ICES CM 2014/F:06

Shape matters: Ecomorphology informs on functional traits and diversity of Barents Sea fish.

Charlotte Weber[1], Magnus Wiedmann[1], Michaela Aschan[1] and Raul Primicerio[1]

[1]UiT The Arctic University of Norway, Faculty of Bioscience, Fisheries and Economics, Norwegian College of Fishery Science, N-9037 Tromsø, Norway. Presenter contact details: Charlotte.t.weber@gmail.com, Phone: +4795419658

Summary

The Barents Sea (BS) is an arcto-boreal sea and one of most productive areas adjacent to the Arctic, hosting many commercial fish stocks. As a result of climate change, high temperature increases and a northward movement of different species in the BS have been predicted, which will likely change community structures and ecosystem functioning. Ecomorphology relates shape directly to function. In this study the shape variation in the 72 most commonly observed fish species of the BS was investigated. Diet and habitat seemed to be the main drivers of shape variation in BS fish whereas biogeography played a less important role. Large demersals and flatfish function as important links between higher and lower trophic levels while eel-like fish are very efficient in using locally abundant resources. Migratory fish, with streamlined bodies are usually key species and essential to ecosystem functioning by transporting energy in the form of resources through time and space. Such shape information are very useful to further investigate ecosystem functioning and its resilience and vulnerability. This will be especially relevant for sustainable management in times of climate change.

Introduction

The Barents Sea is an open arcto-boreal sea which lies entirely north of the Arctic Circle. It is one of most productive areas adjacent to the Arctic and hosts many commercial fish stocks. Due to climate change a pole-ward movement of several species has been observed (Field et al., 2014), which changes the community structure and most likely the ecosystem functioning within the Barents Sea (Drinkwater, 2011). In order to determine function, morphology can be used, such as in ecomorphological studies where shape is related directly to function. We examined the shape variation within the Barents Sea fish community and related fish shape patterns to their functional role within the ecosystem.

Materials and Methods

For this study 72 of the most common fish species within the Barents Sea were selected for shape analysis. Images and drawings of the fish in jpeg-format were obtained through published papers and internet sources. These images were then loaded into the program ImageJ and 14 landmarks were set on the corresponding morphological features for each fish image. The obtained landmark coordinates were then analyzed statistically within the statistical computing program R. A principal component analysis was performed and the resulting shape components were then related to ecological variables via analysis of variance. As a last step a redundancy analysis was performed.

Results

The principal component analysis showed two main shape components and the main shape variation within the Barents Sea fish community was found in the location and the base length of the anal and dorsal fins. Arctic fish showed predominantly long-based anal and dorsal fins whereas boreal fish showed a wider variation within their fins. Fish with different anal and dorsal fins also differed significantly in

their diets and habitat choices. Both arctic and boreal fish showed similar fin base-lengths for the same habitat, no matter their biogeographic association (Figure 1).

Discussion

Variation in body shape and fins in fish is often related to differences in swimming mode and behavior as swimming stands under strong selective pressure (Webb, 1984). Fish with differing fins can therefore be categorized in different groups of swimming modes which are usually adaptations to a certain behavior and/or environment. Fish living in different habitats usually also exploit different resources where shape and swimming modes are adaptations to serve a certain feeding behavior within a certain environment, such as within the demersal or the pelagic (Tytell et al., 2010). Interestingly, adaptations to swimming and feeding behavior seem to be independent from a fish's biogeographic association.

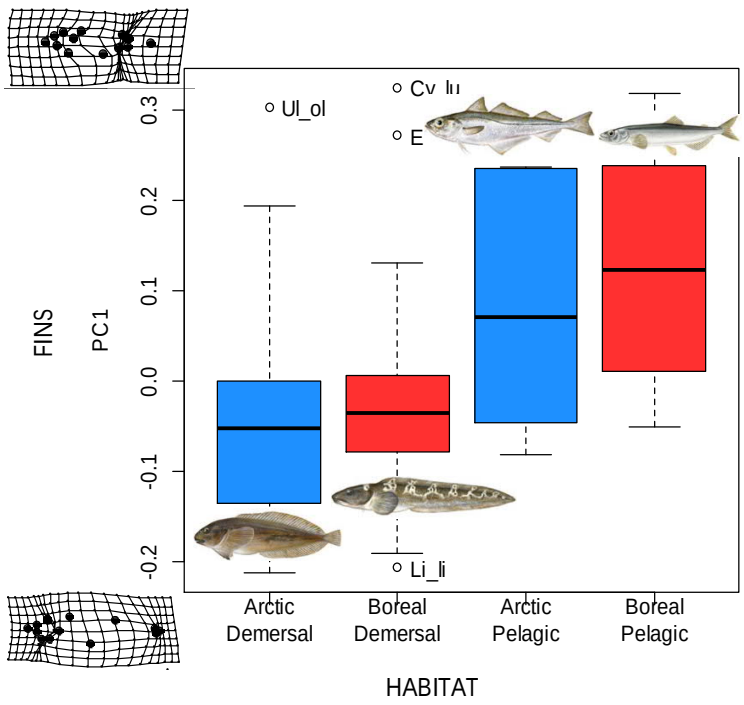

Figure 1. Box and whisker plots of the shape axis one (PC1) resembling shape variation in anal and dorsal fins and its corresponding deformation grids in relation to different habitat types. Fish images represent fish shapes found in each group.

Hence, overall fish shape and the corresponding behavior influence a fish's functional role within the ecosystem. Large demersal fish play an important role in linking lower and higher trophic levels. Streamlined migratory fish are usually essential for ecosystem functioning as they transport energy throughout time and space on a large scale. Therefore knowledge on ecosystem functioning and how it will react to stressors will be necessary in the future for appropriate resource management and sustainable harvest of our marine resources (Wiedmann, 2014).

References

Drinkwater, K. F. 2011. The influence of climate variability and change on the ecosystems of the Barents Sea and adjacent waters: Review and synthesis of recent studies from the NESSAS Project. Progress in Oceanography, 90(1–4): 47-61.

Field, C., Barros, V., Mach, K., & Mastrandrea, M. 2014. Climate change 2014: Impacts, adaptation, and vulnerability: contribution of Working Group II to the fifth assessment report of the Intergovernmental Panel on Climate Change. Ed by Aldunce, J. P. Ometto, N. Raholijao & K. Yasuhara.

Tytell, E. D., Borazjani, I., Sotiropoulos, F., Baker, T. V., Anderson, E. J., & Lauder, G. V. 2010. Disentangling the Functional Roles of Morphology and Motion in the Swimming of Fish. Integrative and Comparative Biology, 50(6): 1140-1154.

Webb, P. W. 1984. Body Form, Locomotion and Foraging in Aquatic Vertebrates. American Zoologist, 24(1): 107-120.

Wiedmann, M. A. 2014. A trait-based assessment of the Barents Sea fish community: implications for vulnerability under environmental change. PhD thesis at UiT The arctic university of Norway, Tromsø, Norway.