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MOTILE MACROINVERTEBRATE ASSEMBLAGES ASSOCIATED WITH SUBMERGED *POSIDONIA OCEANICA* LITTER ACCUMULATIONS

Abstract

In the Mediterranean, seagrass leaf litter derived from Posidonia oceanica *beds constitutes an important source of detritus. Large areas with* P. oceanica *leaf litter are ubiquitous in the infralittoral, but data on the species assemblages characterising this habitat are lacking. Samples of leaf litter were collected in December 2001 from 8 stations in each of two bays on the northern coast of Malta, using a suction sampler. A total of 4794 motile macroinvertebrates comprising 43 species were recorded. Overall, diversity and evenness values were low, however, abundance values were very high. Detritivorous crustaceans were the most abundant taxon (>97 %), with amphipods having the highest abundance (81.8 %). Our results indicate that* P. oceanica *leaf litter is a distinct habitat that supports characteristic motile macroinvertebrate assemblages dominated by gammarid amphipods. Mediterranean marine* Gammarus *spp. are typically found in brackish habitats, and only infrequently occur in fully marine waters. However, no sources of brackish water were present in the vicinity of our study sites, which seems to indicate that the occurrence of* Gammarus *spp. in* P. oceanica *leaf litter accumulations may be widespread. We suggest that the* P. oceanica *leaf litter habitat supports unique macroinvertebrate assemblages composed mostly of motile detritivores and which may constitute an important link in transferring production from* P. oceanica *leaves to higher trophic levels.*

Key-words: *seagrass,* Posidonia oceanica*, leaf litter, crustaceans,* Gammarus *spp., Maltese islands.*

Introduction

Most of the primary production in seagrass ecosystems is not consumed directly by herbivores (Pergent *et al.*, 1997; Cebrián and Duarte, 1998) but is decomposed within the meadow to form litter and detritus, a proportion of which may be exported to other ecosystems (40–80%, Cebrián and Duarte, 2001; 10–20%, Mateo and Romero, 1997). Seagrass litter exported to adjacent biotopes adds complexity to the habitat, particularly when it settles on sandy bottoms. The exported drifting macrophyte litter provides an unlimited supply of food and refuge from predators to benthic invertebrates (Vetter, 1995; Norkko *et al.*, 2000), while the latter serve as a valuable food resource for higher trophic levels (Vetter, 1995). Drifting macrophyte litter can also affect the distribution (or redistribution) of fauna, since some species utilise it as a transport medium through rafting (Norkko and Bonsdorff, 1996). The dominant macrofauna in drifting macrophyte litter consists of motile macroinvertebrates (Vetter, 1995; Norkko *et al.*, 2000), mainly detritivorous and omnivorous species (Gore *et al.*, 1981). Sublittoral accumulations of drifting macrophytes may have high abundances of motile macroinvertebrates, with the highest values recorded for accumulations of kelp and surfgrass detritus off the West Coast of the USA (Vetter, 1995), and from intertidal (Norkko *et al.*, 2000) and pelagic (Ingólfsson, 1998) drift algal mats.

In the Mediterranean, few studies have addressed the motile macroinvertebrate assemblages associated with drifting macrophyte litter, despite the presence of vast quantities of such material in shallow coastal waters that originates mainly

from *Posidonia oceanica* beds. As in other parts of the Mediterranean, drifting macrophyte litter accumulations occur around the Maltese Islands. Litter derived from Maltese *P. oceanica* meadows is present at different depths and on different bottom types, and represents a significant repository of biomass. The present study aimed to characterise the motile macrofaunal assemblages associated with drifting seagrass litter present in shallow waters (3-6 m) on sandy bottoms.

Material and methods

The study was conducted in two bays: Qortin Bay (14°21′N, 36° 00′E) and Armier Bay (14°21.5′N, 36° 00′E), located on the northern coast of mainland Malta (Fig. 1). Both bays have a sandy bottom in shallow waters (2–6 m) and a similar exposure to northerly and northwesterly winds. Preliminary surveys indicated that *P. oceanica* litter starts to accumulate on the sandy bottoms from late summer and persists until late spring, with very small isolated patches (~1 m^2) remaining during the summer period (Dimech, 2003). The accumulations have a thickness of 5-17 cm and consist mainly of *P. oceanica* leaves (>94% dry weight), roots and rhizomes (2% w/w) of the same seagrass, and various algae (4% w/w). In winter these accumulations may cover up to 80% of the otherwise bare sandy bottom (Dimech, 2003).

Eight replicate samples (0.05 m^2) of leaf litter, together with the associated macrophyte debris and macrofauna, were collected in December 2001 from each bay using a suction sampler. The samples were first washed on a 0.5 mm mesh sieve to remove fine sand, and then transported to the laboratory where they were fixed and stored in 10% formal saline. The samples were washed with tap water and sorted to extract the motile macroinvertebrates, which were identified and counted.

