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The epiflora of a rhodolith bed from the Island of Ustica (Southern Tyrrhenian Sea)

Abstract

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The results of a study carried out on the epiflora of a rhodolith bed from the Ustica Island Marine Reserve (Mediterranean Sea) are herewith presented. A list of 117 taxa at specific and infraspecific level (4 *Cyanophyceae*, 80 *Rhodophyceae*, 8 *Ulvophyceae*, 2 *Chlorophyceae* and 23 *Phaeophyceae*) has been obtained, among which *Alsidium corallinum* C. Agardh is a new record for the Island of Ustica. Among Rhodophyceae, eight rhodolith-forming taxa have been recognised; *Lithophyllum*, *Lithothamnion*, *Neogoniolithon* and *Phymatolithon* were the predominant genera. The calculated Rhodophyceae/Phaeophyceae index value of 3.5 shows evidence of the high abundance of the red algae and of the subtropical character of this flora.
The floristic composition of this rhodolith bed could suggest the presence of the facies commonly known in the Western Mediterranean as "Free Melobesiae", of which the *Phymatholitho-Lithothamnietum corallioidis* association (Giaccone 1965) Giaccone 1994 represents the typical aspect. Moreover, the transitional position of this community, probably due to a locally occurring combination of both climatic and edaphic factors, has been demonstrated.

Introduction

Circalittoral soft bottoms, influenced by laminar currents (horizontal currents with very low vertical mixing), are usually colonised by benthic macro-algal communities, called "rhodolith beds", whose accumulation produces characteristic calcareous deposits.

These communities are dominated by free-living structures composed mostly of non-geniculate coralline algae (*Corallinaceae*, *Rhodophyceae*), living or dead, and referred to as "rhodoliths". A rhodolith can be composed entirely of a non-geniculate coralline alga or can present a core of sandy granules or shells with a more or less regular and concentric growth around them.

Light and water motion constitute the main factors influencing the distribution of rhodolith-forming species; however, grazing, burial, fouling, competition (e.g. with corals and sponges) and bioturbation (rolling of rhodoliths due to movements of crustaceans and fishes) are also regarded as important influencing elements, affecting their form, shape and

size (Bosellini & Ginsburg, 1971; Adey & MacIntyre, 1973; Basso, 1992; Di Geronimo & Giaccone, 1994; Foster, 2001).

This community usually colonises, with different taxa, shallow subtidal waters and it is found too in coastal lagoons (Calvo & al., 1982) but never in brackish areas. It is widely distributed from the Arctic to the Tropics; in the Northeast Atlantic this community is found mostly concentrated on the Western European coasts, from the Canaries and Madeira to the Arctic (Adey & Adey, 1973; Cabioch, 1974; Alfonso-Carrillo & Gil-Rodriguez, 1982; Littler & al., 1991).

In the Western Mediterranean this community, commonly known as "Free Melobesiae", forms the *Phymatholitho-Lithothamnietum corallioidis* association (Giaccone 1965) Giaccone 1994, whose main coralline algae are *Phymatolithon calcareum* (Pallas) W. H. Adey & D. L. McKibbin and *Lithothamnion corallioides* (P. L. & H. M. Crouan) P. L. & H. M. Crouan. According to Pérès & Picard (1964) this association, colonising both the infralittoral and circalittoral zones (Giaccone & al., 1994), corresponds to a facies of the Coastal Detritic biocoenosis, usually referred to as "maërl" in the Atlantic area (Lemoine, 1910; Pérès, 1967; Giaccone & al., 1994).

This community is characterised by a consistent degree of biodiversity and biomass and provides food and shelter for numerous species of flora and fauna (Cabioch, 1969; Blunden & al., 1977; Basso, 1996; Castriota & al., 1998).

The epiflora, generally found only on living rhodoliths, plays an important role within this community. The growth-form of the epiphytic species can weaken the influence of the currents, facilitates the consolidation of the sediment by marginal proliferations from their base and also favours the development of little algal epiphytes that are taking advantage of the shelter being provided to them (Cabioch, 1969). Moreover, its composition mainly depends on the interaction of three factors: sedimentation, irradiance and hydrodynamics (Augier & Boudouresque, 1978).

Although several studies on the epiflora of the rhodolith beds from the Western Mediterranean have been carried out (Dieuzede, 1940; Feldmann, 1943; Huvé, 1955; Jacquotte, 1962; Giaccone, 1965, 1969, 1971; Bourcier, 1968; Falconetti, 1970; Augier & Boudouresque, 1978; Di Geronimo & Giaccone, 1994; Basso, 1996), little is known about this community in the Southern Tyrrhenian Sea.

