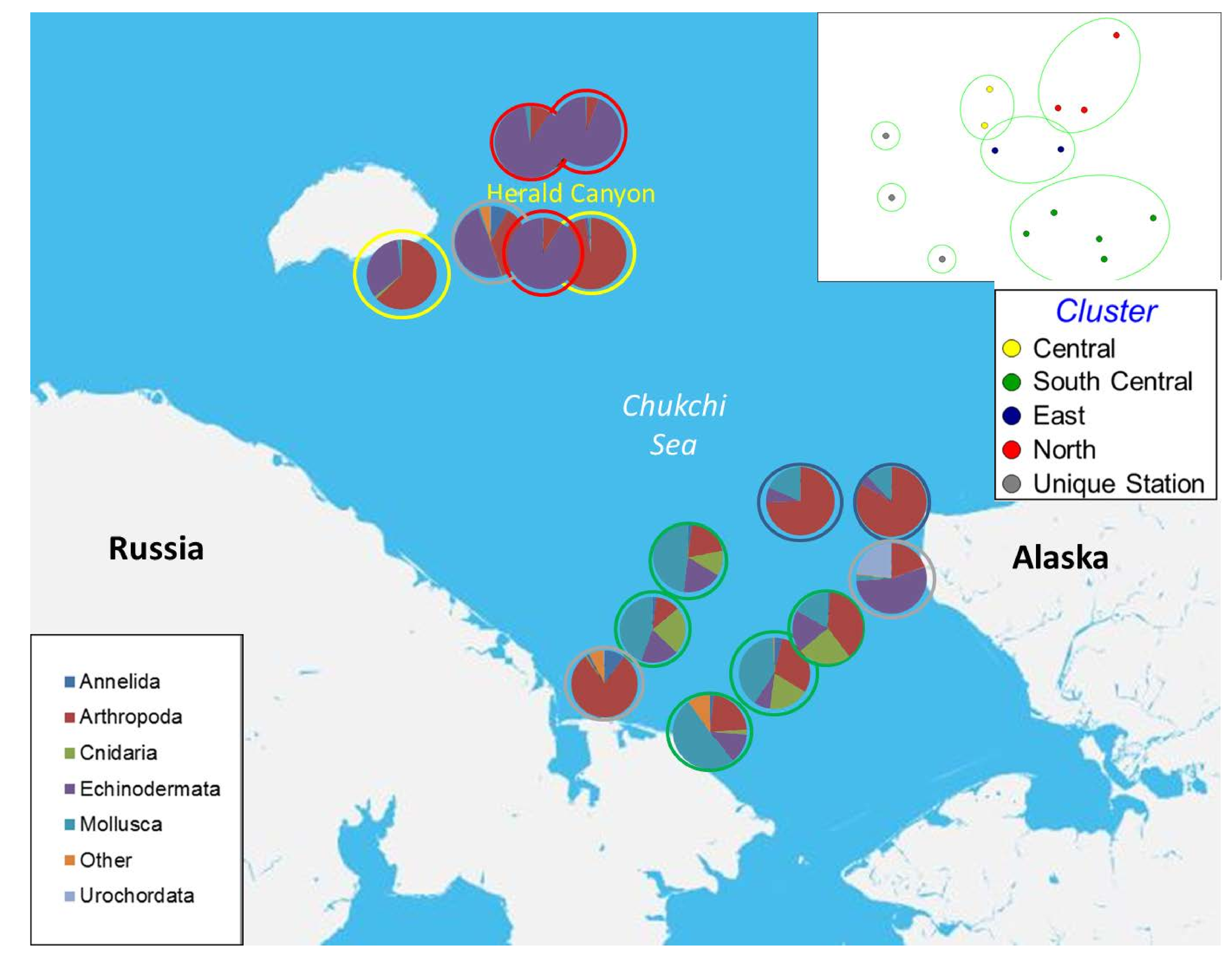

Figure 4. Relative taxanomic composition (biomass, 2012) at sample stations with clusters identified by MDS. **Inset:** Ordination of sample stations (biomass) with clusters at 30% similarity.

