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Le macroalghe delle coste italiane: aspetti floristici e vegetazionali

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RIASSUNTO

Dopo un breve excursus sulla storia dell'algologia in Italia, vengono illustrati gli aspetti floristici e vegetazionali del macrophytobenthos delle coste italiane. La flora, ottenuta sulla base delle segnalazioni riportate in lavori pubblicati a partire dal 1950, consta di 944 *taxa* a livello specifico e infraspecifico (46 Cyanophyta, 534 Rhodophyta, 214 Ochrophyta e 150 Chlorophyta) accettate a seguito di una revisione tassonomica e nomenclaturale. Viene inoltre sottolineata la presenza, recentemente attenzionata dalla comunità scientifica, di specie aliene. Vengono infine riportate le principali comunità fitobentoniche presenti lungo le coste italiane e commentati i cambiamenti in esse riscontrate in anni recenti.

Parole chiave: Fitobenthos, Flora marina, Vegetazione marina, Italia.

SUMMARY

Macroalgae of Italian coast: floristic and vegetational aspects

After a brief excursus on the history of studies on Italian macroalgal species, both floristic and vegetational characteristics of benthic macroalgae of Italian coast are presented. The flora, obtained from literature records since 1950, consists of 944 *taxa* at specific and infraspecific level (46 Cyanophyta, 534 Rhodophyta, 214 Ochrophyta and 150 Chlorophyta) accepted under current taxonomy. Moreover, the occurrence recently emphasized of alien species in indigenous communities, is pointed out. The main phytobenthic communities occurring along Italian coast and changes in their characteristics recently observed in different traits of coast, were also reported.

Key words: Phytobenthos, Marine flora, Marine vegetation, Italy.

INTRODUCTION

The first data on macroalgae of Italian coast are found in papers published in the 19th century by different Authors like C. Agardh (1820, 1822-23, 1828), Naccari (1828*a*,*b*), Delle Chiaje (1829), Zanardini (1841, 1843, 1847, 1858, 1860-71), Meneghini (1842, 1843, 1846), J. Agardh (1842, 1851-63), Kützing (1849, 1854-69), Ardissone (1864, 1883, 1886-87), Langenbach (1873), Reinke (1878), Falkenberg (1879, 1901), Solms-Laubach (1881), Berthold (1882*a*,*b*), Valiante (1883), Hauck (1885), Borzì (1886), Piccone (1889). Species quoted in the above papers are reported in De Toni's (1889, 1895, 1897, 1900, 1903, 1905,1924) *Sylloge algarum omnium hucusque cognitarum* which represents a compendium of macroalgal floristic knowledge to that date. Afterwards, a noticeable slackening in Italian phycological research was registered up to the beginning of sixties. In fact, in that period only some papers were published like those by Mazza (1902, 1903, 1904), Spinelli (1903, 1905), Schiffner & Vatova (1937), Levring (1942), Funk (1955) and Cavaliere (1956, 1957, 1958, 1959, 1963).

The paper by Pignatti (1962) on algal associations of Venice lagoon marks the restarting of the phycological research in Italy carried out by "contemporary" researchers (for papers published since 1960, see references in Furnari *et al*., 2003, 2010).

RESULTS AND DISCUSSION

Flora

Results of studies carried out in the "contemporary" period, reported in 533 scientific papers published from 1950 to 2000, allowed to compile a catalogue of phytobenthic biodiversity of Italian coast (Furnari *et al.*, 2003). The catalogue was recently updated by Furnari *et al.* (2010) taking into consideration papers published between 2001 and 2009.

From the above catalogues, the macroalgal floristic richness of Italian coast consists of 944 accepted *taxa* at specific and infraspecific level (46 Cyanophyta, 534 Rhodophyta, 214 Ochrophyta, 150 Chlorophyta). Of these, about 200 resulted interesting from a phytogeographic point of view being new to Italy or to the Mediterranean Sea. It is noteworthy that many of the above studies dealt with the taxonomy of different genera like *Cystoseira*, *Anotrichium*, *Acanthophora* as well of the *Laurencia*-complex and resulted in the description of two genera of Rhodophyta: *Halosia* Cormaci *et* G. Furnari (1994) and *Woelkerlingia* Alongi *et al*. (2007*a*) and 22 *taxa* at specific and infraspecific level new to the science (1 Cyanophyta, 18 Rhodophyta, 3 Ochrophyta) (tab. I).