The investigation of the epiflora of a rhodolith bed from the Island of Ustica, on which are so far available a lot of information on the benthic marine algal flora (Giaccone, 1967; De Cristofaro, 1970; Furnari, 1984; Giaccone & al., 1985 a, 1985 b), constitutes the object of our study.

Investigated area

The Island of Ustica (Southern Tyrrhenian Sea, 38° 42' N, 13° 10' E, Fig. 1) is located at 67 Km from the northern coast of Sicily; it was stated Natural Marine Reserve by the Ministerial Decree of 12 November 1986. It has a volcanic origin, rising to more than 2000 m from the Tyrrhenian bottom. Currents around the island have a cyclonic circulation (anticlockwise) coming from the West. The island is also influenced by the Atlantic current. The island, surrounded by very clear waters, lies on a short continental shelf with its

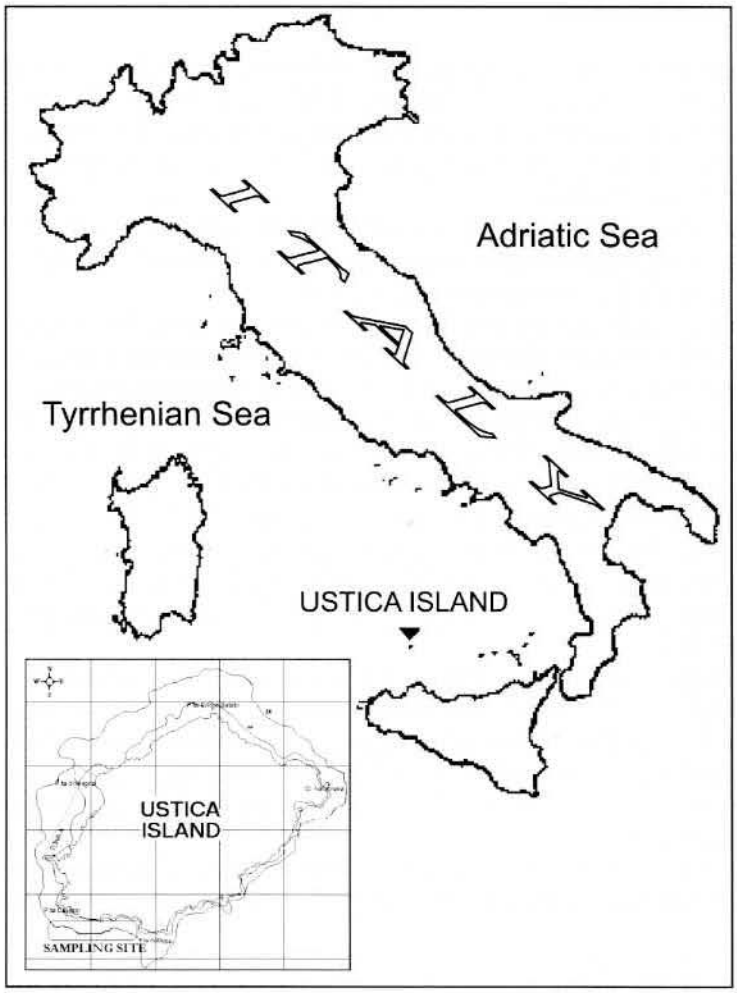

Fig. 1. Map of the sampling site.

maximum extension of 1800 m in the northern area of the island. This area is almost entirely colonised by seagrass *Posidonia oceanica* (L.) Delile reaching depths of 40-45 m.

The southern coast, instead, is characterised by a shorter continental shelf with steep rocky bottoms where algal communities have settled. Until depths of 35 m short *Posidonia oceanica* meadows occur. *Posidonia oceanica* disappears at a depth of 40-50 m, 150 m from the coast, and it is replaced by sandy bottoms characterised by the presence of organogenic detritus, arising from present-day organisms and colonised by calcareous *Rhodophyceae*.

This soft bottom has been the object of the present investigation. Within the assessed area temperature ranges from 13 °C in winter to 17 °C in summer and salinity from 36.9 to 37.9‰.

Materials and methods

Sampling was carried out during 1996-1998 cruises, according to the following calendar: November 1996, July 1997, December 1997, June 1998, in order to be able to record the occurring of any differences in community composition. The samples were collected at a depth of 50 m, by a van Veen grab 0.1 m^2, 16 l volume, along a transect of about 2 Km, parallel to the coast.

During each sampling period, we collected five replicates according to Stirn (1981), each one in a different point of the studied area, for a total of 20 samples. Samples were preserved in 4% formalin solution with sea water.

