2.2.2 Detached macrophyte accumulations in surf zones: significance of macrophyte type and volume in supporting secondary production

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Executive summary

Detached seagrasses and macroalgae (wrack) are transported from more offshore areas and accumulate in large volumes in surf zones. This study investigated how wrack transported from one habitat to a second habitat can be considered as a spatial subsidy for the recipient habitat, with significant consequences for community dynamics and food webs (Polis and Hurd 1996, Polis *et al*. 1997). The primary aim of this study was to determine the significance of the different components of wrack (i.e. seagrass and brown, red and green algae) as a direct and indirect food source and habitat for invertebrates and fish in surf zones of south-western Australia. The importance of different volumes of surf zone wrack on fish abundance and composition was also investigated. These aims were achieved by examining the food and habitat preference of invertebrates and the habitat preference of fish through laboratory trials and field experiments, as well as stable isotope, fatty acid and lipid class analysis. The dominant macroinvertebrate in surf zone wrack, the amphipod *Allorchestes compressa* showed a preference for consuming brown algae. Stable isotope and lipid analyses also indicated that *A. compressa* assimilates nutrients predominantly from brown algae, which in turn are consumed by second-order consumers, particularly juveniles of the fish species *Cnidoglanis macrocephalus* (cobbler) and *Pelsartia humeralis* (sea trumpeter). *Allorchestes compressa* showed a strong preference for different types of detached macrophytes as a habitat, with seagrass ranking below other types of macrophytes in the field. In contrast, neither *C. macrocephalus* or *P. humeralis* showed a preference for inhabiting different types of detached macrophytes, but were strongly influenced by the volume of wrack in the surf-zone. The study revealed that both the type and volume of detached macrophytes in surf zones subsidizes consumers and plays a crucial role in supporting secondary production in less productive surf-zone habitats of south-western Australia.

Introduction

Accumulations of detached macrophytes within nearshore surf-zones and on beaches are commonly referred to as wrack (Kirkman and Kendrick 1997). Detached macrophytes can be an important source of food and habitat for juveniles of some fish species, and their invertebrate prey (Robertson and Lucas 1983). In south-western Australia, wrack comprises a mixture of seagrasses and macroalgae (Hansen 1984). The broad objective of this study was to investigate the links between detached macrophytes, invertebrates and fish in terms of food supply and habitat, in particular, to determine the role of different types of wrack (i.e. seagrass, brown, red and green algae) as a habitat and food source for fish and invertebrates in nearshore waters. The influence of different volumes of surf-zone wrack on fish abundance and composition was also investigated.

Invertebrate research

Aims and objectives

The focus of the invertebrate research for this study was on the semi-aquatic amphipod

Allorchestes compressa, which in south-western Australia constitutes more than 90% of the macroinvertebrate fauna and is one of the main prey of juvenile fish in wrack habitats (Robertson and Lucas 1983; Robertson and Lenanton 1984). The aim was to determine the habitat and food preference of *Allorchestes compressa* for different types of macrophytes. The plant type(s) that contribute most to the detached macrophyte – amphipod – fish food chain in nearshore regions in south-western Australia was also investigated.

Methods and study sites

A habitat preference experiment was conducted using different types of detached macrophytes in aquaria. To test which type of macrophyte *Allorchestes compressa* uses as a habitat in the field with the presence of fish predators, an experiment was conducted with different types of detached macrophytes contained in cages in surf-zone wrack at Two Rocks and Shoalwater Bay in south-western Australia.

A feeding preference experiment offering different species of detached macrophytes to *A. compressa* over four days was carried out in the laboratory. To investigate which types of wrack *A. compressa* consumes and assimilates, samples of detached macrophytes, *A. compressa* and 2 key fish predators (sea trumpeter and cobbler) were collected at 3 sites (Two Rocks, Hillarys and Shoalwater Bay) for biomarker analysis. The samples were analysed for stable isotopes ($\delta^{13}C$, $\delta^{15}N$ and $\delta^{34}S$), as well as fatty acids and lipid classes. The stable isotope values ($\delta^{13}C$ and $\delta^{15}N$) of *A. compressa,* after being fed on different plant types under controlled conditions, were also investigated to determine the expected enrichment between *A. compressa* and different types of wrack (both fresh and decomposed plant material) over 3 weeks. Plant material and amphipods were subsampled weekly to determine how these signatures change over time.

