Mediterranean Marine Science

Vol 2, No 1 (2001)

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doi: 10.12681/mms.276

Mediterranean Marine Science
Vol. 2/1, 2001, 57-67

The *Cystoseira* spp. Communities from the Aegean Sea (NE Mediterranean)

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Manuscript received: 21 June 1999; accepted in revised form: 1 March 2001

Abstract

A synthetic study of qualitative and quantitative data from some algal communities dominated by different species of the genus Cystoseira has been carried out in three coastal areas of the Aegean Sea. Seasonal samples were taken from 10 stations and a list of 30 species presenting coverage values > 1% was compiled. Ecological indices, such as Shannon Diversity Index, Pielou Eveness and Bray-Curtis Similarity Index were calculated using the PRIMER software. The results from the Aegean Sea were compared with other Mediterranean areas, and the use of Cystoseira communities as ecological quality indicators was discussed.

Keywords: *Cystoseira,* Phytobenthos, Aegean Sea, NE Mediterranean.

Introduction

The genus *Cystoseira* C. Agardh (Fucales, Fucophyceae), is a taxon with a worldwide distribution. Nevertheless, about 80% of the species occur along the Mediterranean and the adjoining Atlantic coasts (ROBERTS, 1978). Especially in the upper infralittoral zone (0-1m depth) of the Mediterranean coasts, the species of the genus *Cystoseira* are usually the dominant element of the benthic vegetation on unpolluted hard substratum and the *Cystoseira* algal community is considered as the final stage (climax) in a succession of photophilic algal communities (PERES & PICARD, 1964). Thus, it is worth examining if the presence of *Cystoseira* species could be used as a coastal water quality indicator in the sense of the European Union Commission (EU, 1994). Also in the frame of the "habitat" Directive (92/43/EEC), it is worth examining if the different species of the genus *Cystoseira* could be used for a better definition of the NATURA 2000 habitat code 1170, on the Mediterranean coasts (ARIANOUTSOU *et al.,* 1996; PANAYOTIDIS &

DRAKOPOULOU, 2000).

The *Cystoseira* communities of the NW Mediterranean are relatively well known (MOLINIER, 1960ab; BOUDOURESQUE, 1969; GIACCONE & BRUNI, 1972-1973; BALLESTEROS, 1984, 1988, 1990; VERLAQUE, 1987). HUVE (1972) described the distribution of some *Cystoseira* species in the Aegean and the present study is a new contribution to the knowledge of the *Cystoseira* communities of the NE Mediterranean.

Materials and Methods

The study area

Three sampling areas were chosen at the upper infralittoral zone (0-1m depth) in the Aegean Sea (Fig. 1), in order to compare several coastal environments under different hydrodynamic conditions. Coastal environments presenting extremely high hydrodynamic conditions were avoided. Three stations (K1, K2 and K3) are located in Kalloni Bay, a semi-enclosed Aegean embayment on Lesbos Island. Station K1 is located at the entrance of the bay and is more exposed than K2, which is located at the central part and K3 at the inner and more sheltered part. Three stations (O1, O2 and O3) are located in the Orei channel, which connects the North Euvoikos Gulf with the Aegean Sea, presenting a gradient of hydrodynamic conditions. Station O1 is located in a position facing towards the open sea, O2 is located in the central part