For Scanning electron microscopy, coralline red algae were first rinsed in demineralised water and then air dried. Fractured fragments were subsequently mounted on double sided sticky tape and coated with gold. Mono and multispecific rhodoliths have been collected, in both cases only the living thalli have been identified, and assigned to genera and species according to Woelkerling (1988), Woelkerling & al. (1993), Irvine & Chamberlain (1994), Chamberlain (1996), Babbini & Bressan (1997), Cabioch & al. (1998), Woelkerling & Lamy (1998), Woelkerling & al. (1998), Athanasiadis (1997, 1999).

A floristic list was then prepared, in which taxa had been listed in systematic order (generic and specific taxa were sorted out alphabetically). Each taxon is also being attributed its own phenology, chorology and ecological group (see Appendix for the key to abbreviations).

Chorological codes have been assigned according to Cormaci & al. (1982) and Giaccone & al. (1985 b) whilst ecological group codes follow Boudouresque (1984). A comparison with other floristic lists concerning Atlantic and Western Mediterranean maërl and "free-living *Peyssonnelia*" beds (Cabioch, 1969; Augier & Boudouresque, 1978; Ballesteros, 1994, 1988; Basso, 1994) has also been made in order to establish floristic similarity among them.

The R/P biogeographic index (number of Rhodophyceae to the number of Phaeophyceae in a given floristic list), introduced by Feldmann (1937), has been calculated.

Results and Discussion

The study of the samples has led to the identification of 117 taxa at specific and infraspecific level (4 *Cyanophyceae*, 80 *Rhodophyceae*, 8 *Ulvophyceae*, 2 *Chlorophyceae* and 23 *Phaeophyceae*). Among them, *Alsidium corallinum* C. Agardh is a new record for the Island of Ustica.

The floristic list provides us with some very interesting data such as the high occurrence of red algae (68.4%). Red algae completely dominate this assemblage showing the greater ability this group has to adapt to high depths referring to other groups. Among red algae, coralline algae demonstrate a particularly good capacity to adapt to depth due to the low degree of grazing by zoobenthic organisms and the low rate of respiration activity of this group comparing with other species of red algae (Littler, 1976; Kirk, 1983). On the contrary, green algae show a low capacity to adapt to this environment, but thanks to the opportunistic character of a lot of species (Ballesteros & al., 1984) they can reach good levels of occurrence. The presence of rhodoliths explains the occurrence of species nor-

mally confined to hard substrates, indeed rhodoliths represent together with *Peyssonnelia* species the basal stratum of this community.

From a phenological point of view, only a few thalli of the epiphytic fleshy algae were reproductive, probably because the need of saving energy led species through vegetative forms of reproduction but also because these species reproduce in summer and in the winter samples (november and dicember) they are generally sterile. Sterile thalli were tentatively identified also by a comparison with herbarium specimens.

Species occurring only in the winter samples show a higher incidence (24.8%) than those occurring only in the summer samples (16.2%). Both incidences are lower than the incidence of species occurring in both seasons (52.1%).

Members of the *Gelidiales*, *Cryptonemiales*, *Corallinales* and *Ceramiales* are being present with the highest frequency of occurrence. The forms with a linking power due to the marginal proliferations from the base (e.g. *Dictyota*, *Gelidiella*, *Rhodymenia* and *Spyridia*) occurred more frequently than foliaceous and filamentous ones.

The calculated 3.5 R/P index value indicates the extensive occurrence of the red algae and the subtropical character of this community. Indeed, from cold temperate to tropical regions, the diversity of brown algae reduces drastically and red and green algae begin to dominate, with the obtained R/P index rising from 1.1 in the cold temperate regions to a maximum of 4.3 in the tropical regions (Lüning, 1990).

The studied assemblage resulted rather rich in species if compared with other Western Mediterranean maërl beds: a total number of 106 taxa were reported by Augier & Boudouresque (1978) for the Island of Port-Cros, 93 by Basso (1994) for the Arcipelago Toscano and Ponziano, and Ballesteros (1988) found 85 species in the maërl beds from Tossa de Mar.

The comparison among these floristic lists showed a high level of similarity with a mean value of 30 taxa having resulted in common, and members of the *Cryptonemiales*, *Ceramiales*, *Dictyotales* and *Sphacelariales* orders are being present with the highest number of taxa.

The high diversity occurring in the compared rhodolith beds could be a general feature of these communities, probably due to the provision of a broad range of "hard bottom" habitats related to the range in size and shape of rhodoliths, and "soft bottom" habitats due to rhodolith fragments mixed with sediments. This high floristic diversity is also related to reduced grazing and predation (Foster, 2001).

Comparing our list with those recorded by Cabioch (1969) for Atlantic maërl beds, 17 taxa resulted in common, this author having already noticed a certain degree of similarity between floristic lists of Atlantic and Mediterranean maërl beds.

