Biol. Mar. Medit. (2006), 13 (4): 174-180

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IS AMPHIPOD DIVERSITY RELATED TO THE QUALITY OF *POSIDONIA OCEANICA* BEDS?

Abstract

The Amphipod fauna (Crustacea, Peracarida) associated with the seagrass Posidonia oceanica *was studied on four localities in the eastern Tunisian coast exposed to increasing levels of anthropogenic influence (Mahdia, Hergla, Monastir and El Kantaoui) using diversity indexes and statistical analysis. At each locality, three sites were sampled along a depth gradient at 2, 5 and 10 m. To study associated amphipods,* Posidonia *shoots were collected in three replicates at each station using a quadrate (30*30 cm) by SCUBA diving. Thirty-seven amphipod species were identified with an important abundance particularly in Mahdia sites. The data analysis revealed a clear relationship between amphipod diversity and epiphyte biomass. A correlation was also found between amphipod population diversity and the quality of* Posidonia *meadows. Amphipod population structure appears to be more stable in* Posidonia *meadows in good health. No particular groups of amphipod species were specifically linked to the degree of degradation of* Posidonia *meadows. However,* Apocorophium acutum, Ampithoe helleri *and* Ampithoe ramondi *were more frequent in degraded meadows. These species can be proposed as bioindicators of the bad quality of* Posidonia oceanica *meadows.*

Key words: *Amphipods,* Posidonia oceanica*, diversity, Tunisian eastern coasts.*

Introduction

Posidonia oceanica is the most abundant and widely distributed seagrass species along the Tunisian coast. *P. oceanica* meadows constitute a very important habitat for benthic communities. They provide habitat, protection and trophic resources for many species, particularly crustaceans amphipods which are one of the most abundant groups associated to this seagrass (Chessa *et al.*, 1983). *P. oceanica* has been used as a bioindicator of coastal water quality (Pergent *et al.*, 1995), and also amphipods have been studied to assess the coastal water pollution (Bellan Santini, 1980; 1981; Guerra Garcia and Garcia Gomez, 2001). However few studies, focusing on the relationship between associated Amphipods and *P. oceanica* meadow quality, have yet been developed (Diviacco, 1988; Scipione, 1998).

Materials and methods

The study area was located in the eastern Tunisian coasts in the Gulf of Hammamet (Fig. 1). Four localities were chosen (Mahdia, Hergla, Monastir and El Kantaoui) where *Posidonia* meadows are exposed to an increasing level of human impact. Fieldwork was carried out in October 2004. At each locality, three stations were sampled at 2, 5 and 10 m depth. A study of bed and plant features of the four localities was carried out in order to evaluate *P. oceanica* meadow status and the result was presented in Sghaier *et al*. (2006, this volume).

To sample the amphipods associated to *Posidonia* we used a quadrate of 30 cm side and 25 cm height. The quadrate was placed in each *Posidonia* meadow.

The shoots were pulled up and collected in a bag (net size 0.3 mm). A total of 9 samples were sampled in each localities, 3 replicates for each depth.

P. oceanica shoots collected were washed with freshwater over a 0.5 mm sieve. Retained amphipods were sorted, identified and counted.

The species abundance data were analysed through cluster analysis using Bray-Curtis similarity index (fourth root transformation). Difference between amphipod density averages was tested using ANOVA analysis. The regression analysis was performed using non-parametric Spearman correlation to reveal an eventual relationship between *Posidonia* meadows features and amphipods diversity.

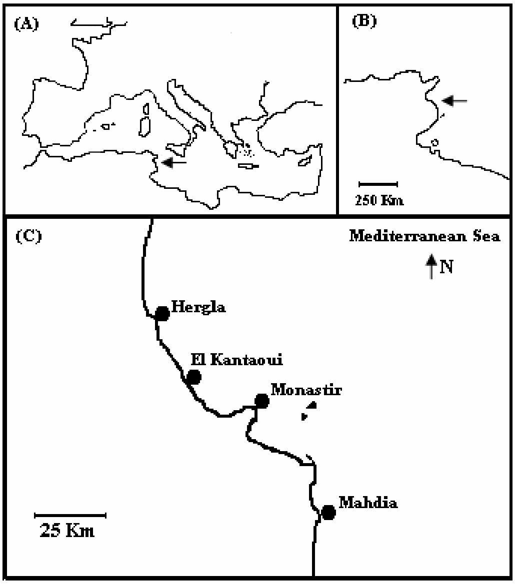

Fig. 1 - Sampling localities in the Tunisian eastern coast

Results

A total of 37 species of amphipods were identified (Tab. 1); among them *Ampelisca unidentata, A. rubella, Ampithoe helleri, Leptocheirus guttatus, Ericthonius punctatus, Elasmopons brasiliensis* and *Maera inaequipes* are particularly frequent representing 70.4% of the total of specimens. These species exhibited a large distribution, occurring in almost all the samples.