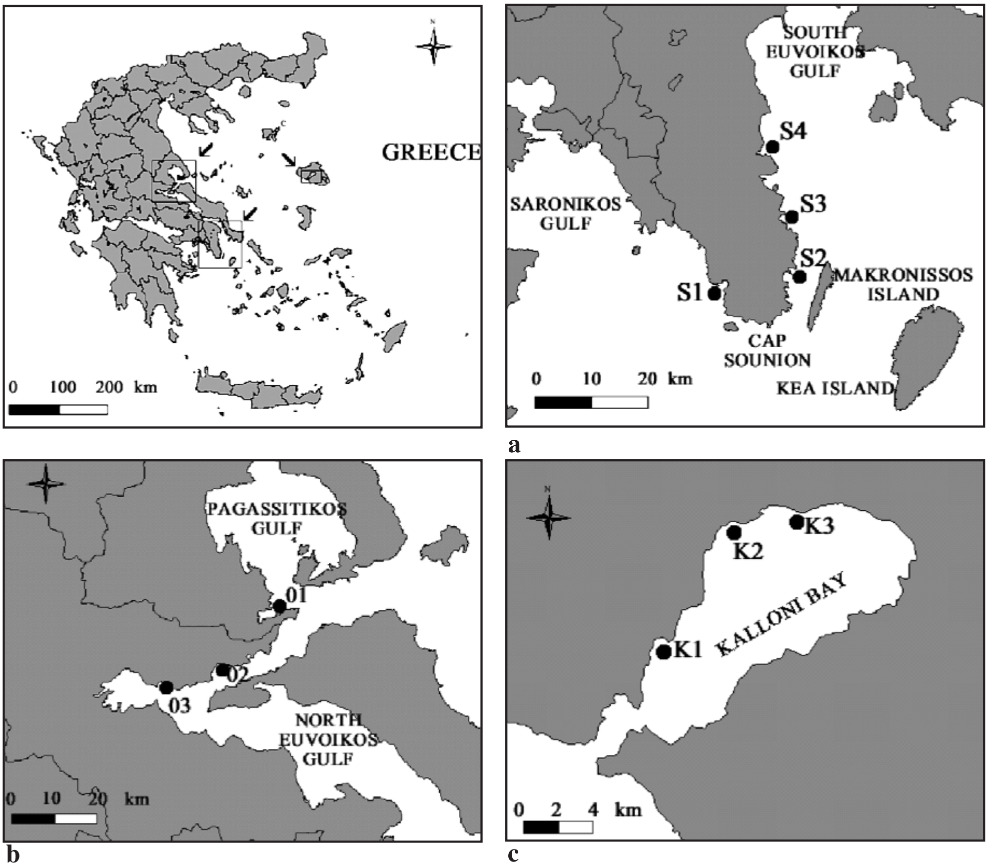

Fig. 1: The study areas.
a: Cape Sounio, b: Orei channel, c: Kalloni Bay.

and O3 is located in the inner -more sheltered- part of the channel. Finally, four stations (S1, S2, S3 and S4) are located on the perimeter of Cape Sounion, an area exposed to relatively high hydrodynamic conditions, gradually decreasing from Station S1 to Station S4.

Samplings, algal taxonomy and statistical analysis

The source publications, the positioning of the sampling stations and the sampling period are presented in Table 1. The data used in the present paper were always collected and analyzed using the same methodology, which is described *in extenso* in the source publications and could be summarised as following:

1) The sampling was destructive, on a quadrate 20cm X 20cm (400 cm^2), which is considered to be the minimal sampling area for the infralittoral communities of the Mediterranean (DHONT & COPPEJANS, 1977; BOUDOURESQUE & BELSHER, 1979).

2) The identification of the marine algae was carried out at the Biodiversity Laboratory of the National Center for Marine Research in Athens, following the classification and authorities proposed by RIBERA *et al.* (1992) for the Fucophyceae, GALLARDO *et al.* (1993) for the Chlorophyceae and ATHANASIADIS (1987) for the Rhodophyceae.

3) The quantitative study was performed according the methodology proposed by BOUDOURESQUE (1971a) and developed by VERLAQUE (1987). Each sample was carefully sorted and the surface covered by each species, in horizontal projection, was quantified in cm^2. These values of absolute coverage were also expressed as coverage of the sampling surface (4 cm^2 = 1% of the sampling surface). As the coverage values can exceed 100%, the data were also standardized, expressed as percentage coverage.