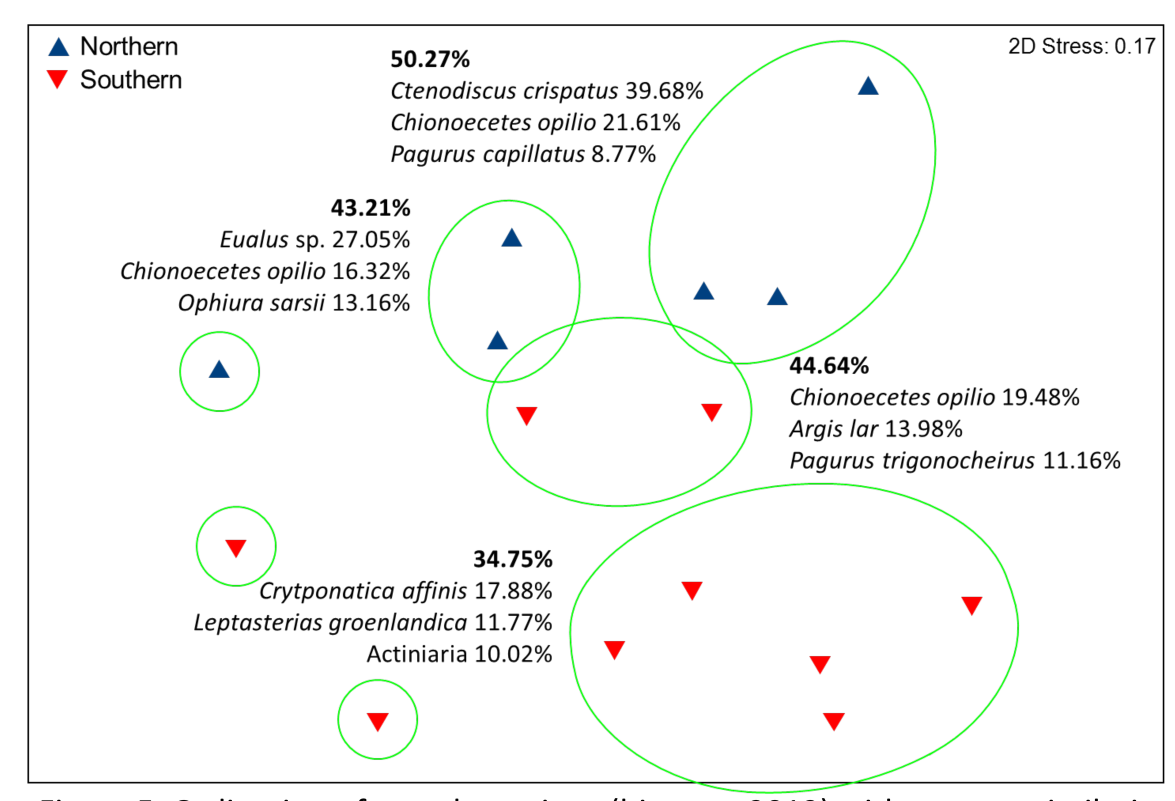

Figure 5. Ordination of sample stations (biomass 2012) with average similarity within clusters and taxa contributing the most to similarity.