The amphipods in El Kantaoui stations, the most disturbed particularly in A1 station (-2m depth), are dominated by *A. helleri*, *Amphitoe ramondi*, *E. punctatus* and *Pseudoprotella phasma*. Whereas, *Ampelisca unidentata*, *A. rubella*, *E. punctatus* and *E. brasiliensis* are more frequent at Mahdia stations (D1, D2 and D3). In term of density, *A. helleri* and *A. ramondi* showed the highest densities at El Kantaoui probably related to the high epiphyte biomass recorded in these sites (A1 and A2). On the other hand, *A. rubella*, *A. unidentata* and *Ampelisca spinipes* occurred mainly at Mahdia characterized by clean and the transparent water conditions.

Density of amphipods per m^2, species richness (total and average), diversity index (Shannon-Weaver) and Evenness were shown in Tab. 2. The highest value of amphipods density was recorded in Mahdia; (ANOVA test; $p<0.001$). The

Tab. 1 - Average density of amphipod species at El Kantaoui (A), Monastir (B), Hergla (C) and Mahdia (D). Standard deviations are given in parentheses

		A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3
1.	*Ampelisca rubella* A. Costa, 1864	-	55.56 (19.25)	-	44.44 (19.25)	3.70 (6.42)	162.96 (33.95)	66.67 (22.22)	51.85 (25.66)	44.44 (11.11)	162.96 (16.97)	122.22 (22.22)	137.04 (33.95)
2.	*Ampelisca spinipes* Boeck, 1861	7.41 (6.42)	7.41 (6.42)	-	3.70 (6.42)	7.41 (12.83)	-	7.41 (6.42)	14.81 (6.42)	3.70 (6.42)	22.22 (11.11)	22.22 (19.25)	29.63 (16.97)
3.	*Ampelisca unidentata* (Schellenberg, 1936)	7.41 (6.42)	51.85 (16.97)	18.52 (6.42)	40.74 (27.96)	37.04 (6.42)	170.37 (65.11)	129.63 (16.97)	77.78 (48.43)	162.96 (23.13)	177.78 (22.22)	196.30 (61.20)	151.85 (12.83)
4.	*Amphilochus neapolitanus* Della Valle, 1893	-	7.41 (6.42)	-	-	11.11 (11.11)	-	-	3.70 (6.42)	7.41 (6.42)	-	-	-
5.	*Peltocoxa marioni* Catta, 1875	-	14.81 (6.42)	-	-		22.22 (11.11)	-	-	14.81 (16.97)	-	-	-
6.	*Ampithoe helleri* G. Karaman, 1975	677.78 (55.56)	140.74 (16.97)	-	59.26 (33.95)	-	-	111.11 (40.06)	51.85 (6.42)	3.70 (6.42)	14.81 (16.97)	29.63 (12.83)	11.11 (0.00)
7.	*Ampithoe ramondi* Audouin, 1826	148.15 (16.97)	7.41 (6.42)	3.70 (6.42)	62.96 (6.42)	-	7.41 (12.83)	18.52 (16.97)	-	-	18.52 (12.83)	14.81 (6.42)	22.22 (11.11)
8.	*Aora gracilis* (Bate, 1857)	7.41 (6.42)	-	-	-	25.93 (16.97)	18.52 (6.42)	18.52 (12.83)	22.22 (11.11)	3.70 (6.42)	22.22 (11.11)	25.93 (6.42)	29.63 (12.83)
9.	*Lembos* sp	-	-	-	51.85 (16.97)	-	-	-	-	-	-	-	-
10.	*Lembos websteri* Bate, 1857	7.41 (6.42)	-	-	-	-	-	-	-	-	-	-	-
11.	*Leptocheirus guttatus* (Grube, 1864)	18.52 (6.42)	11.11 (0.00)	22.22 (11.11)	55.56 (11.11)	40.74 (16.97)	137.04 (39.02)	18.52 (16.97)	77.78 (11.11)	185.19 (16.97)	10 (29.40)	114.81 (23.13)	118.52 (16.97)
12.	*Tethylembos viguieri* (Chevreux, 1911)	-	-	-	-	-	-	-	-	-	22.22 (11.11)	18.52 (6.42)	11.11 (11.11)
13.	*Apocorophium acutum* (Chevreux, 1908)	14.81 (6.42)	-	-	-	-	-	-	-	-	-	-	-
14.	*Dexamine spiniventris* (A. Costa, 1853)	-	25.93 (6.42)	-	66.67 (11.11)	-	137.04 (27.96)	14.81 (16.97)	3.70 (6.42)	11.11 (11.11)	25.93 (6.42)	25.93 (12.83)	37.04 (6.42)
15.	*Dexamine spinosa* (Montagu, 1813)	-	-	-	-	7.41 (12.83)	-	14.81 (6.42)	11.11 (0.00)	3.70 (6.42)	-	-	-
16.	*Tritaeta gibbosa* (Bate, 1862)	-	11.11 (11.11)	-	-	-	59.26 (23.13)	44.44 (11.11)	48.15 (16.97)	-	-	-	-
17.	*Hyale comptonyx* (Heller, 1866)	51.85 (16.97)	44.44 (29.40)	-	77.78 (48.43)	-	-	-	-	-	-	-	-
18.	*Parahyale aquilina* (A. Costa, 1857)	14.81 (6.42)	25.93 (6.42)	-	-	-	-	7.41 (12.83)	-	-	-	-	-