We have also noticed that in all compared floristic lists occurred the following group of species: *Peyssonnelia rubra* (Greville) J. Agardh, *Laurencia obtusa* (Hudson) J. V. Lamouroux, *Halopteris filicina* (Grateloup) Kützing and *Dictyota dichotoma* (Hudson) J. V. Lamouroux. Probably a wide ecological tolerance allows them to adapt well in both environments, characterised by different climatic conditions. Moreover, a group of eight species (preceded by an asterisk in the floristic list) always occurred in all examined Mediterranean maërl floristic lists. This group of species probably constitutes the narrow group of characteristic species of the community colonising maërl beds in the Western Mediterranean.

Table 1. Chorological spectrum.

	A *	M	C **	CB	IP	P
CYANOPHYCEAE			4			
RHODOPHYCEAE	40	9	23	1	3	1
ULVOPHYCEAE	5				1	2
CHLOROPHYCEAE	1	1				
PHAEOPHYCEAE	6	2	12	1		
TOTAL	52	12	39	2	4	3
TOTAL %	44.4	10.2	33.3	1.7	3.4	2.6

*Atlantic comprising boreo-Atlantic, boreo-tropical Atlantic, Atlantic tropical, Indo-Atlantic, Indo-Atlantic tropical;
**Cosmopolite comprising Subcosmopolitan.

Table 2. Qualitative dominance of the ecological groups in each systematic groups.

	SM	SIC	SC	Ig *	Cg **	Other
RHODOPHYCEAE	4	6	9	31	5	5
ULVOPHYCEAE				1		2
CHLOROPHYCEAE					1	
PHAEOPHYCEAE			1	10		
TOTAL	4	6	10	42	6	7
TOTAL %	3.4	5.1	8.5	36.0	5.1	6.0

* Infralittoral groups;
** Coralligenous groups.

Moreover, a comparison among our list and some Mediterranean "free-living *Peyssonnelia* beds" (Augier & Boudouresque, 1978; Ballesteros, 1994), considered as a facies of the Coastal Detritic assemblages (Jacquotte, 1963; Augier & Boudouresque, 1978) has shown inside the studied community a quite good incidence of species belonging to this facies. According to Augier & Boudouresque (1978) these beds could be also assigned to the *Phymatolitho-Lithothamnietum corallioidis* association (Giaccone 1965) Giaccone 1994.

Some species belonging to the community of *Arthrocladia villosa* (Hudson) Duby and *Sporochnus pedunculatus* (Hudson) C. Agardh (*Arthrocladio-Sporochnetum pedunculati* Ollivier 1929) have also been noticed. This community would substitute the maërl community in a shallower zone than that in which the maërl community usually occurs (Ballesteros, 1988).

The presence in the samples of some *Posidonia* remains (fragments of leaves) shows

evidence of a sedimentary instability due to seasonal input from the neighbouring *Posidonia* meadows (Basso, 1992).

The chorological spectrum (Table 1) shows a high incidence of Atlantic species (44.4%) and a low incidence of Indo-Pacific species (3.4%), pointing out the strong influence of the Atlantic current licking the Island of Ustica with its northern branch. The chorological spectra previously published for Ustica and Sicilian floras (Giaccone & al., 1985 a, 1985 b) are showing again a high incidence of Atlantic species and a low incidence of Indo-Pacific species. The incidence of Mediterranean species (10.2%) is here less relevant than that previously reported for Ustica and Sicilian floras (Giaccone & al., 1985 a, 1985 b).

By examining Table 2, we can notice a good percentage frequency (17) of the species belonging to SM, SC and SIC ecological groups. According to Augier & Boudouresque (1978) the combination of these groups characterises the *Phymatolitho-Lithothamnietum corallioidis* association (Giaccone 1965) Giaccone 1994, particularly, the SM group proves to be the characteristic group within this association. On the contrary, a higher percentage frequency (36.0) has been recorded for species belonging to the other infralittoral groups. Species belonging to coralligenous groups are present with a lower percentage frequency (5.1).

The examination of the rhodoliths has led to the identification of 8 taxa, representing 6 genera from three subfamilies (Woelkerling, 1988). *Lithophyllum racemus* (Lamarck) Foslie, *Neogoniolithon brassica-florida* (Harvey) Setchell & L. R. Mason, *Spongites fruticulosus* Kützing, *Lithothamnion corallioides* and *Phymatolithon calcareum* were the predominant species. *Lithophyllum incrustans* Philippi, *Lithothamnion philippii* Foslie, *Mesophyllum lichenoides* (J. Ellis) Me. Lemoine and *Neogoniolithon* spp. were less abundant. Both status and disposition of *Lithothamnion philippii* Foslie is uncertain (Woelkerling & al., 1998).