Tab. I. New *taxa* described by Italian authors from Italy
Tab. I. Nuovi *taxa* descritti dagli autori Italiani per l'Italia

Taxa	Type locality	References
Cyanophyta		
Symploca codiiformis Giaccone [= *Schizothrix codiiformis* (Giaccone) Giaccone]	Molinazzo (Palermo)	Giaccone (1969)
Rhodophyta		
Antithamnion piliferum Cormaci *et* G. Furnari	Capo Passero (Syracuse)	Cormaci & Furnari (1987)
Antithamnionella elegans (Berthold) J.H. Price *et* D.M. John var. *decussata* Cormaci *et* G. Furnari	Augusta (Syracuse)	Cormaci & Furnari (1988)

Ceramium giacconei Cormaci *et* G. Furnari	Lachea Island (Catania)	Cormaci & Furnari (1991)
Chylocladia wynnei Alongi, Cormaci *et* G. Furnari	Salina Island (Aeolian islands)	Alongi *et al*. (2008)
Cordylecladia guiryi Gargiulo, G. Furnari *et* Cormaci	Bay of Augusta (Syracuse)	Gargiulo *et al*. (1991)
Crouania francescoi ("*francisci*") Cormaci, G. Furnari *et* Scammacca	Castelluccio (Syracuse)	Cormaci *et al.* (1978)
Fosliella cruciata Bressan [= *Hydrolithon cruciatum* (Bressan) Y.M. Chamberlain]	Trieste	Bressan *et al*. (1977)
Gracilaria dendroides Gargiulo, De Masi *et* Tripodi	Rivafiorita (Naples)	Gargiulo *et al*. (1985)
Gracilaria longa Gargiulo, De Masi *et* Tripodi	Rivafiorita (Naples)	Gargiulo *et al*. (1987)
Halosia elisae Cormaci *et* G. Furnari	Vulcano Island (Aeolian Islands)	Cormaci & Furnari (1994)
Halymenia asymmetrica Gargiulo, De Masi *et* Tripodi	Isle of Nisida, Naples	Gargiulo *et al*. (1986)
Hypnea furnariana Cormaci, Alongi *et* Dinaro	Punta del Gigante, Maddalena Peninsula (Syracuse)	Cormaci *et al*. (1993)
Laurencia minuta Vandermeulen, Garbary *et* Guiry ssp. *scammaccae* G. Furnari *et* Cormaci	Capo Passero (Syracuse)	Furnari & Cormaci (1990)
Osmundea maggsiana Serio, Cormaci *et* G. Furnari	Pantelleria Island (Straits of Sicily)	Serio *et al*. (1999)
Osmundea pelagiensis G. Furnari	Lampedusa Island (Pelagean Islands)	Cormaci *et al*. (1994*b*)
Polysiphonia perforans Cormaci, G. Furnari, Pizzuto *et* Serio	Acicastello (Catania)	Cormaci *et al*. (1998)
Verosphacela silvae Alongi, Cormaci *et* G. Furnari	Salina Island (Aeolian Islands)	Alongi *et al*. (2007*a*)
Woelkerlingia minuta Alongi, Cormaci *et* G. Furnari	Salina Island (Aeolian Islands)	Alongi *et al*. (2007*b*)
Ochrophyta		
Cystoseira balearica Sauvageau v. *claudiae* Giaccone [= *C. brachycarpa* J. Agardh *emend.* Giaccone v. *claudiae* (Giaccone) Giaccone]	Linosa Island (Pelagean Islands)	Amico *et al*. (1986)
Cystoseira hyblaea Giaccone	Punta d'Aliga (Ragusa)	Giaccone (1986)
Taonia lacheana, Cormaci, G. Furnari *et* Pizzuto	Lachea Island (Catania)	Cormaci *et al*. (1994*a*)

Moreover, due to nomenclatural studies, many new combinations were proposed and the typification of three species of *Cystoseira*: *C. algeriensis* Feldmann and *C. elegans* Sauvageau (Furnari *et al*., 1999) and *C. squarrosa* De Notaris (Alongi *et al*., 2002), was made too.

