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Changes of algal flora in the Gulf of Trieste (Northern Adriatic Sea)

Abstract

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The aim of this work is to evaluate the long term changes of the marine vegetation in the Gulf of Trieste (North Adriatic Sea) comparing the current status of the algal flora with that of earlier surveys of 30 years ago. The present survey of benthic algae is the result of field studies conducted in the surroundings of Trieste in montly samplings from 1998 to 2000. More recent changes between sixties involve floristic impovereshiment and also the deterioration of Fucales stands.

Introduction

Profound changes in the algal flora have been reported in many regions of the Mediterranean subject to different forms of pressures of anthropical origin and/or to pollution (Munda 2000)..The main causes of these regressions are linked to the littoral urbanization, reflow sewage, uncontrolled development of aquiculture, as well as the loss of habitats (Walker & Kendrick 1988).

The aim of this work is to evaluate the long term changes of the marine vegetation in the Gulf of Trieste (North Adriatic Sea) comparing the current status of the macroalgal flora with that of earlier surveys of 30 years ago.

Methods

The evaluation of the current status of the vegetation has been carried out by means of extensive collections of macroalgae along the rocky shore (natural and artificial) from 9 representative localities of the Gulf of Trieste (Fig. 1). Investigations were carried out monthly from March 1998 to February 1999. Algal samples were collected by means of herbarization and by means of a 1/4 m2 frame, within which the substratum was scrubbed clean. The samples were then fixed in a 4% formaldehyde sea water solution for taxonomic identification.

The evaluation of long term changes of the marine vegetation has been carried out comparing Pignatti & Giaccone (1967) floristic list with that drawn in the present study. To make comparisons data available, scientific names of the two floristic lists were brought up following Funari & al. 1999.

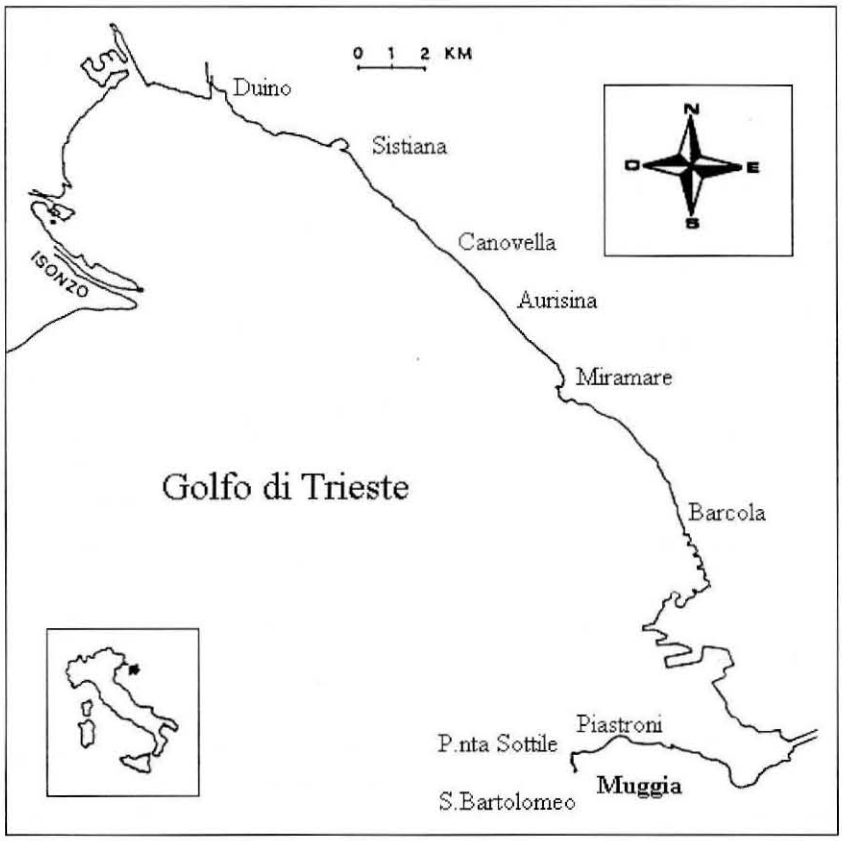

Fig. 1. Sampling sites.

From the comparison of the two lists Cyanobacteria were excluded from Pignatti & Giaccone (1967) work and have not been discussed in the present research. Encrusting Corallinales have partially been dealt in the comparison since their determination is currently under study.

An herbarium kept at the Department of Biology of the University of Trieste, and a databank were set up.

Results

The floristic analysis of the collected samples has led to the overall identification of 207 taxa of which 136 *Rhodophyceae*, 38 *Phaeophyceae* and 33 *Chlorophyceae*.

In Table 1 the number of species listed in the 1967 work (excluding the encrusting Corallinales) and those collected in the present research is reported. In Table 2 the number of encrusting algae, determined in the two subsequent studies, is indicated; thus, it is reminded that the determination of these species has not been completed yet.

From the comparison of the two floristic lists (Falace 1999) it has resulted that 134 taxa

Table 1. Number of species (excluding the encrusting *Corallinales*).