Samples of *Lithothamnion corallioides* and *Phymatolithon calcareum* were branched and unattached, and fleshy epiphytes were abundant. *Lithophyllum racemus* formed rounded, more or less branched nodules, 1 to 4 cm wide, with a quite regular growth and a compact structure, and fleshy epiphytes were rare.

Both *Neogoniolithon brassica-florida* and *Neogoniolithon* spp. were colonised by quite abundant fleshy epiphytes. Observations on collected samples of rhodolith-forming species showed different degrees of branches, width from 1 to 4 cm and a growth-form variation essentially ranging from fruticose to lumpy to partially encrusting.

Branch shape spanned from cylindrical to knobby; branch density and arrangement also varied from sparse dominant and open to dense and closely crowded. Sparse and open forms were predominant. The demonstrated close relation between form and branch density of rhodoliths and environmental factors, particularly hydrodynamics (Basso, 1992; Di Geronimo & Giaccone, 1994), could suggest that a water motion of medium intensity and laminar bottom currents affected the surveyed area.

Conclusions

Our survey brings us to the conclusion that in the examined community rhodolith-forming species belonging to *Lithophyllum, Lithothamnion, Neogoniolithon, Phymatolithon* and *Spongites* are predominant. The epiflora, characterised by a quite high number of

species, is closely related to those previously described relative to other Western Mediterranean maërl beds. A group of species occurring in the compared Mediterranean floristic lists, has been identified as the group of characteristic species of this flora together with its subtropical feature.

The floristic composition, a high percentage frequency of open rhodolith growth-forms and the occurrence of characteristic species belonging to the *Phymatolitho-Lithothamnietum corallioidis* association (Giaccone 1965) Giaccone 1994, could suggest the presence of the facies belonging to the Coastal Detritic biocoenosis, commonly known in the Western Mediterranean as "Free Melobesiae", of which this association represents an aspect.

Moreover, the high percentage frequency of species belonging to infralittoral and coralligenous groups, the presence of species belonging to the community of *Arthrocladia villosa* (Hudson) Duby and *Sporochnus pedunculatus* (Hudson) C. Agardh (*Arthrocladio-Sporochnetum pedunculati* Ollivier 1929) together with the presence of species belonging to the facies of "free-living *Peyssonnelia*", could provide evidence of the transitional position of this community. The local combination of the environmental factors, could favour the development of species belonging to other infralittoral and coralligenous communities causing them to dominate over the characteristic species of the *Phymatolitho-Lithothamnietum corallioidis* association (Giaccone 1965) Giaccone 1994.

The data obtained by this investigation allowed us to characterise the epiflora of this rhodolith bed, to confirm previous floristic observations regarding soft bottom communities, but also to provide new data and suggestions.

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Appendix 1. Chorological codes list (Cormaci & al., 1982; Giaccone & al., 1985a)

A: Atlantic
Ab: boreo-Atlantic
Abt: boreo-tropical Atlantic
At: Atlantic tropical
C: Cosmopolite
CB: Circumboreal
IA: Indo-Atlantic
IAt: Indo-Atlantic tropical
IP: Indo-Pacific
M: Mediterranean
SC: Subcosmopolitan
P: Pantropical

Appendix 2. Ecological groups codes list (Boudouresque, 1984)

RM: Midlittoral rocks
ISR: Infralittoral, hard bottoms
PhI: Photophilous, infralittoral
PhIB: Photophilous, infralittoral, wave washed

PhIC: Photophilous, infralittoral, quiet environment
PhIP: Photophilous, infralittoral, harbours
PhIT: Photophilous, infralittoral, thermophilous
SIC: Sciophilous, infralittoral and circalittoral
SI: Sciophilous, infralittoral
SSB: Sciophilous, infralittoral, wave washed
SSBf: Sciophilous, infralittoral, wave washed, cold waters
SSBc: Sciophilous, infralittoral, wave washed, warm waters
SC: Sciophilous, relatively quiet environment
SCI: Sciophilous, infralittoral, relatively quiet environment
SCIT: Sciophilous, infralittoral, relatively quiet environment, tolerant
SRh: Sciophilous, rheophilous
SM: Sciophilous, soft bottoms
CCT: Coralligene concretions, tolerant
CC: Coralligene concretions
AS: Antisciophilous
HP: Posidonia leaves
ETN: Eutrophic, tionitrophilous

Floristic list.

Bold letters refer to chorology (see Appendix for the key to abbreviations); letters in square brackets refer to sampling period (w = winter; s = summer); letters in round brackets refer to ecological group (see Appendix for the key to abbreviations); bold letters in round brackets refer to phenology (**S** = sporophitic; **M** = male; **F** = female).