4) The calculation of ecological indices was based on absolute coverage measurements, a methodology adapted to the phytobenthos by BOUDOURESQUE (1971a) and FRONTIER (1983). The Diversity Index (H') was calculated according to SHANNON & WEAVER (1963), the Evenness Index (J') according to PIELOU (1969) and the Similarity Index (S), according to BRAY & CURTIS (1957). Calculations were performed using the PRIMER software (CARR, 1997). A similarity matrix was also performed without transformation of the data, using the Group Average linkage as criteria. A dendrogram and a projection on the horizontal plane by Multi Dimensional Scaling (MDS) were depicted according to UNEP (1992) methodology.

Table 1
Sampling areas, position of stations, sampling periods and source of data.

Sampling areas	Stations	Position	Sampling period	Source of data
Cape Sounion	S1	37^0 42' 56.62" N - 230 55' 23.51" E	9/96, 2/97, 5/97	PANAYOTIDIS &
	S2	37^0 44' 27.48" N - 240 4' 52.44" E		CHRYSSOVERGIS, 1998
	S3	37^0 49' 2.19" N - 240 2' 58.19" E		
	S4	37^0 55' 20.53" N - 240 0' 21.72" E		
Orei channel	O1	39^0 1' 37.88" N - 220 58' 9.23" E	3/92, 9/92, 2/93, 7/93	CHRYSSOVERGIS &
	O2	38^0 55' 13.60" N - 220 55' 23.87" E		PANAYOTIDIS, 1995
	O3	38^0 52' 59.26" N - 220 42' 22.32" E		
Kalloni Bay	K1	39^0 7' 51.73" N - 260 7' 11.48" E	6/95, 3/96	PANAYOTIDIS
	K2	39^0 11' 59.43" N - 260 10' 22.62" E		*et al.,* 1999
	K3	39^0 11' 44.01" N - 260 16' 16.53" E		

Results and Discussion

Floristic aspects

Table 2 presents the species with Coverage values >1 %. Nine of them belong to the genus *Cystoseira*, which is the dominant element of the studied algal communities.

The distribution and autoecology of the *Cystoseira* species

The nine species of the genus *Cystoseira* found in the study areas are the following:

1) The species *Cystoseira barbata* C. Agardh var. *barbata*. This species is an important element of upper infralittoral benthic vegetation in semi enclosed bays and even in small fishing ports (ERCEGOVIC, 1952; GIACCONE & BRUNI, 1972-1973). Thus, it is considered to be the most sensitive to hydrodynamic conditions (wave energy). For this reason HUVE (1972) reports *C. barbata* as a rare species at the upper infralittoral zone of the Aegean archipelagos, where the wave energy is usually very high.

2) The species *Cystoseira barbatula* Kutz. (=*C. graeca*, Schiffn. *ex* Gerloff & Nizamuddin), is known as a characteristic element of the benthic vegetation of unpolluted coasts with moderate wave energy (CORMACI *et al.,* 1992).

3) The species *Cystoseira brachycarpa* J. Agardh *emend*. Giaccone, var. balearica (Sauv.) Giaccone (= *C. caespitosa* Sauv.), is known as an important element of infralittoral benthic vegetation, always in sheltered and unpolluted waters (BALLESTEROS, 1990).

4) The species *Cystoseira compressa* (Esper.) Gerloff & Nizamuddin f. *compressa*, which is synonymous with *C. fimbriata* (Desf.) Bory, is known as an important element of infralittoral benthic vegetation, very tolerant of hydrodynamic conditions (HUVE, 1972). Nevertheless, the same author reports from the Aegean that *C. compressa* is tending to be replaced by *C. corniculata* in exposed stations and by *C. crinita* in sheltered stations.

5) The species *Cystoseira corniculata* (Wulfen) Zanardini, is reported from the Aegean by HUVE (1972) as an important element of infralittoral benthic vegetation in stations with high, but not direct, wave energy (oscillating zone).

6) The species *Cystoseira crinita* (Desf.) Bory f. *crinita*, is also reported from the Aegean by HUVE (1972) as an important element of infralittoral benthic vegetation, in exposed as well as in sheltered stations. ERCEGOVIC (1952) considers *C. crinita* as a species tolerant of the wave energy.

