

Study of the effects of Makarska Port (Middle Adriatic) on the changes in benthic algal settlements

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A study of the zero state of benthic algal settlements in the wider area of Makarska Port were carried out in 1991 to provide the basis for forecast of possible effects of intended building of marina in this port.

The study was performed on a total of seven transects, three laid out in the port (zones B and C) and four out of it (zone A) on hard and sediment supralittoral, mediolittoral, infralittoral and partly circalittoral bottoms and a rather large number of additional stations in all the zones of study area (Fig. 1). Direct SCUBA diving method and indirect dredging method on 20-60 m depths were applied.

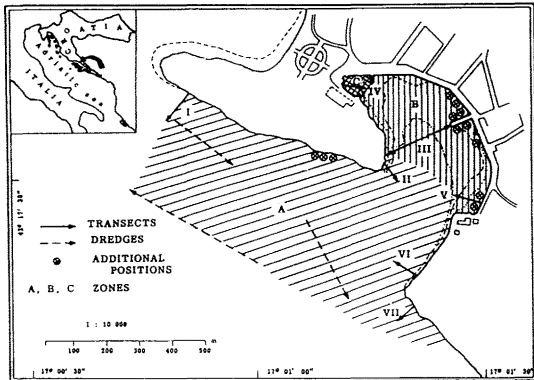


Fig. 1. Study area

A total of 269 taxa of benthic algae were determined: 172 or 63.9% Rhodophyta, 46 or 17.1% Phaeophyta and 51 or 19.0% Chlorophyta (Table 1). Obtained inventory is relatively rich but not typical for clean Middle Adriatic coastal waters. Their qualitative composition and structure resemble those of the settlements in the port areas and adjacent to them, where the numbers and percentages of Chlorophyta exceed those of Phaeophyta. Some earlier studies in different preserved Eastern Adriatic areas regularly reported prevalence of the numbers and percentages of Phaeophyta over those of Chlorophyta.

Of the total of 269 determined taxa, 252 were distributed out of the port (zone A) whereas the number of determined taxa was 130 in the zones B and C, not exceeding 48 taxa in zone C (Table 1). Settlements wherefrom 102 taxa of benthic algae were determined, were formed between 20 and 60 m on detritic-sandy bottoms of the zone A. This is indicative of the fact that they were not exposed to the pollution of the port waters. Marine phanerogams are almost completely absent from the study area; a poor settlement of *Posidonia oceanica* was recorded from 15 m depth at transect V.

Comparing the data on species composition and structure of benthic algal settlements in the Makarska area to those in the Split area (SPAN and ANTOLIC, unpublished results) showed far smaller number of taxa in the latter area (169), 163 in zone A and 48 in zones B and C, and only 25 in zone C (Table 1), even though it is much larger and better seasonally studied area. Presented data show that changes in the benthic algal settlements have the same trend in both study areas, but that their extent and intensity are not so pronounced in Makarska.

To conclude, even though the pollution level in the Makarska port area is lower than in the Split port area its extent caused the regression of benthic algal settlements so that present situation calls for their protection and healing.

Table 1. Numbers (N) and percentages (%) of benthic algae taxa in the wider area of Makarska and Split ports (zones: A - out of the port; B - inside the port; C - special transect in the western most part of the port) and throughout the study area (T)

ZONES:	A		B		C		T	
	N	%	N	%	N	%	N	%
Makarska port								
RHODOPHYTA	164	65.1	83	63.8	27	56.3	172	63.9
PHAEOPHYTA	41	16.3	20	15.4	7	14.6	46	17.1
CHLOROPHYTA	47	18.6	27	20.8	14	29.1	51	19.0
TOTAL	252		130		48		269	
Split port								
RHODOPHYTA	91	55.8	23	51.1	9	36.0	97	57.4
PHAEOPHYTA	35	21.5	9	20.0	1	4.0	35	20.7
CHLOROPHYTA	37	22.7	13	28.9	15	60.0	37	21.9
TOTAL	163		45		25		169	

Note on the biology of *Carcinus aestuarii* (Crustacea, Decapoda, Brachyura) in the Rovinj area

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The Mediterranean shore crab *Carcinus aestuarii* NARDO, 1847 is fairly scarce in the Rovinj area, and only sparse data on its ecology in the area exist (FORSTNER, 1967). Studies of the species in the area had been performed in 1976-1978 at shore in Ruja Cove near the hospital on the Cape Muca (Mucia) (present results), and later in the 1981-1991 period in seagrass beds of Leso (Lesso), Ruja and Saline coves (STEVICIC, in press).