Finally, following the accidental introduction in the Mediterranean Sea of *Caulerpa taxifolia* (Vahl) C. Agardh (Meinesz & Hesse, 1991), an alien species with invasive behaviour, many Italian researchers turned their attention to introduced species. From their studies it results that 31 *taxa* at specific and infraspecific level (23 Rhodophyta, 5 Ochrophyta and 3 Chlorophyta) were to date recorded from Italian coast (tab. II). Of them, the Rhodophyta *Lophocladia lalle-*

mandii and *Womersleyella setacea*, the Ochrophyta *Sargassum muticum* and *Undaria pinnatifida* and the Chlorophyta *Caulerpa racemosa* var. *cylindracea* and *Caulerpa taxifolia*, show an invasive behaviour (Cormaci *et al*., 2004*b*; Zenetos *et al*., 2006).

Tab. II. Alien *taxa* recorded from Italian coast. References refer to the first record from Italy. In the first column R= Rhodophyta, O= Ochrophyta, C= Chlorophyta.

Tab. II. *Taxa* alieni segnalati per le coste Italiane. I riferimenti bibliografici si riferiscono alla prima segnalazione in Italia. Nella prima colonna R= Rhodophyta, O= Ochrophyta, C= Chlorophyta.

	Taxa	References
R	*Acrothamnion preissii* (Sonder) E.M. Wollaston	Cinelli & Sartoni (1971, from Antignano and Secche della Meloria, Leghorn)
R	*Aglaothamnion feldmanniae* Halos	Sartoni & Sarti (1976, from Leghorn)
R	*Antithamnion amphigeneum* A. Millar	Rindi *et al.* (1996, from La Spezia)
R	*Antithamnion hubbsii* E.Y. Dawson	Curiel *et al.* (1996, from Venice Lagoon, as *A. nipponicum* Yamada *et* Inagaki)
R	*Apoglossum gregarium* (E.Y. Dawson) M.J. Wynne	Sartoni & Boddi (1993, from Tuscan Archipelago)
R	*Asparagopsis armata* Harvey	Funk (1955, from Gulf of Naples)
R	*Bonnemaisonia hamifera* Hariot (only tetrasporophyte)	Cinelli *et al.* (1976*a*, from Linosa Island, Pelagean Islands)
R	*Botryocladia madagascariensis* Feldmann-Mazoyer	Cormaci *et al.* (1992, from Lampedusa Island, Pelagean Islands, and Castelluccio, Syracuse)
C	*Caulerpa racemosa* (Forsskål) J. Agardh var. *cylindracea* (Sonder) Verlaque, Huisman *et* Boudouresque	Alongi *et al*. (1993, as *C. racemosa*, from Baia Santa Panagia, Syracuse and Lampedusa Island, Pelagean Islands,)
C	*Caulerpa taxifolia* (Vahl) C. Agardh	Relini & Torchia (1992, from Imperia)
R	*Ceramium strobiliforme* G.W. Lawson *et* D.M. John	Cormaci *et al.* (1992, from Salina Island, Aeolian Islands)
R	*Chondria polyrhiza* Collins *et* Hervey	Cecere *et al.* (1996, from The Cheradi Islands, Taranto)
R	*Chondria pygmaea* Garbary *et* Vandermeulen	Cormaci *et al.* (1992, from Harbour of Catania)
C	*Codium fragile* (Suringar) Hariot ssp. *fragile*	Furnari [1974, as *C. fragile* ssp. *tomentosoides* (Goor) P.C. Silva, from Lake of Faro Messina]
R	*Grateloupia turuturu* Yamada	Solazzi *et al.* (1991-1994, from Venice Lagoon)
R	*Hypnea cornuta* (Kützing) J. Agardh	Cecere *et al*. (2004, from Mar Piccolo of Taranto)
R	*Hypnea spinella* (C. Agardh) Kützing	Cormaci & Furnari (1989, from Brucoli, Syracuse)
R	*Hypnea valentiae* (Turner) Montagne	Sfriso & La Rocca (2005, from Venice lagoon)
R	*Laurencia majuscula* (Harvey) A.H.S. Lucas	Caccamese *et al.* (1986, from Castelluccio, Syracuse)
O	*Leathesia difformis* (Linnaeus) Areschoug	Bellemo *et al.* (1999, from Venice Lagoon)
R	*Lomentaria hakodatensis* Yendo	Curiel *et al.* (2004, from Venice Lagoon)