7) The species *Cystoseira crinitophylla* Ercegovic is not a common element of benthic vegetation, (ATHANASSIADIS, 1987). According to ERCEGOVIC (1952), its habitat requirements are similar to *C. crinita.*

8) The species *Cystoseira mediterranea* Sauv. var. *mediterranea*, is known as the dominant element of upper infralittoral benthic vegetation on the exposed Mediterranean coastal areas (BOUDOURESQUE, 1969; BALLESTEROS, 1988).

9) The species *Cystoseira schiffneri* Hamel, which is synonymous with *C. discors* (L.) C. Agardh f. *discors*, common in the Aegean Sea, is reported from sheltered habitats of the upper infralittoral zone (ATHANASSIADIS, 1987). The specimens found in the present study correspond with *C. schiffneri f. latiramosa*.

Structure of the vegetation

According to the results of the studied *Cystoseira* communities the most important floristic elements (Table 2) are the erect photophilic species covering the free space between *Cystoseira* thalli. The most constant and dominant species of this group are the brown algae *Sphacelaria cirrosa, Halopteris*

Table 2
Algal species from *Cystoseira* spp. communities presenting mean percentage coverage >1%.

Sampling station	Species with percentage coverage >1%
S1	*Cystoseira crinitophilla (42.4 %), Cystoseira mediterranea (2.2 %), Caulerpa racemosa (7.4%), Sphacelaria cirrosa (15.7%), Halopteris scoparia (4.4%), Haliptilon virgatum (8.7%), Hydrolithon farinosum (1.3%), Jania rubens (5.1%), Dasya corymbifera (1.1%), Dipterosiphonia rigens (1.1%)*
S2	*Cystoseira crinitophilla (2.5 %), Cystoseira corniculata (46.6 %), Cystoseira compressa (11.8 %), Cystoseira brachicarpa (9,1 %), Sphacelaria cirrosa (12.9%), Dilophus sp. (5.5%), Padina pavonica (1.1%), Haliptilon virgatum (1.8%), Hydrolithon farinosum (1.5%), Pneophyllum lejolisii (1.0%), Jania rubens (1.8%)*
S3	*Cystoseira compressa (4.3 %), Cystoseira crinita (39.7 %), Cystoseira crinitophylla (1.4%), Anadyomene stellata (2.1%), Sphacelaria cirrosa (14.7%), Dilophus sp. (5.4%), Padina pavonica (1.1%), Haliptilon virgatum (4.5%), Hydrolithon farinosum (1.9%), Pneophyllum lejolisii (1.4%), Jania rubens (1.7%), Ceramium codii (1.1%), Herposiphonia secunda (2.3%), Rhytiphlaea tinctoria (7.9%)*
S4	*Cystoseira barbata (22.3 %), Cystoseira barbatula (12.4 %), Cystoseira compressa (20.3 %), Cystoseira crinita (24.8 %), Cystoseira crinitophilla (6.2 %), Cladophora sp. (1.2%), Sphacelaria cirrosa (1.2%), Haliptilon virgatum (2.9%), Hydrolithon farinosum (2.5), Jania rubens (1.2%)*
O1	*Cystoseira barbata (6.1 %), Cystoseira corniculata (69.9 %), Anadyomene stellata (1.9%), Valonia utricularis (2.9%), Dasycladus vermicularis (1.4%), Sphacelaria cirrosa (17.5%), Halopteris scoparia (3.3%), Dictyota linearis (2.7%), Dilophus sp. (1.2%), Padina pavonica (5.5%), Haliptilon virgatum (3.8%), Hydrolithon farinosum (7.1%), Jania rubens (4.8%), Titanoderma sp. (1.8%), Peyssonnelia sp. (2.0%), Ceramiun gracillimum (1.3%)*
O2	*Cystoseira barbata (15.0 %), Cystoseira compressa (8.8 %), Ulva rigida (1.9%), Cladophora sp. (2.2%), Valonia utricularis (1.3%), Dasycladus vermicularis (3.6%), Sphacelaria cirrosa (18.1%), Halopteris scoparia (1.9%), Dictyota linearis (2.9%), Padina pavonica (13.3%), Pterocladiella capillacea (7.3%), Haliptilon virgatum (2.9%), Hydrolithon farinosum (9.4%), Pneophyllum lejolisii (1.1%), Jania rubens (2.3%), Titanoderma sp. (1.3%), Anotrichiumtenue (1.1%), Dasya corymbifera (1.3%), Herposiphonia secunda (1.6%), Laurencia obtusa (10.3%), Lophosiphonia sp. (1.1%), Polysiphonia sp. (1.5%)*
O3	*Cystoseira barbata (43.8 %), Cystoseira compressa (1.3 %), Ulva rigida (2.0%), Ectocarpus sp. (1.8%), Sphacelaria cirrosa (4.5%), Padina pavonica (3.4%), Pterocladiella capillacea (4.3%), Hydrolithon farinosum (2.7%), Pneophyllum lejolisii (1.1%), Spyridia filamentosa (8.8%), Laurencia obtusa (3.7%), Polysiphonia sp. (2.2%)*
K1	*Cystoseira barbata (17.6 %), Cystoseira crinita (56.5 %), Enteromorpha sp. (6.4%), Cladophora sp. (4.8%), Halopteris scoparia (15.5%), Padina pavonica (10.9%), Jania rubens (4.7%)*
K2	*Cystoseira barbata (44.7 %), Cystoseira crinita (32.3 %) Cladophora sp. (2.9%), Halopteris scoparia (5.4%), Padina pavonica (13.5%), Polysiphonia sp. (1.2%)*
K3	*Cystoseira barbata (25.4 %), Cystoseira crinita (22.4 %)Enteromorpha sp. (7.5%), Ulva rigida (6.5%)*