[1] T.i.=Taxon *inquirendum* (Furnari & al.,1999).

[2] According to Woelkerling & al. (1998) both status and disposition of this taxon is uncertain.

CYANOPHYTA
CYANOPHYCEAE

CHROOCOCCALES

CHROOCOCCACEAE

Anacystis thermalis (Meneghini) Drouet et Daily **C** [w,s]
Entophysalis deusta (Meneghini) Drouet et Daily **C** [w,s]

NOSTOCALES

RIVULARIACEAE
Calothrix crustacea Thuret — **C** [w,s]

OSCILLATORIACEAE
Microcoleus lyngbyaceus (Kützing) P. L. et H. M. Crouan — **C** [w,s]

RHODOPHYTA
RHODOPHYCEAE

BANGIOPHYCIDAE
PORPHYRIDIALES

PORPHYRIDIACEAE
Chroodactylon ornatum (C. Agardh) Basson — **C** [w,s]
Stylonema alsidii (Zanardini) K.M. Drew — **C** [w,s] (ISR)

ERYTHROPELTIDALES

ERYTHROTRICHIACEAE
Erythrocladia irregularis Rosenvinge — **SC** [w,s]
Erythrotrichia carnea (Dillwyn) J. Agardh — **C** [w,s] (ETN)

FLORIDEOPHYCIDAE
ACROCHAETIALES

ACROCHAETIACEAE
[1]*Acrochaetium lenormandii* (Suhr ex Kützing) Nägeli (T.i.) — **Ab** [w,s] (**S**)
Acrochaetium spp. — [s]
Audouinella trifila (Buffham) P.S. Dixon — **Ab** [w,s] (RM)

GELIDIALES

GELIDICEAE
Gelidium bipectinatum G. Furnari — **Ab** [w,s] (SC)
Gelidium spathulatum (Kützing) Bornet — **Ab** [s] (PhIC) (**M**)
Gelidium spinosum (S.G. Gmelin) P.C. Silva var. *spinosum* — **SC** [w,s] (PhI)
Gelidium spinosum (S.G. Gmelin) P.C. Silva
var. *hystrix* (J.Agardh) G. Furnari — **M** [s]
Pterocladiella capillacea (S.G. Gmelin) Santelices and Hommersand — **SC** [w] (SSB)

GELIDIELLACEAE
Gelidiella lubrica (Kützing) Feldmann and Hamel — **IP** [w] (PhIC)
Gelidiella pannosa (Feldmann) Feldmann and Hamel — **SC** [w,s] (PhI) (**S**)
Gelidiella ramellosa (Kützing) Feldmann and Hamel — **IP**[w,s](SSBc)

GRACILARIALES

GRACILARIACEAE

Gracilaria corallicola Zanardini	**M** [w,s] (CC)

CRYPTONEMIALES

KALLIMENIACEAE

Meredithia microphylla (J. Agardh) J. Agardh	**Abt** [s] (SC)

PEYSSONNELLIACEAE

Peyssonnelia bornetii Boudouresque and Denizot	**M** [w,s] (SC) (**S**)
Peyssonnelia dubyi P.L. and H.M. Crouan	**Ab** [w,s] (ISR)
**Peyssonnelia harveyana* P.L. and H.M. Crouan ex J. Agardh	**Ab** [w,s] (SC) (**S**)
Peyssonnelia polymorpha (Zanardini) F. Schmitz	**SC** [s] (SIC)
**Peyssonnelia rosa-marina* Boudouresque and Denizot	**M** [w] (SM)
Peyssonnelia rubra (Greville) J. Agardh	**IA** [w,s] (SC)
Peyssonnelia squamaria (S.G. Gmelin) Decaisne	**M** [w,s] (SCIT)
Peyssonnelia stoechas Boudouresque and Denizot	**M** [w,s]

RHIZOPHYLLIDACEAE

Contarinia peyssonneliaeformis Zanardini	**M** [s] (SSBc)

CORALLINALES

CORALLINACEAE

AMPHIROIDEAE

Amphiroa rigida J.V. Lamouroux	**SC** [w] (PhI)

CORALLINOIDEAE

Corallina elongata J. Ellis and Solander	**Ab** [w] (ISR)
Jania rubens (Linnaeus) J.V. Lamouroux var. *rubens*	**C** [w,s] (Phl) (**S**)
Jania rubens (Linnaeus) J.V. Lamouroux var. *corniculata* (Linnaeus) Yendo	**Ab**[w,s](PhlC) (**S**)

