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Short Research Note

Benefit from an invader: American slipper limpet *Crepidula fornicata* reduces star fish predation on basibiont European mussels

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Abstract

Introduced species have recently become a major concern in ecological research and aquatic conservation. This is due to an increasing appearance of introduced species at a global scale and a multitude of negative impacts on native biota. However, impacts of introduced species are not necessarily only negative. The epizootic American slipper limpet *Crepidula fornicata*, native at North American Atlantic shores, was introduced to Europe in the 1870s and is now widespread along the Atlantic coast of Europe. Negative effects like trophic and spatial competition have been reported. In its major basibiont in the Wadden Sea, the blue mussel *Mytilus edulis*, attached limpets reduce survival and growth. However, a laboratory experiment also showed sea star (*Asterias rubens*) predation on mussels with limpet epigrowth to be three times lower than in unfouled mussels. Hence, although negatively affected by *C. fornicata* in one way, this epigrowth is beneficial for fouled mussels in another. This indicates that the actual impact of an introduced species is a complex interplay of positive and negative effects which may only be revealed experimentally.

Introduction

During the last decades introduced species have become a major concern in ecology and aquatic conservation. With increasing global exchange of species and often negative concomitant effects on the recipient biota, they are now considered to be a major threat to biodiversity (Grosholz, 2002; Olden et al., 2004).

One of these problematic species is the American slipper limpet *Crepidula fornicata* which was introduced to Europe attached to oysters in the 1870s (Blanchard, 1997). Since then, it spread along the Atlantic coast of Europe and now locally reaches high abundances. A multitude of negative effects on native biota has been described but the main impact is supposed to be trophic competition with other filter feeders (Orton, 1927; Korringa, 1951; Blanchard, 1997) potentially resulting in changes of the trophic structure of benthic communities (Hily, 1991; Chauvaud et al., 2000). *C. fornicata* also has high economic impacts on shellfish industries (Blanchard, 1997).

In the northern part of its European range, *C. fornicata* can be found on mussel beds (*Mytilus edulis*) where it predominantly occurs epizootic on mussels (Thieltges et al., 2003). Epigrowth of *C. fornicata* has been shown to reduce survival and growth in the mussels, hence exerting a strong negative effect (Thieltges, in press). However, for other epigrowth positive effects on mussel basibionts have also been described like reduced predation pressure on basibionts due to epigrowth (Wahl et al., 1997; Laudien & Wahl, 1999; Saier, 2001).

To reveal potentially positive effects of *C. fornicata* epigrowth on its basibiont *M. edulis,* predation by sea stars (*Asterias rubens*), major predators of mussels in the Wadden Sea (Saier, 2001), on mussels with and without epizootic *C. fornicata* was investigated in a laboratory experiment.

Methods

Sea stars (*Asterias rubens*) of approximately 100 mm arm length (from mouth to tip of arms) were collected in the subtidal of the List tidal basin in the northern Wadden Sea (North Sea) in November 2000. Blue mussels (*Mytilus edulis*) of 40–50 mm length with and without *Crepidula fornicata* (stacks of 3–4 individuals of 10–30 mm length) epigrowth were collected on a mussel bed in the north of the island of Sylt in the List tidal basin. Six sea stars were kept separately in 60 l aquaria with running sea water at a temperature equivalent to the one in the field (10–12 °C). Light was adjusted accordingly. Handling of sea stars was reduced to a minimum to avoid handling artefacts (Sloan, 1980). Prior to the experiment, sea stars were starved for 4 days. Sea stars were offered three *M. edulis* without and three *M. edulis* with *C. fornicata* epigrowth. Consumed prey was recorded daily and replaced. The experiment lasted 14 days.

Data were tested for normality and homogeneity of variance. Due to the particular nature of feeding choice experiments (violation of the assumption of independence) data were tested using a t-test for paired samples (Peterson & Renaud, 1989; Roa, 1992).

Results

Sea stars preferred unfouled mussels over mussels with *C. fornicata* epigrowth (paired t-test; $p < 0.05$) (Fig. 1). Mean consumption per sea star per day was 0.48 ± 0.09 mussels without and 0.15 ± 0.04 mussels with *C. fornicata* epigrowth. Only two *C. fornicata* were consumed together with the mussel basibiont during the experiment.

