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Short communication

Drift algae reduce foraging efficiency of juvenile flatfish

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Abstract

Although flatfish species utilise a wide range of habitats as adults, several species are confined to a very limited habitat as juveniles. Recruitment levels are dependent on the quality and quantity of these nursery areas and changes therein. In the Baltic Sea, these shallow environments are often subject to influxes of drifting macroalgae, which add structure to otherwise bare sandy substrate. Structure, such as vegetation, alters predator–prey interactions of a wide range of fauna and in an array of marine, freshwater, and terrestrial systems. The aim of our study was to assess the inhibition potential of drifting macroalgae on the foraging efficiency of juvenile flatfish (young of the year *Scophthalmus maximus* L., young of the year- and group 1+ *Platichthys flesus* L.) through a series of microcosm experiments. Our results show that foraging success is restricted by drift algae as predation efficiency of all predator species and size classes was negatively affected by the presence of macroalgae. Overall, there was a reduction in predation success by 80 ± 12% due to structural effects and/or the induced changes in water chemistry associated with the algae. Flatfish depend on shallow sandy areas as feeding and nursery grounds during their juvenile stage and frequently occurring macroalgal assemblages drastically change the features of the otherwise bare substrate, setting the stage for small-scale, localised processes potentially affecting population dynamics.

Keywords: Predator–prey interactions; Habitat structure; Benthos; Macrophytes; Refuge

1. Introduction

Many ecological interactions, such as those between predator and prey, are greatly influenced by habitat structure. At high densities, structures reduce foraging success (measured as growth rates, prey capture rates etc.) by increasing search and pursuit times and consequently lowering encounter and capture rates, compared to habitats with no or sparse structure (Crowder and Cooper, 1982; Diehl, 1992; Persson and Eklöv, 1995). The effects on predation success depend on the levels of complexity (Nelson and Bonsdorff, 1990; Bartholomew et al., 2000), such as density and species/features of the structure, and responses that are predator and prey specific in terms of size and species (Crowder and Cooper, 1982; Isaksson et al., 1994; Spitzer et al., 2000).

The shallow soft bottoms in the Baltic Sea have undergone dramatic changes in structural characteristics during the last decades due to increasing occurrences of drifting algal mats (Bonsdorff, 1992; Berglund et al., 2003). A macroalgal assemblage affects the biota through its physical presence but also by depletion of

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Table 1
Species composition of drifting macrophytes

Phaeophyceae
Pylaiella littoralis (L.) Kjellman / *Ectocarpus siliculosus* (Dillwyn) Lyngbye[d]
Dictyosiphon foeniculaceus (Hudson) Greville / *Stictyosiphon tortilis* (Ruprecht) Reinke[+]
Fucus vesiculosus L.[+]
Elachista fucicola (Velley) Areschoug
Chlorophyceae
Cladophora glomerata (L.) Kützing[d]
Ulva sp. (syn. *Entermorpha* sp.)
Cladophora rupestris (L.) Kützing
Rhodophyceae
Ceramium tenuicorne (Kützing) Waern[d]
Polysiphonia fucoides (Hudson) Greville
Rhodomela confervoides (Hudson) P.C. Silva
Furcellaria lumbricalis (Hudson) J.V. Lamoroux
Charophyceae
Chara aspera Willdenow
Haloragaceae
Myriophyllum spicatum L.
Zosteraceae
Zostera marina L.[+]

[d]=dominant species, [+]=commonly occurring species. The taxonomy follows Guiry and Guiry (2006).

oxygen during decomposition (Bonsdorff, 1992; Norkko and Bonsdorff, 1996a; Raffaelli et al., 1998). Juvenile flatfish, such as flounder, *Platichthys flesus* L., and turbot, *Scophthalmus maximus* L. (syn. *Psetta maxima*), are dependent on shallow soft bottoms as nursery and feeding grounds (Gibson, 1994). The prey utilised by these species include infaunal macroinvertebrates, which are, like the predators, directly impacted by occurrences of macroalgal mats and increased habitat structure. Several studies show macroalgal-induced changes in prey availability and foraging efficiency for benthic predators (Wilson et al., 1990; Isaksson et al., 1994; Norkko and Bonsdorff, 1996b; Norkko, 1998; Aarnio and Mattila, 2000; Andersen et al., 2005).

This study examined the impact of drifting algae on the foraging efficiency of *P. flesus* and *S. maximus*. We predicted that drifting algae would negatively affect the foraging efficiency (the number of prey items consumed in a given time period) of juvenile flatfish. We wanted to determine whether the effects of drifting algae differ based on predator species and size, which to our knowledge has not been addressed in the literature for juvenile flatfish prior to this study. We expected that smaller fish may be better able to manoeuvre in a structurally complex habitat, and as *S. maximus* have a larger gape size than *P. flesus* of the same length (Aarnio et al., 1996), they may be better equipped to utilise the food resources available.

2. Methods

2.1. Experimental organisms

Organisms were collected from Hinderbengtsviken Bay (60° 10′ N, 20° 32′ E), Åland Islands. *Platichthys flesus* (TL 39–96 mm) and *Scophthalmus maximus* (TL 26–43 mm) were collected using a beach seine (4 mm net, 2 mm mesh bag) and a push net (2 mm mesh). *Bathyporeia pilosa* Lindström is a common and often numerically dominant infaunal member on these sandy bottoms (Blomqvist and Bonsdorff, 1986), and constitutes an important food object for epibenthic predators such as *P. flesus* and *S. maximus* (Aarnio et al., 1996). *B. pilosa* (2.43 ± 0.04 mm) were collected with a shovel and a bucket sieve (1 mm). Drift algae, consisting of brown, green, and red algae (dominated by filamentous species) and some angiosperms (Table 1), were collected at the same site. After collection, the organisms were transported to the laboratory and placed in holding tanks. Fish were starved for at least 24 h prior to the start of a trial. Any associated animals were removed from the algae.

2.2. Laboratory experiment

The laboratory experiment was conducted at Husö Biological Station, Åland Islands, northern Baltic Sea, in summer 2005. The experimental set-up was a two factorial design with three structure levels (no structure/artificial algae/drift algae) and two predator levels (present/absent). This set-up (with n replicates = 3) was utilised in three consecutive runs varying predator sizes and species. We conducted trials using year 1 + flounder (TL 80 ± 4 mm; hereafter 1 + *P. flesus*), young-of-the-year flounder (TL 47 ± 2 mm; YOY *P. flesus*) and turbot (TL 33 ± 2 mm; YOY *S. maximus*). Aquaria (16 × 16 × 9 cm; 2.3 l) were filled with a 2.5 cm layer of sieved azoic sand and filtered (20 μm) seawater. Each tank contained 45 adult *B. pilosa*, approximating natural densities of 1642 ind m^{-2} (Blomqvist and Bonsdorff, 1986). The amphipods were acclimated to the tanks for at least one hour before predators and algae were added and the trial was started (Mattila and Bonsdorff, 1998). Predator treatments used one fish per tank. Algal treatments received 30 g wwt of drift algae, which is consistent with intermediate densities found in the natural environment (~1000 g wwt m^{-2}, Norkko and Bonsdorff, 1996b). To simulate algal structure in our artificial algae treatments, 9 g of filter wool (high-grade, saltwater-proof, synthetic fibres) was used. The amount was determined by visual approximation to the surface area and thickness of the layer created in our real algal