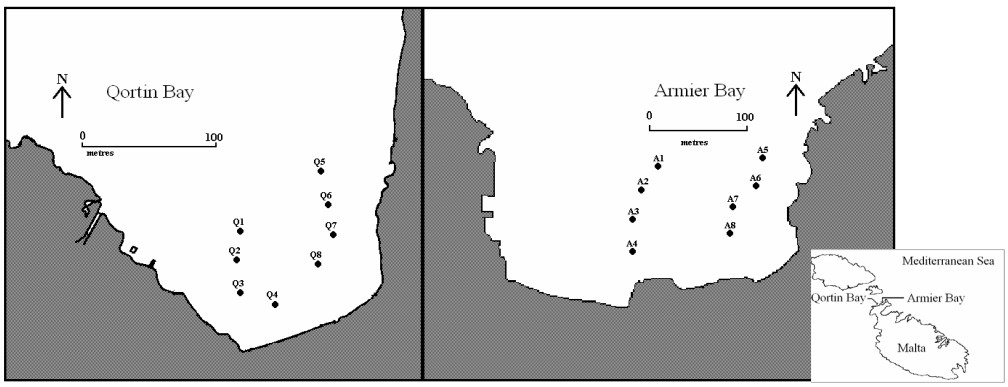

Fig. 1 - Location of Qortin Bay and Armier Bay, showing the distribution of eight replicate stations in each bay. Note the slight difference in scale.

Results

A total of 4794 individuals comprising 43 species were identified. In terms of abundance, Crustacea were most numerous (>96 % of all individuals), of which amphipods accounted for 81.8% of the total abundance. Eight species accounted for 96.9 % of the total abundance (Tab. 1). Three of the four Mediterranean marine *Gammarus* species (*G. aequicauda*, *G. subtypicus* and *G. crinicornis*) were

present, however, due to the large number of juveniles and the difficulty in identifying them, individuals of the three species were grouped as '*Gammarus* spp.'

Tab. 1 - Mean total abundance of species recorded from the *P. oceanica* litter samples. (a) Amphipoda, (i) Isopoda, (p) Polychaeta.

Species	Mean Total Abundance (ind/m^2) n = 16	Standard deviation	Relative Abundance (%)
Gammarus spp. (a)	3553	3593	59.28
Atylus swammerdami (a)	836	1031	13.95
Idotea baltica (i)	520	656	8.68
Ostracoda sp.	381	576	6.36
Atylus guttatus (a)	240	413	4.01
Scolelepis sp. (p)	134	258	2.23
Idotea hectica (i)	75	98	1.25
Melita hergensis (a)	66	193	1.11
Others	188	136	3.13

Discussion

In terms of abundance, detritivorous crustaceans, mostly amphipods (81.8%), were dominant in the *P. oceanica* leaf litter from the study area, as noted in other studies on shallow water drifting macrophyte detritus habitats (Vetter, 1995; Norkko *et al*., 2000). However, outside the Mediterranean, other crustacean groups may be dominant (e.g. Leptostraca; Vetter, 1995; Ostracoda; Norkko *et al*., 2000). Although the mean abundance recorded in this study (5.9×10^3 ind./m^2) is much lower than that found by Vetter (1995) for kelp and surfgrass detritus (1.1×10^6 ind./m^2), abundance values from the present study are higher than those for local *P. oceanica* meadows (2×10^3 ind./m^2; Borg *et al*., 2006). On the other hand, mean diversity and evenness values (H' = 1.29, J' = 0.54) were much lower than for local *P. oceanica* meadows (H' = 3.45, J' = 0.91; Borg *et al*., 2006), due to dominance of amphipods (mainly *Gammarus* spp.) and isopods (mainly *Idotea baltica*) in the leaf litter. The relatively low diversity in the drifting *P. oceanica* leaf litter may be attributed to disturbance and transport of the litter by currents in the bays, as most of the litter is eventually washed ashore or transported to deeper waters. Vetter (1995) also found a low diversity in disturbed leaf litter patches and attributed these to disturbance by currents. The large proportion of relatively indigestible fibre present in *P. oceanica* may contribute since only a small number of species can consume the litter. In Vetter's (1995) study, the leaf litter was mainly composed of kelp, which is more digestible than *P. oceanica* litter. Despite their low diversity, *P. oceanica* leaf litter accumulations enhance the diversity of motile macrofauna on otherwise bare sandy bottoms that typically have an impoverished epifauna, and contribute to increase diversity in shallow coastal waters.

The leaf litter also supports unique benthic assemblages, predominant members of which are motile detritivores characteristic of this habitat but rarely found elsewhere. A number of these species are considered rare (e.g. *Idotea hectica*, Charfi-Cheikhrouha, 2000), or absent (e.g., *Gammarus aequicauda*, *Gammarus crinicornis*, *Gammarus subtypicus*; Scipione, 1998) from *P. oceanica* beds. *Gammarus* spp., the most abundant in this study, usually occur in brackish water habitats or in waters subjected to fluctuating salinity (Mancinelli and Rossi, 2002), and only rarely in fully marine environments. The dominance of this taxon in fully marine seagrass litter habitats appears to have been overlooked. Other studies in the Mediterra-

nean (Mancinelli and Rossi, 2002) found relatively high abundances of *Gammarus* spp. (e.g. *Gammarus aequicauda*) in sediments enriched with leaf litter, which were attributed to passive dispersal of the gammarids from nearby brackish lagoons. Accumulations of *P. oceanica* leaf litter are present mostly in winter, and by summer much of the litter is either washed onshore or has decomposed, therefore, the habitat is somewhat transient. The most abundant species in the litter are not common in other habitats, and since there is evidence that colonisation of decaying drifting algae and seagrass by invertebrates is rapid (Norkko and Bonsdorff, 1996), there must be a source for the litter macrofauna. A likely candidate are the isolated pockets of leaf litter that persist during the summer period in depressions on the seabed, implying that *Gammarus* spp. and the rest of the litter macrofauna live permanently in fully marine conditions, either in large litter accumulations or in refugia. The present results demonstrate the importance of the *P. oceanica* litter accumulations – a decaying necromass that supports unique and diverse assemblages of motile macrofauna.

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