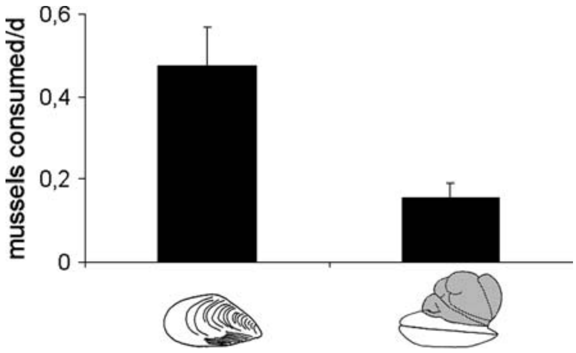

Figure 1. Mean number (+SE) of mussels (*Mytilus edulis*) with and without *Crepidula fornicata* epigrowth consumed by seastars (*Asterias rubens*) per day. Left: unfouled mussels, right: mussels with *C. fornicata* epigrowth. Duration of the experiment was 14 days. $n = 6$ sea stars.

Discussion

Sea star predation on mussels with *C. fornicata* epigrowth was three times lower than on unfouled mussels. This is possibly due to easier handling of unfouled mussels by sea stars in the course of the predation process. Sea stars open mussels by pulling the two valves apart which is presumably more difficult in mussels with *C. fornicata* epigrowth. *C. fornicata* itself does not seem to be preyed upon by sea stars (Thieltges et al., 2004) which might add to the low attraction of mussels overgrown with the limpet.

Epibiont induced reduction of predation pressure by sea stars on *M. edulis* was also experimentally observed for algae, hydrozoan and barnacle epigrowth (Laudien & Wahl, 1999; Saier, 2001). Easier handling of unfouled mussels in terms of optimal foraging criteria (Emlen, 1968; Laudien & Wahl, 1999) was suggested to be responsible for the observed effect. For other predators, Wahl et al. (1997) demonstrated a reduced predation on mussels with different epigrowth by shore crabs (*Carcinus maenas*). However, since crabs generally prey on smaller mussels (Elner & Hughes, 1978; Ameyaw-Akumfi & Hughes, 1987; Mascaro & Seed, 2000) that mostly lack limpet overgrowth, a similar effect of limpet epigrowth on crab prey choice behaviour seems less likely. For another major mussel predator, the common eider (*Somateria mollissima*) data are contradictory and await further study: Swennen (1976) reported eiders to avoid mussels with barnacle epigrowth while Ens & Kats (2004) found no differential predation. Effects of *C. fornicata* epigrowth on feeding preferences of other predators besides sea stars remain to be tested.

The observed positive reduction in predation pressure of mussels with *C. fornicata* epigrowth is in strong contrast to the negative effects of *C. fornicata* epigrowth observed in field experiments where Thieltges (in press) found a 3–8-fold reduction in survival and growth in mussels with limpet epigrowth. Hence, the actual impact of *C. fornicata* on mussels on the scale of epibiont-basibiont interactions is not necessarily a negative one but can also be positive. Sea stars are one of the major benthic predators on mussel beds in the Wadden Sea preying almost exclusively on *M. edulis* (Saier, 2001). Since *C. fornicata* lives mainly on mussel beds (Thieltges et al., 2003) a reduced predation pressure by sea stars due to *C. fornicata* epigrowth is of strong advantage for infested mussels. However, on a larger scale differential sea star predation might result in an enhanced predation pressure on mussels not directly affected by the limpets by diverting predation from fouled to unfouled mussels. A positive impact due to predation refuge in already weakened mussels with *C. fornicata* epigrowth might thus lead to an indirect negative impact in healthy unfouled mussels. Hence, the net effect of this interplay on the population level might be zero. However, if sea stars were switching to different prey or localities at high *C. fornicata* infestation areas, the net effect could also be positive. This remains to be investigated.

Data on other potentially positive small scale effects of *C. fornicata* on the level of epibiont-basibiont interactions are not available. However, on a larger scale an increase in biodiversity of macrozoobenthic and suprabenthic fauna (Montaudouin & Sauriau, 1999; Montaudouin et al., 1999; Vallet et al., 2001) and stabilization of pelagic primary production in eutrophicated systems (Chauvaud et al., 2000) have been reported as positive effects of *C. fornicata* on native biota. Hence, the actual impact of an introduced species is a complex interplay of negative and positive effects on different scales. This should be kept in mind when conducting impact studies on introduced species.

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