R	*Lophocladia lallemandii* (Montagne) F. Schmitz	Furnari & Scammacca (1971, from Gulf of Catania)
O	*Padina boergesenii* Allender *et* Kraft	Sortino (1967, from Palma di Montechiaro, Agrigento)
R	*Palisada maris-rubri* (K.W. Nam *et* Saito) K.W. Nam	Serio *et al*. (2010, from Lachea Island, Catania)
R	*Plocamium secundatum* (Kützing) Kützing	Cormaci *et al.* (1991, from Ognina, Catania)
R	*Polysiphonia morrowii* Harvey	Curiel *et al.* (2001, from Venice Lagoon)
O	*Sargassum muticum* (Yendo) Fensholt	Gargiulo *et al.* (1992, from Venice Lagoon)
O	*Scytosiphon dotyi* M.J. Wynne	Giaccone (1978*a*, from Trieste)
R	*Symphyocladia marchantioides* (Harvey) Falkenberg	Sartoni (1986, as *S.* cf. *marchantioides*, from Leghorn)
O	*Undaria pinnatifida* (Harvey) Suringar	Rismondo *et al.* (1993, from Chioggia, Venice)
R	*Womersleyella setacea* (Hollenberg) R.E. Norris	Benedetti-Cecchi & Cinelli (1989, from Rosignano Solvay, Leghorn)

Vegetation

Besides floristic studies, marine plant communities were also studied. The aim of such studies was to identify and describe the different types of vegetation present in a given territory and to correlate them with environmental factors. That in order to compare similar vegetation situations to assess the degree of affinity and foresee, where possible, changes in the vegetation in the course of time (dynamics). Taking into account that i. each species has its own specific range of tolerance for the various environmental factors within which its ecological and physiological optimum is to be found; ii. that several species having similar degrees of tolerance may coexist in the same environment, reaching a good balance that limits interspecific competition and favours coexistence, the result of this is that, according to environmental conditions present in a certain area, a specific plant community is there set up. It is characterized by characteristic species of its own and by an elective composition of flora (Cormaci *et al*., 2004*a*). Marine vegetation, depending on the environmental conditions, and in particular the light, the physical composition of the substratum, and the hydrodynamism resulted relatively diversified, even in the same area. On the basis of the three main factors listed above, it is subdivided, respectively, into hard and soft substratum vegetation; into photophilic and sciophilous vegetation; into calm and exposed to intense hydrodynamism environments vegetation (Giaccone *et al*., 1993, 1994a, 1994b; Giaccone & Di Martino, 1997; Marino *et al*., 1999). Following such studies different new phytosociological Associations were also described from Italy (tab. III).

Tab. III – New phytosociological Associations described by Italian authors from Italy
Tab. III – Nuove Associazioni descritte per l'Italia da autori Italiani

HARD SUBSTRATA

Photophilic vegetation

Midlittoral zone

Bangietum atropurpureae Giaccone 1993 (Giaccone *et al*., 1993)

Polysiphonio-Lithophylletum papillosi Marino, Di Martino *et* Giaccone 1999 (Marino *et al*., 1999)

Lithophylletum byssoidis Giaccone 1993 (Giaccone *et al*., 1993)
Ceramio-Corallinetum elongatae Pignatti 1962 (Pignatti, 1962)
Fucetum virsoidis Pignatti 1962 (Pignatti, 1962)
Enteromorphetum compressae (Berner 1931) Giaccone 1993 (Giaccone *et al*., 1993)