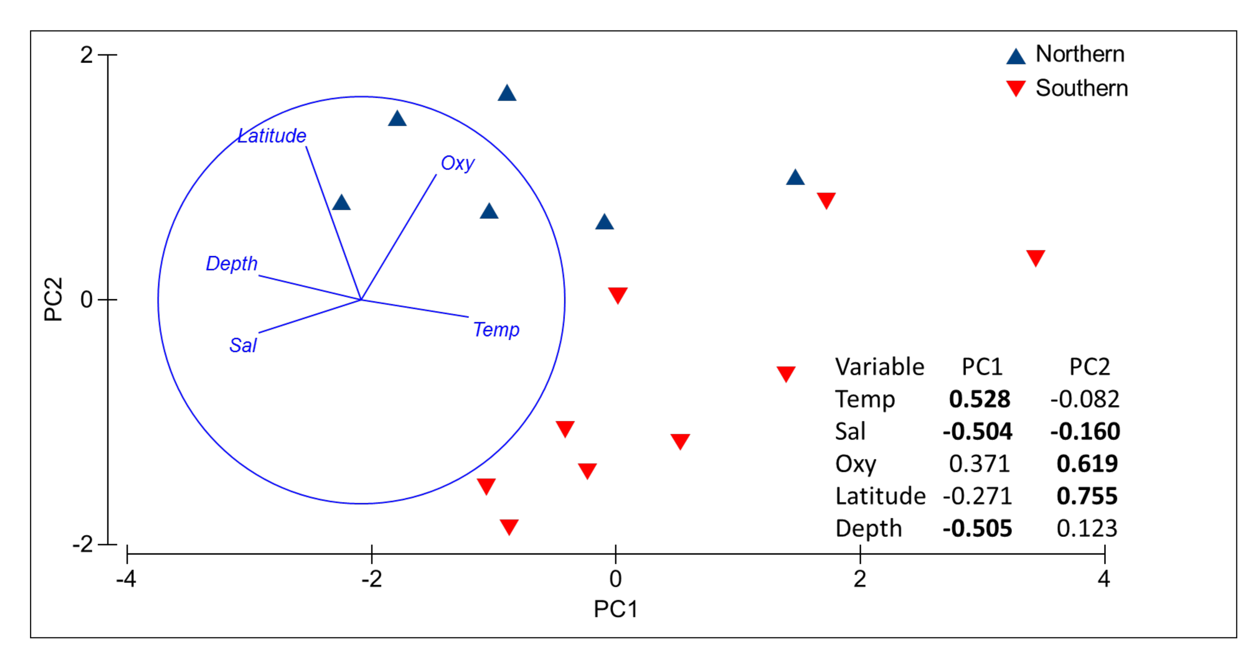

Figure 6. PCA of environmental variables (2012) and sampling stations. Table lists the three variables most correlated to PC1 and PC2. PC1 explains 44.8% of variability, PC2 explains 26.4%

Results

Abundance

- In 2009, abundance was dominated by echinoderms (48%) mollusks (26%) and arthropods (21%). Echinoderms dominated abundance in northern stations (55%), while southern stations were more even in composition.
- In 2012, abundance was dominated by arthropods (61%) echinoderms (19%) and mollusks (12%). Arthropods were 64% of abundance at southern stations, while arthropods and mollusks were each 48% of abundance at northern stations.
- In 2009, average similarity between clusters identified by MDS ranged between 44-47% with gastropods, decapods and echinoderms contributing the most to similarity.
- In 2012, average similarity between clusters ranged between 31-44% with decapods, asteroids and gastropods contributing most to similarity.

Biomass

- In 2009 echinoderms were 46% of total biomass, arthopods were 34%. In 2012 echinoderms were 38% of total biomass while arthropods were 29%

Relevant Environmental Factors

- In 2009, the combination of salinity, latitude, water depth and infaunal biomass had the highest correlation coefficient (0.55) with the species distribution patterns.
- In 2012, the combination of temperature, latitude and depth had the highest correlated (0.544) with species distribution patterns.

Discussion

Community composition was variable among stations, however patterns consistent with previous studies emerged. In 2009 echinoderms, particularly ophiuroids, dominated the biomass and represented a large proportion of total abundance. This is in agreement with earlier studies investigating epifaunal distributions in the Chukchi Sea (e.g., Ravelo et al. 2014). A latitudinal shift in dominance between ophiuroids and decapod crustaceans was also observed. Food availability for sea stars in the absence of large crabs is believed to be a main driver for this pattern (Feder et al. 2005) highlighting the importance of biological interactions in shaping community structure. Latitude and depth were the only environmental variables found to be correlated to biological patterns in both years. Latitude can act as an indicator of water mass properties and thus serve as a proxy for food availability (Feder et al. 2005) or it may reflect historical distribution patterns (Bluhm et al. 2009). The next steps include the integration of additional environmental data as they become available and a more detailed analysis of the environmental drivers that shape community composition.

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