scoparia, Padina pavonica and *Dictyota spp.*, the red algae *Jania* spp., *Haliptilon virgatum* and *Laurencia obtusa*, as well as the green algae *Anadyomene stellata, Valonia utricularis* and *Dasycladus vermicularis*. Under low hydrodynamic conditions (stations dominated by *C. barbata*), the free space between *Cystoseira* thalli is usually covered by fine sediments, unfavorable for algal installation. Eutrophication indicator species (e.g. *Ulva, Enteromorpha* and *Cladophora* species) are usually present. At stations dominated by *C. corniculata*, a species forming a pillow-like stratum on the rock, the above - mentioned erect photophilus species are rare and the community contains only encrusting sciaphilic species and small epiphytes.

The most common encrusting sciaphilic species, fixed on the substratum under *Cystoseira* thalli, are the red algae and *Titanoderma* sp. and *Peyssonnelia* sp.

As far as the epiphytes on *Cystoseira* thalli is concerned, they are mainly red algae, encrusting algae such as *Hydrolithon farinosum, Pneophyllum lejolisii* but also filamentous brown algae (mainly Ectocarpales), and green algae (mainly *Cladophora* spp.), as well as small erect red algae species (mainly Ceramiales). Apart from the species *Hydrolithon farinosum, Pneophyllum lejolisii*, the epiphytes are seasonal elements of the *Cystoseira* communities: the Ectocarpales are abundant during spring and the Ceramiales during autumn.

Phytosociological aspects

Cystoseira communities are determining the physiognomy of Mediterranean benthic vegetation. GIACCONE & BRUNI (1972-1973), based on numerous regional surveys (FUNK, 1927; FELDMANN, 1937; MOLINIER, 1960; PIGNATTI, 1962; GIACCONE & PIGNATTI, 1967, BOUDOURESQUE, 1971B; GIACCONE, 1968, 1971), proposed three phytosociological associations for *Cystoseira* communities of the upper infralittoral zone of the Mediterranean coasts:

Class *Cystoseiretea* Giaccone 1965
Order *Cystoseiretalia* Molinier 1958
Alliance *Cystoseireton crinitae* Molinier 1958

1. *Cystoseiretum strictae* Molinier, 1958.