Fish research

Aims and objectives

The aim of this aspect of the research was to determine the influence of different volumes of surf-zone wrack on fish abundance and composition in surf zones of south-western Australia. Habitat preferences for two of the dominant fish species in beaches containing wrack, namely the cobbler *Cnidoglanis macrocephalus* and the sea trumpeter *Pelsartia humeralis* (Robertson and Lenanton 1984), were also investigated.

Methods and study sites

Fish were sampled in surf zones using a 21 metre long seine net in nearshore areas containing high, medium or low volumes of wrack, as well as in bare sand areas at both Hillarys and Shoalwater Bay. The data were analysed using nMDS ordinations and Analysis of Variance (ANOVA). A habitat preference experiment was conducted in a series of outdoor aquaria. Different types of macrophytes (i.e. seagrass only, brown algae only and a mixture of both types) were placed at either end of aquaria and the number of fish in each plant type recorded at the end of each trial. Data analyses from this experiment were performed using a non-parametric goodness of fit binomial test.

Results

Invertebrate research: Results of the habitat preference trials revealed that *Allorchestes compressa* prefers seagrass as a habitat under laboratory conditions. However, in contrast to those laboratory trials, *A. compressa* showed a strong preference for either brown algae, red algae or a mixture of different types of plants over seagrass as a habitat in the field (Figure 2.6).

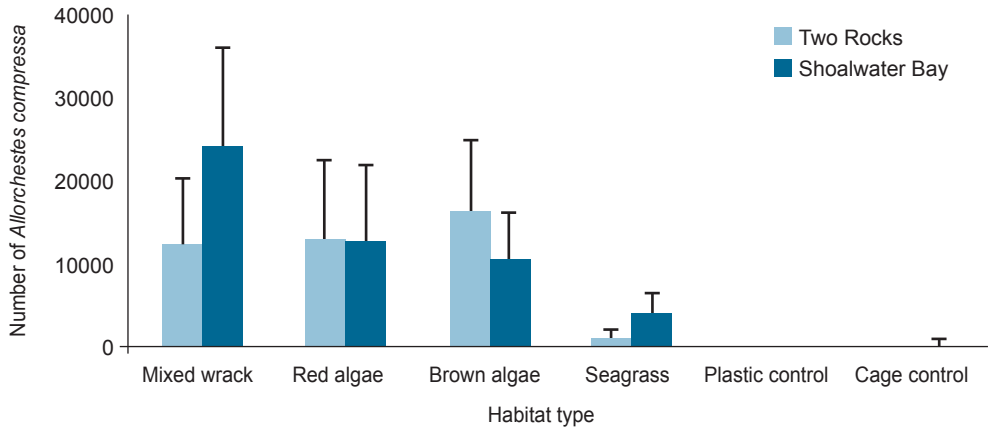

Figure 2.6: Mean abundance of *Allorchestes compressa* (+ S.E.) in different caged macrophyte habitats in caging experiments at Two Rocks and Shoalwater Bay.

Feeding preference trials revealed that *Allorchestes compressa* preferred brown algae (*Ecklonia* and *Sargassum*) compared to other detached macrophyte types as food. While *A. compressa* showed a preference for feeding on brown algae, other types of wrack may be assimilated. Results of stable isotope analysis revealed that *A. compressa* feed on macroalgae rather than seagrass. Fatty acid analysis revealed that the consumers (amphipods and fish) are most similar in fatty acid composition to brown algae *Ecklonia* and *Sargassum* (Figure 2.7) and therefore brown algae are likely to contribute more to the food chain than other types of macroalgae.

Fish research: In surf zones, fish abundance and biomass increased as the volume of wrack increased (Figure 2.8). The types of fish also differed between wrack volumes. Bait species were common in areas of bare sand, or those with low amounts of wrack. In contrast, species such as sea trumpeter (*Pelsartia humeralis*) and cobbler (*Cnidoglanis macrocephalus*) were abundant in areas with mid to high levels of wrack. Habitat preference trials for fish showed that neither sea trumpeter nor cobbler had a clear preference for different types of macrophytes.

