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Food, feeding and growth rates of peracarid macro-decomposers in a Ria Formosa salt marsh, southern Portugal

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Abstract

The diet, feeding rates and growth rates of three species of isopod and three species of amphipod from a Ria Formosa salt marsh in southern Portugal are compared to test the hypotheses that the relative success of amphipods as macro-decomposers in salt marshes worldwide can be a) attributed to their utilizing a distinctly different range of potentially available food resources and b) attributed to them using similar food resources but at different rates.

The first hypothesis was tested using a combination of gut contents analysis, stable isotope analysis and multiple-choice food preference tests. The results of all three analyses showed that there was a very broad overlap in the resource utilization curves for these species for the most abundant potential foods available in the upper salt marsh. The first hypothesis was therefore rejected.

The second hypothesis was tested with palatability experiments in which consumption rates of each of the test animals were compared for each potential food offered alone. The amphipods ate all five of the foods significantly faster, consuming from 3–73× more food per unit mass than the isopods.

Analyses of their relative growth rates from when released from the marsupium until first breeding, showed that amphipods have a faster growth rate than isopods in the field which is consistent with other traits in their rapid development–high fecundity life–history strategy. We conclude that these data support the second hypothesis and that their morphological adaptations to a shredding, high ingestion-rate rapid gut turnover digestive strategy enable them to have a more efficient resource acquisition rate than the slower growing, lower fecundity and slower ingestion-rate longer gut throughput time strategy of most isopods.

Keywords: Amphipod; Consumption rates; Food preferences; Gut contents; Isopod; Stable isotopes

1. Introduction

Primary production in salt marshes is often very high (Odum, 1970; Chapman, 1992; Vernberg, 1993) but consumption by herbivores is extremely limited

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(e.g., Jackson et al., 1985; Daehler and Strong, 1995; Packham and Willis, 1997; Pennings and Bertness, 2001), and most of the biomass of the marsh vegetation passes through the detritus pathway which includes a high range of macro- and microoganisms (Duarte and Cebrián, 1996; Hemminga et al., 1996; Packham and Willis, 1997; Pennings and Bertness, 2001). Salt marshes are, however, also highly stressful environments which are subject to high fluctuations in temperature, moisture content and osmotic pressures. Typically, relatively few species of invertebrates adapt to such conditions but those which have done so can reach extremely high population densities (Montague et al., 1981; Chapman, 1992; Levin and Talley, 2000).

The Peracarida includes some very successful salt marsh species, particularly amongst members of the Amphipoda which are widespread and abundant in many salt marshes (Dahal, 1952; Averill, 1976; Robertson and Lucas, 1983; Stenton-Dozey and Griffiths, 1983; Inglis, 1989), usually more so than members of the Isopoda which are better adapted than most amphipods to fully terrestrial habitats (Sutton, 1980). One reason for the difference in the extent to which they are adapted to the salt marsh habitat might be that amphipods are able to utilize a wider range of foods potentially available in salt marsh habitats. Another possible reason could be that they utilize the same foods but more effectively.

We test these two hypotheses for amphipods and isopods which co-exist in a Ria Formosa salt marsh in southern Portugal (Dias and Hassall, in press-a) by applying a range of methods of diet analysis, including food preference tests, gut contents analysis and stable isotope analysis and by measuring consumption rates on diets of different potential foods. The relative success of the observed resource utilization strategies is then evaluated by comparing growth rates for these species in the field. The conclusions drawn are then interpreted in relation to differences in alimentary morphology between the two orders and the consequences for their resource allocation strategies.

2. Material and methods

2.1. Sample collection

Samples were collected by hand from the upper fringe of a Ria Formosa lagoon salt marsh (southern Portugal) (37° 00′ N, 07° 59′ W). The salt marshes in this lagoon are of the dry-coast type (Adam, 1990) with the vegetation consisting of *Spartina maritima* (Curtis) Fernald in the lower level, *Sarcocornia* spp. and *Atriplex portulacoides* L. in the intermediate region, and *Suaeda vera* J. F. Gmelin, *Suaeda maritima* (L.) Dumort, *Atriplex halimus* L., and *Limoniastrum monoptalum* (L.) Bss. in the upper zone. Six peracarid species inhabiting the superior marsh have been studied: three isopods: *Tylos ponticus* Grebnitzky, 1874 (Tylidae), *Porcellio lamellatus* Budde-Lund, 1879 (Porcellionidae) and *Halophiloscia couchii* (Kinahan, 1858) (Halophilosciidae); and three amphipods: *Orchestia gammarellus* (Pallas, 1766) (Talitridae), *Orchestia mediterranea* A. Costa, 1857 (Talitridae) and *Talorchestia deshayesii* (Audouin, 1826) (Talitridae) (Table 1). Other aspects of the ecology and secondary production of these macrodecomposers have been reported elsewhere (Dias, 2002, 2003; Dias and Sprung, 2003, 2004; Dias and Hassall, in press-a).

Table 1
Characteristics of the isopod and amphipod species in the Ria Formosa salt marsh

	Micro-habitat occupied	Maximum length (mm)	Reproductive period	Mean density (ind. m^{-2})
Tylos ponticus	Burrows in the sand	14	May–Sep/Oct	2950
Porcellio lamellatus	Under wrack	14	March–Sep/Oct	36
Halophiloscia couchii	Under wrack	11	March–Sep/Oct	3
Orchestia gammarellus	Under wrack	16	Year round	358
Orchestia mediterranea	Under wrack	26	Year round	46
Talorchestia deshayesii	Burrows in the sand	11	March–Nov[a]	43

[a] Source: Louis (1980).