Under high hydrodynamic conditions with *C. stricta* (= *C. amentacea* var. *stricta*) as the characteristic species in the Western Mediterranean basin and *C. mediterranea* and *C. amentacea* var. *amentacea* in the Eastern basin.

2. *Cystoseiretum sauvageauanae* Giaccone, 1972.

At the oscillating zone, with *C. sauvageauana* as the characteristic species in the Western Mediterranean basin and *C. corniculata* in the Eastern basin.

3. *Cystoseiretum crinitae* Molinier, 1958.

Under moderate hydrodynamic conditions, with *C. crinita* as the characteristic species for the whole Mediterranean basin, combined with *C. crinitophylla* or *C. barbata* under moderate high or low wave energy, respectively. Nevertheless, PIGNATTI (1962) proposed, for the Venice lagoon, a separate association (*Cystoseiretum barbatae*) in order to describe the community dominated by *C. barbata*.

Actually, some authors consider *Cystoseiretum barbatae* Pignatti as a separate association (VERLAQUE, 1987) and others as a poorish aspect of *Cystoseiretum crinitae* Molinier (GIACCONE & BRUNI, 1972-1973). We consider that the description of the *Cystoseiretum barbatae* by PIGNATTI (1962) in the Venice lagoon does not match the description of our stations which present the important relative dominance of *C. barbata* (e.g. O2), although some other stations (e.g. O3, K2 and K3) are rather close. Thus, we will use the term *"Cystoseiretum barbatae"* only to describe the grouping of our stations regarding wave energy, but we will consider as typical *Cystoseiretum crinitae* examples, cases like station O2, in which *C. crinita* is absent.

Table 3
Minimum and maximum values of some ecological indices of *Cystoseira* communities in the Aegean Sea and in the Western Mediterranean.

Algal community	Number of species (N)	Coverage (C%)	Diversity Index (H')	Evenness (J')	Sampling Station or reference
	28-41	-	2.7-3.6	0.55-0.70	BOUDOURESQUE, 1969
Cystoseiretum strictae	28-51	-	2.1-3.4	0.44-0.60	BELSHER, 1977
Molinier	22-36	144-252	2.2-3.1	0.45-0.69	S1
Cystoseiretum	18-20	97-175	1.9-2.3	0.44-0.56	S2
sauvageauanae Giaccone	32-45	138-195	2.5-3.9	0.47-0.72	O1
	40-76	-	2.5-3.4	-	BALLESTROS, 1984
Cystoseiretum crinitae	35-50	120-186	3.1-4.0	0.56-0.79	O2
Molinier	14-34	93-154	1.3-1.6	0.34-0.70	S3
	14-16	134-167	1.5-2.9	0.41-0.71	S4
	20-28	231-415	1.6-2.2	0.38-0.51	K1
Cystoseiretum barbatae	29-40	67-157	1.9-4.0	0.39-0.51	O3
Pignatti	21-23	168-354	1.1-2.0	0.26-0.43	K2
	19-23	222-350	1.3-2.5	0.29-0.51	K3

Ecological quality indices

As indices of the ecological quality of the studied algal communities, we will consider the number of species per sampling, the coverage, the diversity index and the evenness, although they present great variation among the algal communities and even in the same community (PANAYOTIDIS, 1981). Nevertheless, the spatial and temporal variations as well as the limits of these variations are widely used as valuable indices of the ecological profile of an algal community (CORMACI & FURNARI, 1991; CHRYSSO-VERGIS, 1995; PANAYOTIDIS *et al.*, 1999).