Locality and collecting. In the Ruja Cove the shore crabs were sampled monthly by hand in the intertidal zone during the low tide. 340 specimens were collected in this locality on the following dates:

Date	Males	Females	Date	Males	Females
09. 11. 1976	10	06	19. 07. 1977	17	08
21. 12. 1976	02	04	17. 08. 1977	32	04
17. 03. 1977	11	07	13. 09. 1977	20	19
21. 04. 1977	17	23	27. 09. 1977	18	13
06. 05. 1977	15	11	26. 10. 1977	07	11
24. 05. 1977	13	23	27. 12. 1977	07	01
21. 06. 1977	12	18	06. 04. 1978	06	05

Sex ratio and laterality. Among 340 specimens 187 were males and 153 females. Thus sex ratio is 1,22. The majority of specimens had the right cheliped as the major one (149 males and 104 females). 26 specimens had left cheliped as the major one (12 males and 14 females), whilst only in one case the laterality was indistinct.

Population changes. Specimen abundances varied during the year. Crabs were more frequently observed from April to October, while from October to second part of April the crabs were rare or nearly absent. During the colder period (October-April) an increased number of crabs in the seagrass beds was not observed (STEVICIC, in press), and there was also no indication of their migration into the deeper sublittoral. The crabs were, however, observed to enter the holes in the substrate or galleries (burrowed by themselves or by thalassinids?), and, moreover, digging into the substrate.

Size. Carapace width in males varied from 7,9-48,7 mm, and in females from 11,2-42,8 mm. The Rovinj area shore crabs are relatively smaller in comparison with other Adriatic areas e.g. Venice Lagoon, or mouth of Krka River in Dalmatia (unpublished data).

Habitat. The shore crab prefers a soft sedimentary substrate (FORSTNER, 1967), almost muddy bottom and seagrass beds, in particular where the water is more or less brackish. It occurs as in the intertidal zone, usually under the boulders, as in the shallow sublittoral waters. It is observed, quite unexpectedly, that greater specimens, when emerged during low tide, are nearer to low tide mark, whereas the smaller ones are nearer to the upper tide mark.

Reproductive cycle. Since the crabs are relative rare, usually concentrated in some limited areas, it was impossible to follow their reproductive cycle in its entirety. The ovigerous females were rarely recorded during February, March and September. The copulation occurred in April, when the couples of male and female were observed. From April to May the specimens were often gathered in groups.

Molting period. The specimens with soft integument i.e. immediately after molting were observed relatively often, but usually only one specimen per sample. Only on 21 April 1977 were found 11 moulted (out of 30) specimens, and on 17 August 1977 were found 4 (out of 34) specimens.

Foregut fullness. The foregut (stomach) analysis was performed on 280 specimens, 123 foreguts resulted empty. In the remaining 157 specimens the percentage of foregut fullness is presented in the next table:

Percentage of fullness	No	Percentage of fullness	No
01 - 10	47	51 - 60	5
11 - 20	39	61 - 70	6
21 - 30	16	71 - 80	7
31 - 40	12	81 - 90	13
41 - 50	10	91 - 100	2

Food composition. The analysis of food composition found in the foregut shows that the Rovinj area crab feeds on various food items. The most frequent component of the foregut content was an amorphous organic matter (66 times). Among recognizable parts, bivalve mollusks (almost mussels) were observed 46 times. Polychaetes follow with 32 times. The next group were the decapod crustaceans, predominantly crabs (19). Plant remnants were more rarely identified, various algae (14), whereas higher (vascular) plants were found only once. Gastropods were recorded 11, and polyplacophors 6 times. Among small crustaceans amphipods were found 9 and isopods only three times. Detritus was found 10 times, sand particles 14 times and small stone particles 3 times. These data show that this species is an opportunistic omnivore, that feeds predominantly on sessile and slowly moving animals, whereas quickly moving animals are rarely eaten.

REFERENCES

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