	Pignatti & Giaccone, 1967	Falace, 1999
N° of species	241	205
Taxa inquirenda	4	-
TOTAL	245	205
Exclusives 1967	113	-
Exclusives 1999	-	74

Table 2. Encrusting *Corallinales*.

	Pignatti & Giaccone, 1967	Falace, 1999
N°of specie	12	2
Taxa inquirenda	1	-
TOTAL	13	2

Table 3. Phytogeographical elements.

	C	*A*	*IA*	*M*	*AP*	*P*	*CBA*	*IP*
1967	32,4%	25,7%	17,4%	14,2%	3,9%	3,2%	0,4%	2,8%
1999	35,2%	23,9%	17,9%	10,7%	4,6%	5,1%	1,5%	1,0%

C = Cosmopolite, A = Atlantic, IA = Indo-Atlantic, M = Mediterranean, AP = Atlanto-Pacific, P = Pantropical, CBA = Austral - Circumboreal, IP = Indo-Pacific.

(41,74%) are common to both floras, 113 (35,20%) were not found, 74 (23,05%) were newly found. Therefore the change and the evolution of seaweeds flora occurred in the last thirty years are remarkable (58,25% with 1,82% yearly value). Of the 74 taxa reported in the present research, which do not appear in Pignatti and Giaccone (1976) list: 58 species have already been reported previously in the Gulf of Trieste or in others areas of the the North Adriatic by other authors (in Furnari & al. 1999), 6 have been determined only at genera level and 9 have never been reported. The species signaled for the first time are: *Halymenia elongata* C. Agardh, *Calosiphonia dalmatica* (Kützing) De Toni, *Lomentaria orcadiensis* (Harvey) Collins ex Taylor, *Chondria scintillans* Feldmann, *Lophosiphonia cristata* Falkenberg, *Lophosiphonia reptabunda* (Suhr) Kylin, *Spermatochnus paradoxus* (Roth) Kützing, *Hydroclathrus clathratus* (Bory ex C. Agardh) Howe, *Enteromorpha multiramosa* Bliding.

On the basis of the nomenclatural revisions the percentage of phytogeographical elements have been calculated (Table 3). The comparison of percentage values of the calculated phytogeographical elements shows in both floras the prevalence of the Cosmopolitan, Atlantic and Indo-Pacific element, with percentages very close to one another. It is however possible to find a reduction of the Mediterranean element, represented in the 1967 flora, mainly by the Fucales.

Discussion

In the Gulf of Trieste environmental stresses have profoundly changed the benthic algal vegetation in terms of floristic diversity and leading algal associations patterns. The present

research has in fact enabled to highlight a decrease in the number of species by 20% compared to that reported in 1967 (from 258 to 207 species).

The most significative reduction has been recorded amongst the *Phaeophyceae* (28%) and the *Chlorophyceae* (27%). The groups were the significative differences and the greatest reduction in number of species were noted are for the *Phaeophyceae* the *Ectocarpales* and the *Fucales*, for the *Chlorophyceae* the *Cladophorales*. For the *Rhodophyceae* the most evident differences are in the group of the *Bangiophycideae* and *Corallinales*.

Particularly the reduction in number of *Ectocarpales* and *Cladophorales* pointed out in the present research, may be linked to the concomitant reduction/disappearance of erect thallus algae and in particular of the big size *Phaeophyceae* of which they are often epiphyte.

The disappearance of this populations completely changed the physiognomy of the vegetation in the Gulf of Trieste. *F. virsoides* persist only in some sheltered and undisturbed stations of the Gulf, with reduced stands. The *Cystoseira* species occurred in patches or on single specimens in remote localities. Also other Phaeophyceae, once common in the Gulf, such as *Padina pavonica* (Linnaeus) J. V. Lamouroux, *Dictyopteris polypodioides* (A.P. De Candolle) J.V. Lamouroux or *Dictyota spp.*, occurred in some places scattered in small patches.

Characteristic assemblages found throughout the investigated coasts are perennial turf-like mats of *Gelidium*, *Gelidiella* and *Pterosiphonia* species. Moreover in the northern area of the studied littoral, lower down the sublittoral, bare slopes grazed by sea-urchins, are usual and caused a total deterioration of the vegetation, with some remnants of crustose coralline algae.

A further phenomenon observed, which could be related to the increased turbidity of the North Adriatic waters, is the upwards migrations of several species from the lower sublittoral to the higher sublittoral fringe (e.g. *Halimeda tuna* (J. Ellis & Solander) J. V. Lamouroux, *Flabellia petiolata* (Turra) Nizamuddin).

Conclusion

During the last 3 decades the benthic algal vegetation of the Gulf of Trieste has changed mainly as a result of a combination of environmental stress and human interference (i.e. the imputs of sewage, increasing of the aquiculture, variations of the coastal belt) causing pollution, eutrophication, loss of habitats. The degradation of macroalgal flora may have been the result of a complex interplay of the several ecological factors mentioned above as well as long term changes in abiotic environmental parameters, such as currents, hydrographyc factors, sedimentation and sand movements, which are related to general climatic changes that are particularly severe in the unstable environment of the North Adriatic Sea (Munda 2000). In addition to this the cyclical and unpredictable perturbations must be added due to biotic interference like sea-urchin grazing.

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