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, seasonal variability in temperature and monthly variability in Chl-concentration (NOAA; GlobColour).

Methods

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

Results

TRAITS: 7 quantitative traits

- Maximum length
- Lifespan
- Age at maturity
- Trophic level
- Offspring size
- Fecundity
- Growth coefficient K

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.

ENVIRONMENT:

Depth
Salinity
Chl sd
Chl. Temp.
Temp.ssn

The RLQ 1 represents a depth gradient, along which also vary: temperature (Temp.), seasonal variability in temperature (Temp.ssn), chlorophyll concentration (Chl) and seasonal variability in Chl (Chl.sd).

SAMPLING SITES

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

Species

RLQ 1 identified specialist species having typical fast or slow life histories, e.g. anchovy and common skate. Generalist species, e.g. Atlantic cod and Atlantic herring, were not strongly characterized by RLQ 1 in terms of their traits and distribution. This indicates that the trait values they have allow them to inhabit a wide range of environments. Indeed, the most common species (i.e. that were present at most sampling sites) were generalist species, whereas typical specialist species were less abundant.

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

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