Table 3 presents the variation limits of the number of species (N), the coverage (C), the diversity index (H') and the evenness (J') values in the 10 studied stations together with values from other *Cystoseira* associations studied in the Western Mediterranean. According to these results the algal communities dominated by *Cystoseira* species are characterized by important coverage, relatively high number of species per sample, but low diversity index and evenness, compared with other algal communities (PANAYOTIDIS, 1981; MARCOT-COQUEGNIOT, 1986; VERLAQUE, 1987). This contradictory result is due to the fact that, apart from the *Cystoseira* species, only few other species present important coverage. Thus, there is a negative correlation between the total coverage of the genus *Cystoseira* species per sample and the diversity values. In the three studied areas, stations dominated by *C. barbata* presented lower diversity and evenness values than the others, with the exception of O2. PANAYOTIDIS & CHRYSSOVERGIS, (1998) suggested that, under low hydrodynamic conditions, fine sediments usually accumulate on the rocky substratum inhibiting the development of macrobenthic algal vegetation. Under extreme invasive conditions only *C. barbata* resists, but the coverage remains high due to the "leafy" thalli of this species (e.g. station K3). Usually, 3-4 species of macroalgae cover the substratum and the ecological indices are low, with the exception of evenness (e.g. station S4). In the case of narrow channels, where the wave energy is low but the presence of currents avoids the deposition of fine sediments, rich and well-diversified macroalgal vegetation is developed, together with *C. barbata* (e.g. station O2).

According to our results, the benthic vegetation of the stations K1 and S3, together with K3, K2, O3 and S4, but also O2 could be considered as examples of *Cystoseiretum crinitae* Molinier. In this large group, the stations O3, K2 and mainly K3 are very close to *Cystoseiretum barbatae* Pignatti. The vegetation of stations O1 and S2 could be considered as a typical *Cystoseiretum sauvageauanae* Giaccone and finally, station S1 has the characteristics of a *Cystoseiretum strictae* Molinier, but we could not consider this case as a typical example.

BELSHER (1977) in a study of the photophilic vegetation of the upper infralittoral zone on the French Riviera, proposed a range from 0.5 to 0.7 for evenness. If we could consider these values as representative for the Mediterranean vegetation of the upper infralittoral zone, the observed values of evenness in our study are below these margins for the most of the *Cystoseiretum barbatae* stations and some of the *Cystoseiretum crinitae* stations and within the margins in the case of the *Cystoseiretum sauvageauanae* stations. In the frame of the

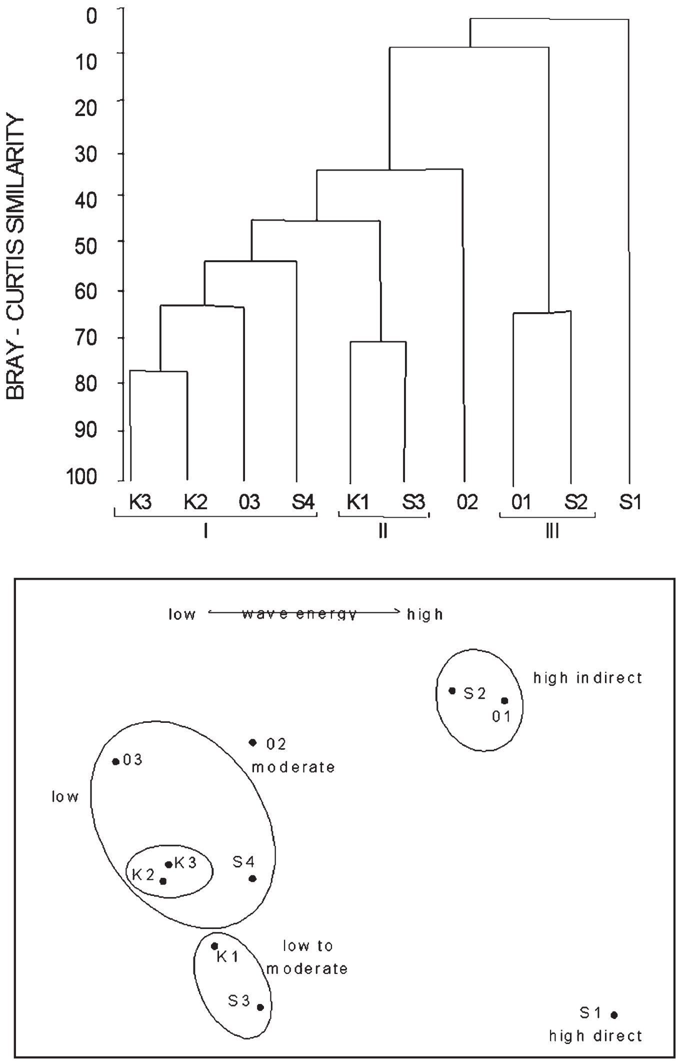

Fig. 2: Bray-Curtis Similarity Clustering and MDS plots of the studied stations in the Aegean Sea.

