Taxonomic and functional diversity patterns of fish assemblages in the European Seas

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Summary
The use of taxonomy-based biodiversity indicators has limitations in terms of describing the functioning of communities and ecosystems. Functional diversity indices take into account such aspects by describing the ecological niche of species present in a community. In this study, we investigated the spatial patterns of taxonomic and functional diversity of fish communities across Mediterranean and Atlantic ecosystems. These ecosystems provide a natural gradient in terms of e.g., temperature and productivity, and are subjected to various anthropogenic pressures such as fisheries and eutrophication. Fish species traits on morphometric, diet and demography were collected and used to calculate and map various functional and taxonomic diversity indices across the European Seas. The species were clustered into four different life-history strategies based on their traits composition (e.g. species with low fecundity and long lifespan vs species with high fecundity and low lifespan). We found clear spatial patterns of species richness, functional richness, and life history strategies, with regions of low functional diversity notably located in the northern North Sea and Baltic Sea, while hotspots of functional diversity were present in the Mediterranean Sea and in some transition areas such as the Kattegat and English Channel. Overall, this study describes the different traits based diversity facets of fish communities in the European shelf and discusses them in function of the environmental variables (e.g. depth, temperature).

Introduction
The use of a trait approach to describe communities has an added value compared to the widely used taxonomic approach, as it permits to investigate the communities in term of their functional composition (Petchey and Gaston, 2002). This study was conducted as part of an ICES working group (WGCOMEDA;ICES, 2015) which aims at studying both the Mediterranean and Atlantic ecosystems together. One of the main advantages of investigating communities along several ecosystems is that the variability in environmental parameters will likely results in higher heterogeneity in the communities' composition. In this study we are investigated the diversity patterns of the fish communities in the European coastal shelf.

Materials and Methods
Fish species presence-absence in several ecosystems of the European coastal shelf was derived from scientific bottom trawl surveys for the years 2000-2010. Traits were collected to characterize the ecological niche and life strategies for the 300+ most occurring species. The traits described the species' demography (fecundity, lifespan, length and age at maturity), morphology (maximum length, body and caudal shape) and diet (trophic level, trophic guilds). Species richness and functional richness indices were calculated and mapped per ICES square. Species richness (SR) is the number of unique species present, while functional richness (FRic) represents the portion of the functional space occupied by the community, defined as the Convex Hull volume that contains all traits present in the community. Traits correlation and trade-offs permitted to cluster the species into life-history strategies using a K-medoids clustering method. The diversity (species and functional) and life-history strategies distributions were discussed in function of environmental drivers.

Results and Discussion

Hotspots of species richness (SR) were identified in several southern and northern areas of the European Seas: in the west Mediterranean Sea, in Kattegat and in the English channel. Functional richness (FR) was also high in these species richness hotspots areas but also in the central North Sea and Bay of Biscay. FR is linked to species richness following an asymptotic relationship, at low SR, FR increases proportionally to the number of species while at high SR, FR stays constant or only marginally increase as SR increase.

Functional dispersion (FDisp), the deviation of FR to the FR~SR model, had clear spatial patterns. FDisp was high in the central North Sea, in the northern Bay of Biscay and in the northern Portuguese shelf. Hence, in these areas, the FR is higher than expected by the SR level, i.e. the species present in these areas have diverse traits values. On the other hand, Northern North Sea, Irish shelf, English Channel and western Baltic Sea have low FDisp. Hence, in these areas the FR is lower than expected by the SR levels, i.e. the species present in these areas have low diversity traits values. In general, the fish communities in Northern Europe, although species rich, appears to have a low traits diversity while communities in the Southern Europe shelf seems to have more traits diversity.

Using a K-medoids clustering, four was the optimal number of cluster to classify fish species according to the continuous traits variables. The four clusters can be mainly characterized by the fecundity and lifespan values of the species, and hence are defined as: LHS1, high fecundity and small lifespan, this group is the most represented; LHS2, high fecundity and long lifespan; LHS3, low fecundity and small lifespan; LHS4, very low fecundity and long lifespan, this groups regroups most of the sharks and rays. LHS1 was the most occurring strategies and the percentage of species with this LHS was rather spatially constant (Fig. 1). On the other hands LHS2,3 and 4 displayed spatial patterns. These patterns were especially related to depth and temperature.

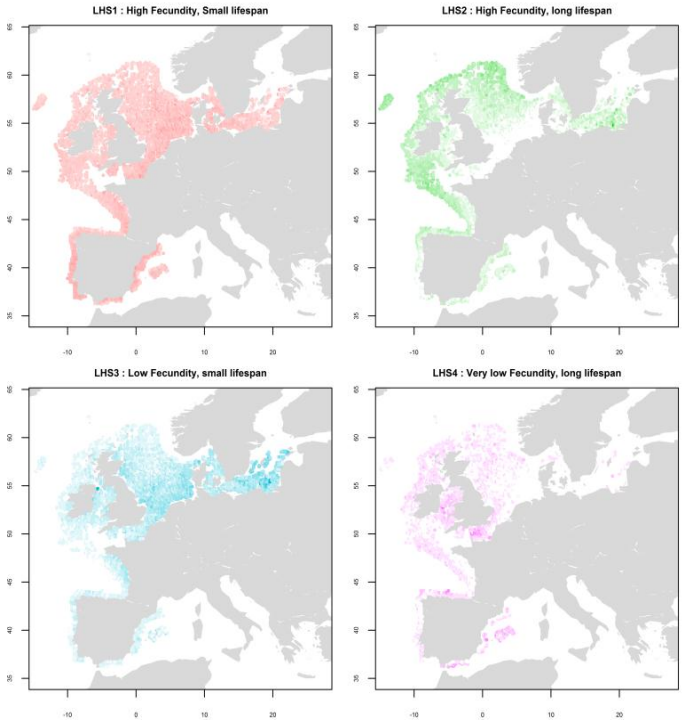

Figure 1. Distribution of the Life History strategies proportion in each 0.1'x0.2' grid. The color intensity represents the proportions

References

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