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Can fish morphology determine its diet ?

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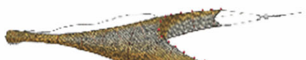
Food webs insure most of energy and matter transfers between an ecosystem's compartments. Understanding the mechanisms governing matter and energy transfers from one trophic level to another is ecologically important. Food webs consist of living components of the biosphere that are interconnected by predator-prey relationships. In marine ecosystems, complex predator-prey relationships exist due to specific and varying feeding behaviours of its living components. Variations in feeding behaviours and food preferences have been observed within fish species due to ontogeny or habitat variation. In many cases, numerous aspects of some fish species' predatory behaviour remain poorly understood. Among these is the relationship between individuals' morphology and their diet.

Correlative relationships between a predatory fish's morphology (i.e., body size, caudal fin or mouth shape) and feeding behaviour have already been demonstrated in other studies (Palomares and Pauly, 1998; Karpouzi and Stergiou, 2003; Peck et al., 2005). In this study, exploratory scaling of interactions between fish morphology and individual diet is presented in order to determine fish trophic guilds using morphometry.

Materials and methods

Gwen Drez

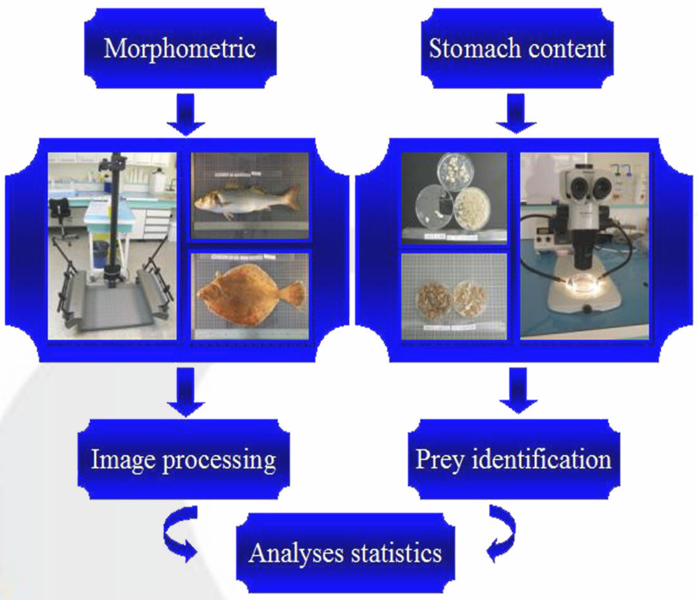


Fish species were collected in the Eastern English Channel during the Channel Ground Fish Survey (CGFS) on board the oceanographic vessel "Gwen Drez" using a high opening bottom trawl in October 2009. This survey focuses on assessing the recruitment of benthic and demersal fish stocks in the study site. Sampling was stratified according to size classes (small, medium and large as determined by the quantiles 33 and 66 of the observed size distribution in the previous years) for each species. Two fish species were used for this study (*Dicentrarchus labrax* and *Pleuronectes platessa*) for which medium and large size classes were considered.

Seabass
Dicentrarchus labrax

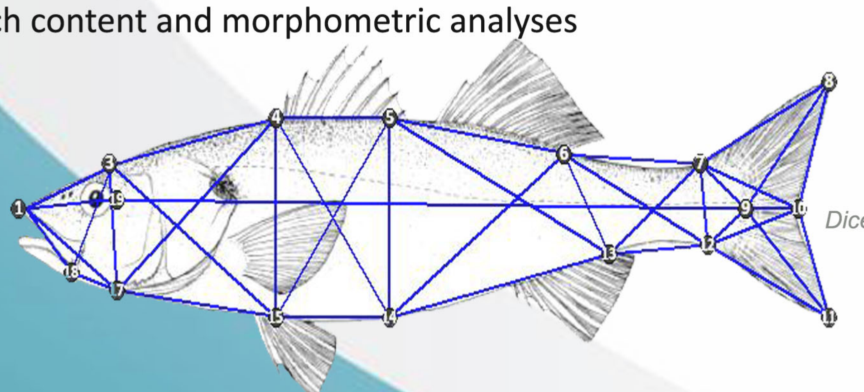
Plaice
Pleuronectes platessa

A total of 184 medium- and large-sized seabass (73) and plaices (111) were collected and analysed for stomach contents and morphometry.



Schematic diagram showing sample treatment, stomach content and morphometric analyses

For stomach contents, observed preys were identified at the species level and grouped according to their class: fish, crustaceans, bivalves, annelids, cnidaria and echinoderms. For morphometric analyses, a Truss network (Strauss & Bookstein, 1982) based on 19 landmark points describing the major morphological features of the body was used to describe the shape of individuals.