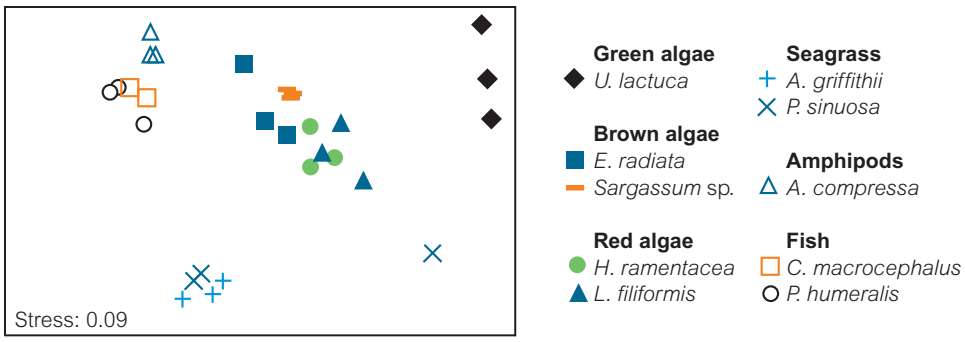

Figure 2.7: Two dimensional ordination of fatty acid composition of macrophyte, amphipod and fish species from three sites in south-western Australia.

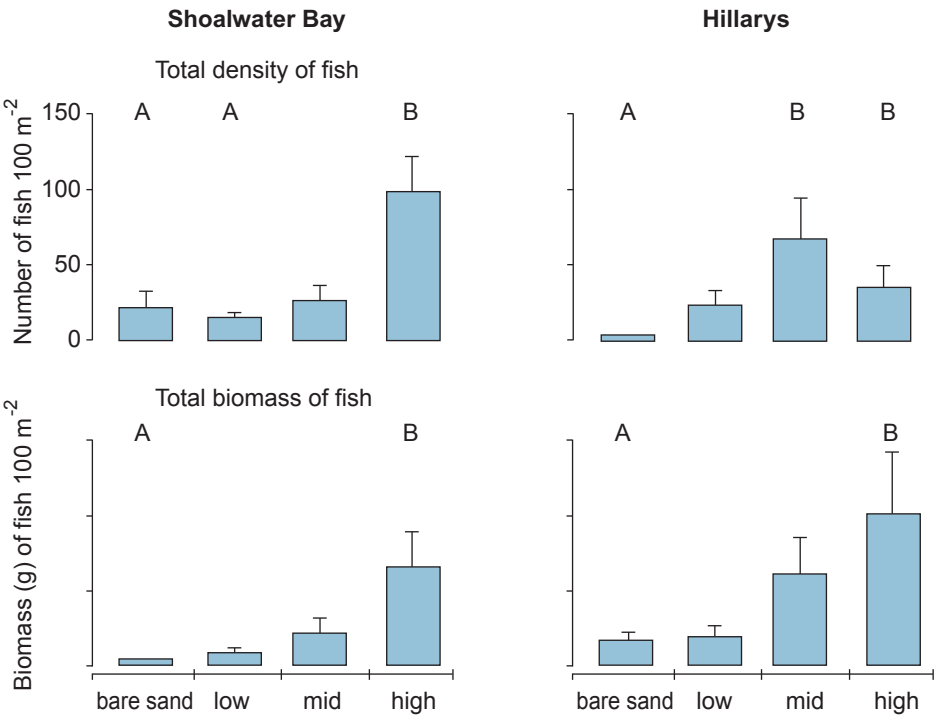

Figure 2.8: Mean (+SE) density and biomass of fish found in bare sand, low, mid and high wrack volumes at Shoalwater and Hillarys. Different letters denote volume categories that are significantly different ($P<0.05$).

