Marine fish traits follow fast-slow continuum along coastal-offshore gradient

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Marine fish traits follow environmental gradients across European seas

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Introduction

One of the major goals in biogeography is describing and understanding species distributions. However, when focusing on species-environment relationships, one may miss the mechanistic understanding of what underlies these distributions. Therefore, trait-environment relationships are useful in explaining where species occur, since traits determine which environment a species can inhabit¹. In this study, we apply this trait-based approach to Europe’s marine fish communities.

Data

SITES & SPECIES:
- ~2200 sampling sites and ~250 species from scientific surveys done in the continental shelf seas of Europe (combination of publicly available and institutional data).

ENVIRONMENT: depth, temperature, salinity, Chlorophyll (Chl) concentration, seasonality variability in temperature and monthly variability in Chl-concentration (NOAA; GlobColour).

Methods

TRAITS: 7 quantitative traits
- Maximum length
- Age at maturity
- Lifespan
- Trophic level
- Offspring size
- Fecundity
- Growth coefficient K

ENVIRONMENT: 
- Temperature (Temp.), seasonal variability in temperature (Temp.ssn), chlorophyll concentration (Chl), and seasonal variability in Chl (Chl.sd)

SPECIES: 
- RLO analysis²: Multivariate ordination approach combining all three datasets (R, L and Q). Gives a score to all data onto the same ordination axes.
- Four-corner analysis²: Makes use of species distributions when testing for correlations between traits and environmental variables.

Results

The first axis of the RLO analysis (RLQ 1) explained 95% of the variation. In terms of traits, RLQ 1 represents a fast-slow continuum, mainly characterized by age at maturity, lifespan and the growth coefficient K.

The RLQ 1 site scores follow a coastal-to-offshore gradient, thereby corresponding to the depth gradient that was found to be an important determinant for fish species distributions.

The fourth-corner analysis confirmed the importance of the three traits that characterize the fast-slow continuum as well as depth as an important environmental variable. The analysis also revealed significant relationships of the fast-slow traits with temperature and with the variability in temperature and Chl-concentration.

Conclusions

We demonstrated that marine fish species can be characterized according to their traits along a fast-slow continuum. Traits in particular related to growth and maturity are key for explaining fish species distributions. The trait continuum is strongly determined by a depth gradient. Along this gradient, other factors vary, such as temperature, productivity, and seasonality, which help in explaining species distributions and the structure of marine fish communities.

References