Tab. 1. *(Continued)*

	A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3
19. Iphimedia sp.	-	-	11.11 (0.00)	-	-	-	-	-	-	-	-	-
20. Gammaropsis ostroumoui (Sowinsky, 1898)	-	-	-	51.85 (23.13)	-	-	-	-	-	-	-	-
21. Ericthonius punctatus (Bate, 1857)	237.04 (23.13)	103.70 (12.83)	22.22 (11.11)	181.48 (16.97)	55.56 (11.11)	74.07 (25.66)	140.74 (16.97)	233.33 (72.86)	51.85 (27.96)	214.81 (16.97)	248.15 (63.18)	218.52 (46.26)
22. Leucothoe spinicarpa (Abildgaard, 1789)	22.22 (11.11)	3.70 (6.42)	-	-	14.81 (6.42)	-	14.81 (6.42)	11.11 (0.00)	44.44 (22.22)	-	-	-
23. Leucothoe venetiarum Giordani-Soika, 1950	-	-	-	-	-	-	-	-	-	-	-	7.41 (12.83)
24. Lysianassa costae Milne Edwards, 1830	7.41 (6.42)	29.63 (6.42)	7.41 (6.42)	-	-	-	7.41 (6.42)	14.81 (16.97)	14.81 (6.42)	-	-	-
25. Lysianassa sp1	-	-	-	-	-	155.56 (22.22)	-	-	-	-	-	-
26. Lysianassa sp2	-	-	-	-	-	148.15 (16.97)	-	-	-	-	-	-
27. Orchomene humilis (A. Costa, 1853)	-	11.11 (11.11)	-	-	-	-	7.41 (6.42)	44.44 (11.11)	22.22 (19.25)	-	-	-
28. Lepidepecreum longicorne Bate & Westwood, 1861	-	18.52 (6.42)	-	-	-	-	-	-	-	-	-	-
29. Socarnes filicornis Heller, 1866	-	-	-	-	-	-	-	-	-	14.81 (6.42)	18.52 (12.83)	14.81 (12.83)
30. Elasmopus brasiliensis (Dana, 1855)	-	-	-	-	-	-	40.74 (35.72)	3.70 (6.42)	55.56 (19.25)	159.26 (16.97)	155.56 (22.22)	20 (44.44)
31. Elasmopus pocillimanus (Bate, 1862)	-	25.93 (6.42)	-	3.70 (6.42)	14.81 (6.42)	18.52 (6.42)	-	-	-	-	-	-
32. Maera hirondellei Chevreux, 1900	33.33 (11.11)	3.70 (6.42)	7.41 (6.42)	-	-	-	25.93 (6.42)	7.41 (12.83)	-	25.93 (12.83)	37.04 (6.42)	44.44 (19.25)
33. Maera inaequipes A.Costa, 1857	59.26 (6.42)	129.63 (12.83)	11.11 (11.11)	103.70 (25.66)	92.59 (27.96)	248.15 (39.02)	10 (29.40)	103.70 (16.97)	222.22 (11.11)	103.70 (35.72)	111.11 (29.40)	114.81 (16.97)
34. Metaphoxus simplex (Bate, 1857)	14.81 (12.83)	7.41 (6.42)	-	-	-	-	3.70 (6.42)	-	18.52 (12.83)	92.59 (6.42)	114.81 (23.13)	77.78 (11.11)
35. Caprella liparotensis (Haller, 1880)	-	-	-	-	-	-	25.93 (25.66)	125.93 (23.13)	25.93 (6.42)	-	-	-
36. Caprella sp.	-	-	-	11.11 (11.11)	3.70 (6.42)	11.11 (11.11)	-	-	-	-	-	-
37. Pseudoprotella phasma (Montagu, 1804)	11.11 (11.11)	40.74 (6.42)	66.67 (11.11)	-	-	-	-	-	-	33.33 (11.11)	25.93 (6.42)	44.44 (11.11)