Discussion

This study showed that different types of detached macrophytes are important for the amphipod *Allorchestes compressa*, which uses different types of plants as food or habitat. *A. compressa* shows a strong preference for feeding on brown algae, with this plant type contributing more than any other type of macrophyte in the detached macrophyte – amphipod – fish food chain in nearshore areas. In terms of shelter, brown and red algae and mixed wrack are important in providing a habitat for *A. compressa*. For fish, the volume, rather than the type, of wrack present in surf-zones has a strong influence on fish assemblages. Dense wrack accumulations are an important habitat for some fish species, particularly juvenile cobbler and sea trumpeter and could be critical for productivity and biodiversity in nearshore areas. Detached macrophytes transported from highly productive offshore areas subsidizes consumers in less productive surf-zone habitats in south-western Australia, where it enables consumer populations to reach greater densities than would be supported by *in situ* production. Removal of wrack could have a detrimental impact on the biodiversity and abundance of some fish species and their invertebrate prey, which rely on wrack for food and shelter.

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Conference attendance and presentations

July 2005: Australian Marine Science Association Conference (Darwin). Oral presentation "*Trophic transfer of carbon, nitrogen, sulfur and fatty acids between detached macrophytes, the amphipod* Allorchestes compressa *Dana and its fish predators in south-western Australia*".

June 2005: SRFME Postgraduate Symposium (CSIRO, Perth). Oral presentation "*Trophic transfer of carbon, nitrogen, sulfur and fatty acids between detached macrophytes, the amphipod* Allorchestes compressa *Dana and its fish predators in south-western Australia*".

March 2005: Rockingham/Kwinana/Mandurah Naturaliste Club. Oral presentation.

November 2004: Seagrass monitoring volunteer group, Rockingham. Oral presentation.

September 2004: Australian Society of Fish Biology Conference (Adelaide). Oral presentation "*The importance of volume and type of wrack on nearshore fish assemblages*".

June 2004: 2nd SRFME Postgraduate Symposium (CSIRO, Perth). Oral presentation "*The importance of volume and type of wrack on nearshore fish assemblages*".

March 2004: The Karrakatta Club (Perth). Oral presentation "*The importance of wrack in nearshore areas*".

July 2003: Australian Marine Science Association Conference (Brisbane). Oral presentation "*The role of different types of detached macrophytes for* Allorchestes compressa*, a surf-zone inhabiting amphipod*".

June 2003: 1st SRFME Postgraduate Symposium (CSIRO, Perth). Oral presentation "*The role of detached macrophytes for nearshore fish production and biodiversity*".

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Publications and awards

Crawley, K.R. and G.A. Hyndes (in press). The role of different types of detached macrophytes in the food and habitat choice of a surf zone inhabiting amphipod. *Marine Biology.*

Crawley, K.R., G.A. Hyndes and S.G. Ayvazian (2006). The influence of different volumes and types of detached macrophytes on fish community structure in surf zones of sandy beaches. *Marine Ecology Progress Series* 307: 233-246.

June 2005: Symposium of the SRFME Postgraduate Scholarship Program (3rd prize).

March 2004: Dame Mary Gilmore Award offered by The Karrakatta Club and Edith Cowan University.

June 2003: Symposium of the SRFME Postgraduates Scholarship Program (3rd prize).

2.2.3 Ecological and historical processes maintaining macroalgal diversity in the Recherche Archipelago, Western Australia

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Executive Summary

The macroalgal flora of the Recherche Archipelago was characteristic of the flora of the southern coast of Australia. Subtidal macroalgal assemblages were similar to assemblages found east of the Great Australian Bight. Patterns in macroalgal diversity in the Recherche Archipelago were presumably related to past speciation events and shared biogeography along the southern coast of Australia. The structure of subtidal macroalgal assemblages consisted of two layers: a locally-maintained, diverse, and abundant canopy layer; and an understory layer that was species-rich. Understory species, with their widespread distributions contributed to high species diversity for macroalgae across the southern coast of Australia.

Introduction

The macroalgal flora of southern Australia is among the richest globally. Records of macroalgal distributions and abundances remain incomplete because of the length and remoteness of the south coast. This thesis provides a comprehensive description of the diverse subtidal flora found in the Recherche Archipelago (RA), links patterns of diversity to dispersal potential, and assesses contemporary diversity in context with biogeography.