Infralittoral zone

Cystoseiretum sauvageauanae Giaccone 1994 (Giaccone, 1994*a*)
Cystoseiretum spinosae Giaccone 1973 (Giaccone & Bruni, 1973)
Cystoseiretum barbatae Pignatti 1962 (Pignatti, 1962)

Circalittoral zone

Cystoseiretum usneoidis Giaccone 1972 (Giaccone, 1972)
Cystoseiretum zosteroidis Giaccone 1973 (Giaccone & Bruni, 1973)
Cystoseiretum dubiae Furnari, Cormaci, Scammacca *et* Battiato 1977 (Furnari *et al*., 1977)

Sciophilous vegetation

Midlittoral zone

Phymatolithetum lenormandii Giaccone 1993 (Giaccone *et al*., 1993)

Infralittoral zone

Rhodymenietum ardissonei Pignatti 1962 (Pignatti, 1962)
Halymenietum floresii Giaccone *et* Pignatti 1967 (Giaccone & Pignatti, 1967)

Circalittoral zone

Lithophyllo-Halimedetum tunae Giaccone 1965 (Giaccone, 1965)

SOFT SUBSTRATA

Photophilic vegetation

Infralittoral zone

Caulerpetum racemosae Giaccone *et* Di Martino 1995 (Giaccone & Di Martino, 1995*a*)
Laurencietum microcladiae Giaccone *et* Di Martino 1995 (Giaccone & Di Martino, 1995*b*)
Microdictyetum tenuii Giaccone *et* Di Martino 1995 (Giaccone & Di Martino, 1995*a*)
Caulerpetum proliferae Giaccone *et* Di Martino 1997 (Giaccone & Di Martino, 1997)

Sciophilous vegetation

Lower Infralittoral and Circalittoral zones

Phymatolitho-Lithothamnietum corallioidis Giaccone 1965 (Giaccone, 1965)

In almost all vegetational studies, a particular attention was turned to communities with *Cystoseira* spp. (Ochrophyta, Fucales) that characterize the vegetation on hard substrata in both infralittoral and upper circalittoral zones. It was observed that different communities characterized by different species of *Cystoseira*, which play a role of "guide species", succeed each other according to the depth. In stations with good environmental conditions the depth succession of the following communities was generally observed: with *C. amentacea* (C. Agardh) Bory v. *stricta* Montagne (fig. 1) in the infralittoral fringe, with *C. crinita* Duby (fig. 2) in the upper infralittoral zone, with *C. sauvageauana* Hamel (fig. 3) in the middle infralittoral zone, with *C. spinosa* Sauvageau (fig. 4) in the lower infralittoral zone, with *C. zosteroides* C. Agardh (fig. 5) or with *C. dubia* Valiante (fig. 6) (the latter in presence of a higher rhythm of sedimentation) in the circalittoral zone.

Fig. 1. *Cystoseira amentacea* v. *stricta* (Photo by M. Catra)