LITHOPHYLLOIDEAE

Lithophyllum incrustans Philippi	**Ab** (ISR) (**S,B**)
Lithophyllum racemus (Lamarck) Foslie	**IA** (SRh) (**S**)

MASTOPHOROIDEAE

Hydrolithon farinosum (J.V. Lamouroux) Penrose and Y.M. Chamberlain var. *farinosum*	**C** [w,s] (**S**)
Neogoniolithon brassica-florida (Harvey) Setchell and L.R. Mason	**IA** (PhI) (**S,F**)
Neogoniolithon spp.	[w,s]
Pneophyllum fragile Kützing	**C** [w,s] (HP) (**S**)
Spongites fruticulosus Kützing	**IP** (SM) (**S,F**)

MELOBESIOIDEAE
Lithothamnion corallioides (P.L. and H.M. Crouan) P. L. and H. M. Crouan — **Ab** (SM) (**S**)
[2]*Lithothamnion philippii* Foslie — **At** (SIC) (**S**)
Mesophyllum lichenoides (J. Ellis) Me. Lemoine — **Abt** (SIC) (**S**)
Phymatolithon calcareum (Pallas) W.H. Adey and D.L. McKibbin — **Ab** (SM) (**S**)

GIGARTINALES

CRUORIACEAE
Cruoria cruoriaeformis (P.L. and H.M. Crouan) Denizot — **Ab** [w] (CCT)

GIGARTINACEAE
Chondracanthus acicularis (Roth) Fredericq — **C** [w,s] (PhIP)

PHYLLOPHORACEAE
[*]*Phyllophora crispa* (Hudson) P.S. Dixon — **Ab** [w,s] (SI)
Phyllophora heredia (Clemente) J. Agardh — **Ab** [w] (SIC)
Phyllophora sicula (Kützing) Guiry and L.M. Irvine — **Ab** [w,s]

PLOCAMIALES

PLOCAMIACEAE
Plocamium cartilagineum (Linnaeus) P.S. Dixon — **SC** [w] (SSBf)

RHODYMENIALES

LOMENTARIACEAE
Lomentaria clavaeformis Ercegovic — **M** [w] (SC)

RHODYMENIACEAE
Botryocladia boergesenii Feldmann — **Ab** [w,s] (SC)
Rhodymenia ardissonei Feldmann — **Ab** [w,s] (SIC)
Rhodymenia pseudopalmata (J.V. Lamouroux) P.C. Silva — **Abt** [s]

CERAMIALES

CERAMIACEAE
Antithamnion cruciatum (C. Agardh) Nägeli — **IA** [w,s] (ISR)
Antithamnion spp. — [s]
[*]*Ceramium codii* (H. Richards) Feldmann-Mazoyer — **SC** [w,s] (SC)
Ceramium tenerrimum (G. Martens) Okamura var. *brevizonatum* (H.E. Petersen) Feldmann-Mazoyer — **SC** [w] (**S**)
Pterothamnion plumula (J. Ellis) Nägeli — **SC** [w,s]
Spermothamnion repens (Dillwyn) Rosenvinge — **Ab** [w] (PhIC) (**S**)
Spyridia filamentosa (Wulfen) Harvey — **C** [w] (PhIT)

DASYACEAE

Dasya rigidula (Kützing) Ardissone	**Abt** [w]
**Eupogodon planus* (C. Agardh) Kützing	**IA** [w,s](CCT)

DELESSERIACEAE

Acrosorium venulosum (Zanardini) Kylin	**IA** [w,s](CCT)
**Erythroglossum sandrianum* (Kützing) Kylin	**Ab** [w] (SC)
Hypoglossum hypoglossoides (Stackhouse) Collins and Harvey	**Ab** [w] (SIC)
Nithophyllum punctatum (Stackhouse) Greville	**IA** [w] (PhIP) (**F**)

RHODOMELACEAE

Alsidium corallinum C. Agardh	**At** [w,s](PhIT)
Chondria capillaris (Hudson) M.J. Wynne	**SC** [w] (PhIC)
Chondria dasyphylla (Woodward) C. Agardh	**SC** [w] (PhIC) (**F**)
Chondrophycus paniculatus (C. Agardh) G. Furnari	**SC** [w]
Halopithys incurva (Hudson) Batters	**IA** [w,s](PhIT)
Herposiphonia secunda (C. Agardh) Ambronn **f.** *secunda*	**P** [w,s] (PhIC) (**F**)
Laurencia obtusa (Hudson) J.V. Lamouroux	**C** [s] (Phl)
Osmundaria volubilis (Linnaeus) R.E. Norris	**IA** [w,s] (AS)
Polysiphonia brodiei ("*brodiaei*") (Dillwyn) Sprengel	**IA** [w,s] (**F**)
Polysiphonia cladorhiza Ardissone	**M** [w,s] (**F**)
Polysiphonia denudata (Dillwyn) Greville	**SC** [w]
Polysiphonia foetidissima Cocks ex Bornet	**Ab** [w,s]
Polysiphonia opaca (C. Agardh) Moris and De Notaris	**Ab** [w,s] (RM) (**F**)
Polysiphonia stricta (Dillwyn) Greville	**CB** [w] (**F**)
**Polysiphonia subulifera* (C. Agardh) Harvey	**Ab** [w,s] (CC)
Rytiphlaea tinctoria (Clemente) C. Agardh	**IAt** [w] (PhIT)