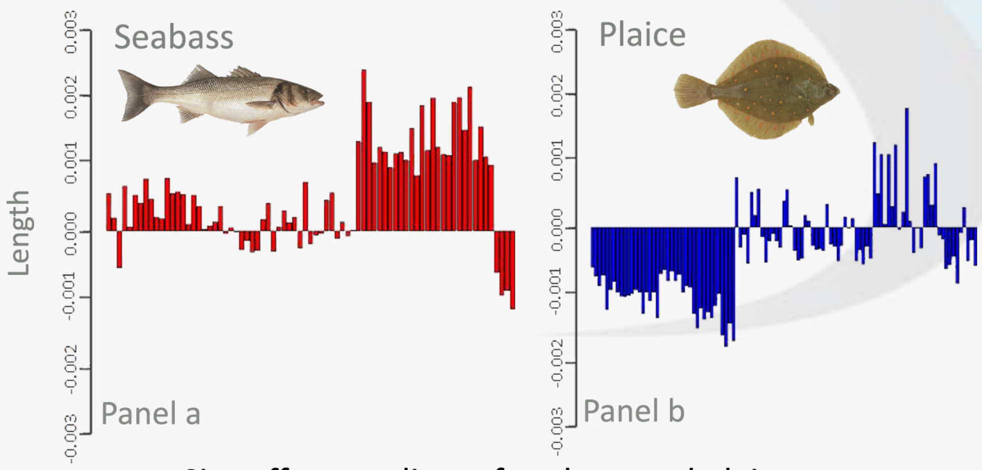


Seabass
Dicentrarchus labrax

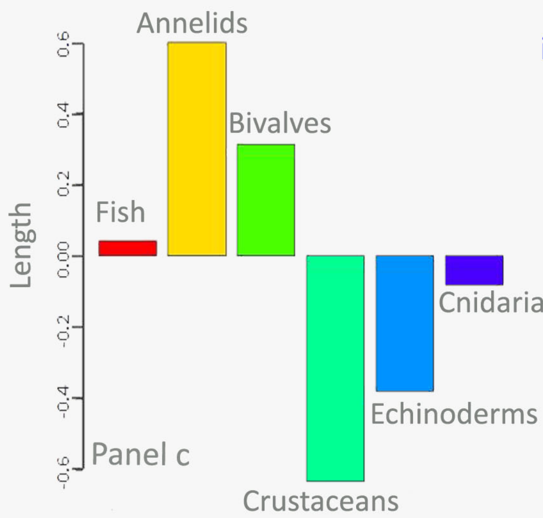
Description of individuals' shape by a truss network based on 19 landmark points and conventional dimensions measured for statistical analyses.

All distances measured were assumed to represent straight lines lying on a flat plane. Data collected from both stomach content and morphometric analyses were analyzed using ordination techniques such as principal component analysis (PCA) and redundancy analysis (RDA).

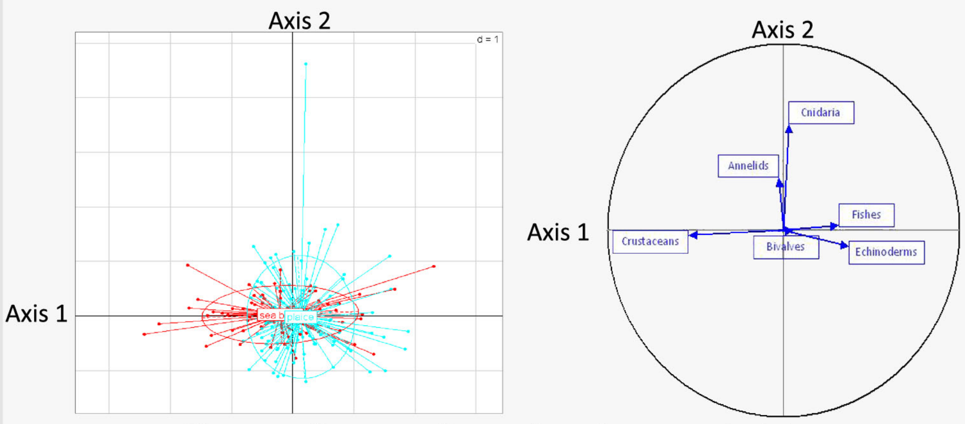
Results



Size effect on diets of seabass and plaice



A first analysis focuses on the influence of individuals' size on their diet (RDA of stomach content explained by individuals' length). We observed that longer individuals such as seabass (panel a) tend to feed on larger preys such as fish, annelids and bivalves (panel c) while smaller individuals such as plaice feed (panel b) mainly on crustaceans, echinoderms and cnidarians (panel c).



Shape effect on diets of seabass and plaice

A second analysis focuses on the influence of individuals' shape on their diet (partial RDA of stomach content explained by individuals' morphometry conditional on individuals' length). Axis 1 is correlated positively with morphometric variables representing individuals' girth and negatively with eye position. Axis 2 is also negatively correlated with variables related to eye position and positively correlated with length-related variables. The correlation circle (right panel) relates prey categories of individuals' diets to their morphological variables. Individuals with a larger girth, positive values on axis 1, will eat "fish" and "echinoderms" preys while thinner fish will feed more on "crustaceans". Smaller fish, positive values on axis 2, will prey on "annelids" and "cnidaria". We can therefore infer that since seabass is long, it will either consume preys such as crustaceans and fish, depending on its actual girth (left panel). In contrast, plaice being small will prefer smaller preys such as annelids, echinoderms and cnidaria, the choice between these depending on the ratio between individuals' length and girth.

Conclusion

In this study, fish morphometrics has been used to successfully relate morphological differences between two fish species to differences in their food preferences and feeding habits.

Karpouzi V.S., Stergiou K.I. (2003) J. Fish. Biol. 62: 1353-1365
Palomares M.D., Pauly D. (1998) Mar. Fresh. Res. 49: 447-453
Peck et al. (2005) J. Fish. Biol. 66: 911-923
Strauss R.E., Bookstein F.L. (1982) Syst. Zool. 31: 113-135