present study, there is no typical example of a *Cystoseiretum strictae*, but the results from S1 are close to the margins proposed by BOUDOURESQUE (1969) and BELSHER (1977) for this algal community.

The similarity matrix, based on the coverage values of the *Cystoseira* species, was used for the performance of the hierarchical clustering of the stations. The obtained dendrogram presents three clusters at the 50% similarity level (Fig. 2). The first cluster groups together the stations K2, K3, O3 and S4, which are dominated by *C. barbata*. The second cluster groups together the stations K1 and S3, which are characterized by the presence of *C. crinita*. The third cluster groups together the stations O1 and S2 which are dominated by *C. corniculata*. At the MDS of these results (Fig. 2), stations S1, S2 and O1 are placed in the right section of the diagram and all the others in the left section. Thus, we could consider that the placing of the stations on this diagram reflects a decrease of hydrodynamism from left to right, and from the top to the bottom it reflects the type of the wave energy (indirect to direct).

Conclusions

The studied *Cystoseira* species have well defined habitats at the upper infralittoral zone. According to our results, the studied species of *Cystoseira* could be considered as indicator species of unpolluted waters, with the exception of *C. barbata* which seems to be tolerant of moderate eutrophication conditions. Nevertheless, the indication of the ecological quality given by each species (or group of species) of the genus *Cystoseira*, is not the same. Environmental parameters, such as hydrodynamic conditions, have to be used in order to define comparable groups of species.

Thus, the studied *Cystoseira* species could be divided into three groups, reflecting three different levels of hydrodynamic conditions. Based on Bray-Curtis similarity results, we could distinguish a) the group which is dominant at the low to moderate-low wave energy stations (*C. barbata, C. barbatula, C. brachycarpa* and *C. schiffneri*), b) the group which is dominant at the moderate wave energy stations (*C. crinita,* and *C. compressa*), c) the group which is dominant at the high to moderate-high wave energy stations (*C. crinitophylla, C. corniculata* and *C. mediterranea*).

As far as the phytosociological character of the studied algal communities is concerned, the most common association is the *Cystoseiretum crinitae* Molinier. In the studied areas of the Aegean Sea the species *C. crinita* presents a large ecological potential, covering the infralittoral rocky substrata under moderate-high as well as under moderate-low hydrodynamic conditions. Nevertheless, the aspect of *Cystoseiretum crinitae* is not the same along a hydrodynamic gradient. The increase of the relative dominance of *C. barbata*, together with the decrease of some ecological indices - such as the number of species per sampling and the diversity index - make the difference between a *Cystoseiretum crinitae* under moderate-low or moderate-high conditions.

The studied algal communities are characterized by important coverage, relatively high number of species per sampling, but low diversity index and evenness, due to the fact that, apart from the *Cystoseira* species, only few other species present important coverage. These species cover the free space between *Cystoseira* thalli. The most constant and dominant elements of the community are the brown algae *Sphacelaria cirrosa, Halopteris scoparia*, and *Padina pavonica*, as well as the red algae *Haliptilon virgatum* and *Jania rubens*.

There is a negative correlation between the total percentage coverage of *Cystoseira* species per sampling and the respective diversity index and evenness values. Thus, in the case that these indices are used as ecological descriptors, compact *Cystoseira* communities have to be avoided in the sampling strategy. Comparison of ecological indices between different *Cystoseira* communities has also to be avoided, because a *Cystoseiretum barbatae* usually presents lower number of species per sampling, as well as diversity index and evenness values, compared with a *Cystoseiretum crinitae* and even lower compared with a *Cystoseiretum strictae*.

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