total species richness, unlike the average richness, increases in relation with the disturbance level of the various studied sites. Diversity index (H') and Evenness (J') are lowest in El Kantaoui compared with the others sites.

Tab. 2 - Density, Specific Richness, Diversity index of Amphipod populating in studied sites.

	El Kantaoui	Monastir	Hergla	Mahdia
Density n. ind/m-²	762.96(333.59)	833. 33(304.80)	874.07(42.17)	1254.32(52.02)
Species Richness total	26	22	22	17
Species Richness average	13.55(5.24)	11.44(2.00)	15.11(2.14)	15.77(0.66)
Diversity H'	3.35	3.80	3.68	3.49
Evenness J'	0.71	0.85	0.82	0.85

The cluster analysis, using the similarity matrix on the average density of amphipods species, shows two distinct groups of stations (Fig. 2). The first group includes El Kantaoui stations (A1, A2 and A3), characterised by the lowest values of shoot density and shoot size, and where the *Posidonia oceanica* meadow can be qualified on in bad-poor ecological status (Sghaier *et al.*, 2006). The second group can be split into three subgroups with different similarity levels (from 45% to 90%); the first subgroup includes Mahdia stations (D1, D2 and D3) characterised by a clean water and the highest values of shoot density and shoot size. The second (C1, C2 and C3) and the third subgroups (B1, B2 and B3), located respectively at Hergla and Monastir, are characterised by medium values of shoot density and shoot size. The *Posidonia* meadows are qualified in these two subgroups, having a moderate status (Sghaier *et al.*, 2006).

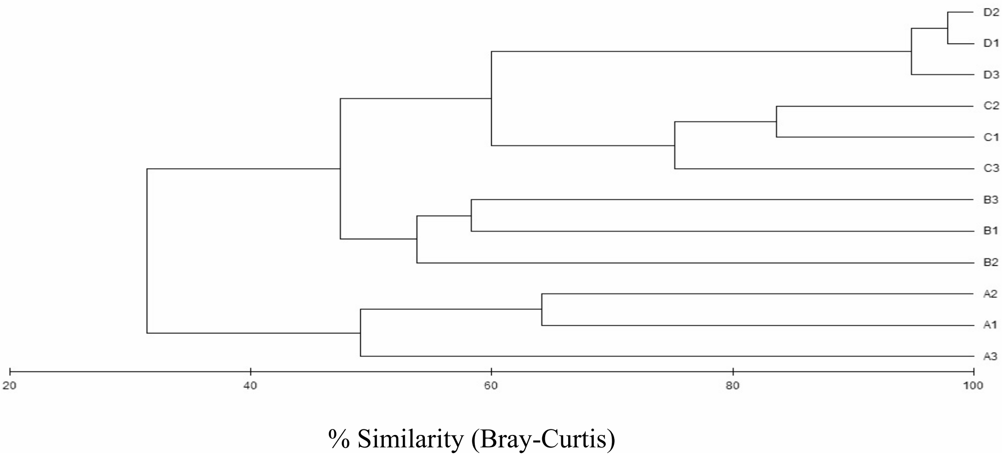

Fig. 2 - Dendrogramme of similarity between the stations of the four localities based on the average density of Amphipods species (A: El Kantaoui, B: Monastir, C: Hergla, D: Mahdia)

The relationships between amphipods and the *P. oceanica* meadow features are shown in Fig. 3. A significant relationship was observed (significant correlation,

$p<0.05$) between the *Posidonia* shoot density and amphipods density (r= 0.94) and also between the epiphytic biomass (mg/cm²) and the species richness (r= 0.98).