CHLOROPHYTA

ULVOPHYCEAE

CLADOPHORALES

CLADOPHORACEAE

Cladophora coelothrix Kützing	**IA** [w]
Cladophora pellucida (Hudson) Kützing	**IA** [w,s]
Cladophora socialis Kützing	**IA** [w,s]
Cladophoropsis modonensis (Kützing) Reinbold	**IA** [w]

CAULERPALES

CODIACEAE

Codium effusum (Rafinesque) Delle Chiaje	**IP** [s] (SCI)

UDOTEACEAE

**Flabellia petiolata* (Turra) Nizamuddin	**At** [w] (AS)
Halimeda tuna (J. Ellis and Solander) J.V. Lamouroux	**P** [w] (AS)

SIPHONOCLADALES

VALONIACEAE
Valonia macrophysa Kützing — **P** [s]

CHLOROPHYCEAE

CHAETOPHORALES

CHAETOPHORACEAE
Entocladia major (Feldmann) R. Nielsen — **M** [w,s] (CCT)
Ulvella lens P.L. and H.M. Crouan — **IA** [w,s]

HETEROKONTOPHYTA
PHAEOPHYCEAE

ECTOCARPALES

ECTOCARPACEAE
Ectocarpus siliculosus (Dillwyn) Lyngbye var. *siliculosus* — **C** [w,s] (**S**)
Ectocarpus siliculosus (Dillwyn) Lyngbye
var. *pygmaeus* (Areschoug) Gallardo — **CB** [s]
Feldmannia irregularis (Kützing) Hamel — **C** [w,s]

CHORDARIALES

CORYNOPHLAEACEAE
Myriactula stellulata (Harvey) Levring — **Ab** [s]

SPERMATOCHNACEAE
Stilophora tenella (Esper) P.C. Silva — **SC** [s]

DICTYOSIPHONALES

ARTHROCLADIACEAE
Arthrocladia villosa (Hudson) Duby — **Ab** [s]

SCYTOSIPHONALES

SCYTOSIPHONACEAE
Scytosiphon lomentaria ("*lomentarius*") (Lyngbye) Link — **C** [s]

CUTLERIALES

CUTLERIACEAE
Cutleria chilosa (Falkenberg) P.C. Silva — **M** [w]

SPHACELARIALES

CLADOSTEPHACEAE

Cladostephus spongiosum (Hudson) C. Agardh **f.** *verticillatus* (Lightfoot) Prud'homme van Reine	**IA** [w,s]

SPHACELARIACEAE

Sphacelaria cirrosa (Roth) C. Agardh	**SC** [w,s] (PhI)
Sphacelaria fusca (Hudson) S.F. Gray	**SC** [s]

STYPOCAULACEAE

Halopteris filicina (Grateloup) Kützing	**SC**[w,s](SCIT)
Stypocaulon scoparium (Linnaeus) Kützing	**SC** [w] (PhIC)

DICTYOTALES

DICTYOTACEAE

Dictyopteris polypodioides (A.P. De Candolle) J.V. Lamouroux	**C** [w] (SI)
Dictyota dichotoma (Hudson) J.V. Lamouroux var. *dichotoma*	**C** [w,s] (PhIC)
Dictyota fasciola (Roth) J.V. Lamouroux var. *repens* (J. Agardh) Ardissone	**IA** [s] (PhIB)
Dictyota linearis (C. Agardh) Greville	**SC** [w,s] (SC)
Lobophora variegata (J.V. Lamouroux) Womersley ex E.C. Oliveira	**SC** [w,s] (SCI)
Spatoglossum solieri (Chauvin ex Montagne) Kützing	**IA** [w,s] (SCI)
Zonaria tournefortii (J.V. Lamouroux) Montagne	**At** [w,s] (SCI)

FUCALES

CYSTOSEIRACEAE

Cystoseira spinosa Sauvageau var. *spinosa*	**M** [s] (SCIT)
Cystoseira spp.	[w,s]

SARGASSACEAE

Sargassum spp.	[w,s]