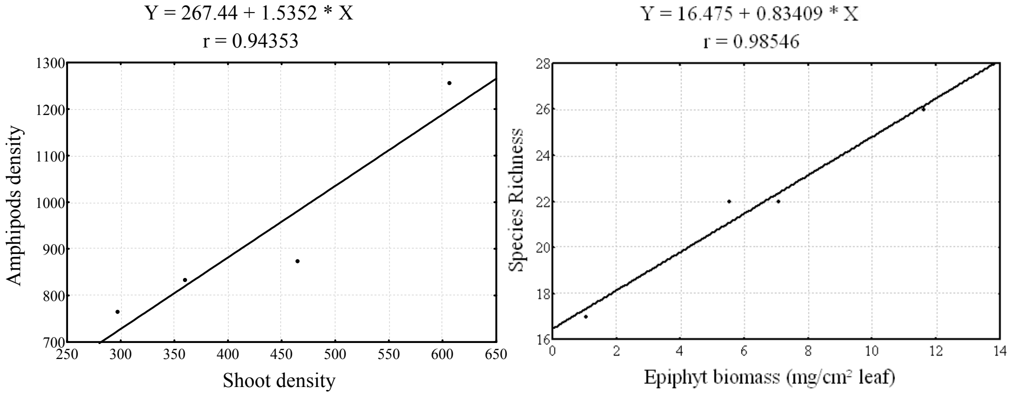

Fig. 3 - Linear regression: Shoot density and Amphipod density (left), Epiphyte biomass and Species Richness (right).

Discussion and conclusions

During this study, a relatively high number of amphipod species have been recorded in Eastern Tunisian *P. oceanica* meadow (37 species) when compared with other sites in Mediterranean coast; 22, 25, 28 and 34 species were identified respectively in *Posidonia* meadow in Alicante coast (Spain) by Sanchez-Jerez *et al.* (1999), in Porto Conte (Sardinia) by Scipione (1998), in Apulia coast (Italy) by Diviacco (1988) and in Punta Vico, Lacco Ameno, Island of Ischia (Italy) by Scipione and Fresi (1984). Differences of number of amphipods species between the various beds in the Mediterranean can be attributed to the sampling method (e.g., Scipione, 1998, used the hand-net method to collect amphipods from the *Posidonia* leaf stratum).

Structure and diversity of amphipods was influenced by the features of *Posidonia* meadows, wich are affected by anthropogenic impact. This is shown in particular by the decrease of amphipod density, average species richness and diversity indexes in the most perturbed sites (e.g. El-Kantaoui). The decrease of number of specimens, when pollution increases, was already observed by Bellan-Santini (1980).

The cluster analysis was in accordance with the classification of meadow status, showing the distinctiveness of El Kantaoui, the most disturbed locality. Furthermore, the highest similarity between stations was recorded in Mahdia indicating more homogeneous amphipod populations (Fig. 2).

The present study suggests that the amphipods are good bioindicator of *Posidonia* meadows quality. The presence/absence and frequency of some species can be considered to underscore the quality of the meadow. *E. punctatus* was the most abundant and frequent species in our samples. It was present in almost all stations with the highest densities in Mahdia. This is also the case of *A. unidentata* and *L. guttatus*. These filter-feeding species (Grassé, 1999) are more abundant and frequent in the low disturbance stations. On the contrary, the grazer species *A. helleri* was present in almost all the stations exhibiting highest density at El Kantaoui; this species consumes epiphytic algae and seems related to photophilic algae more than to the *Posidonia* leaves.

L. websteri, *C. acutum*, *Iphimedia* sp. and *L. longicorne* are found only in El Kantaoui; *C. acutum*, a tube-builder and filter-feeding Amphipod (Grassé, 1999), is a typical species of harbour and silty environments (Conradi and Lopez-Gonzalez, 2001).

This study underscores that amphipods community inhabiting the seagrass *Posidonia* meadow constitutes a useful tool to assess the health status of *Posidonia oceanica* and indirectly the coastal water quality.

Acknowledgments

We thank the MSW committee and MEDPOL for helping the first author to attend the MSW2006.

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This work was supported by the grant of MEDCORE project (ICA3-CT2002-10003) and ARUB