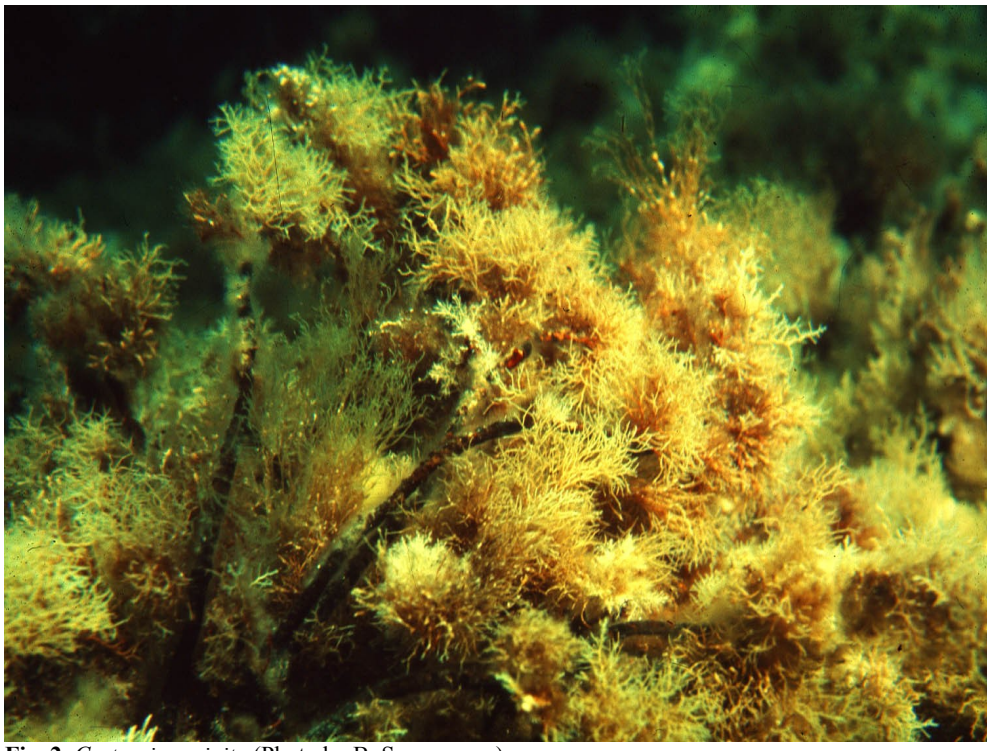

Fig. 2. *Cystoseira crinita* (Photo by B. Scammacca)

Fig. 3. *Cystoseira sauvageauana* (Photo by M. Catra)

Fig. 4. *Cystoseira spinosa* (Photo by M. Catra)

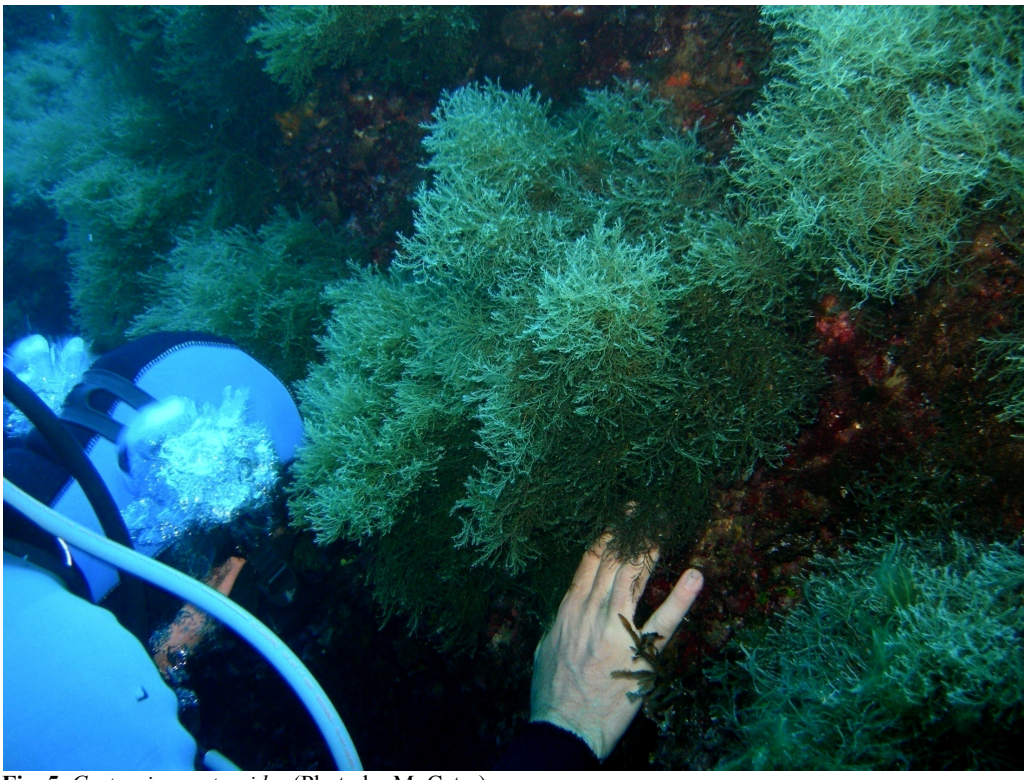

Fig. 5. *Cystoseira zosteroides* (Photo by M. Catra)

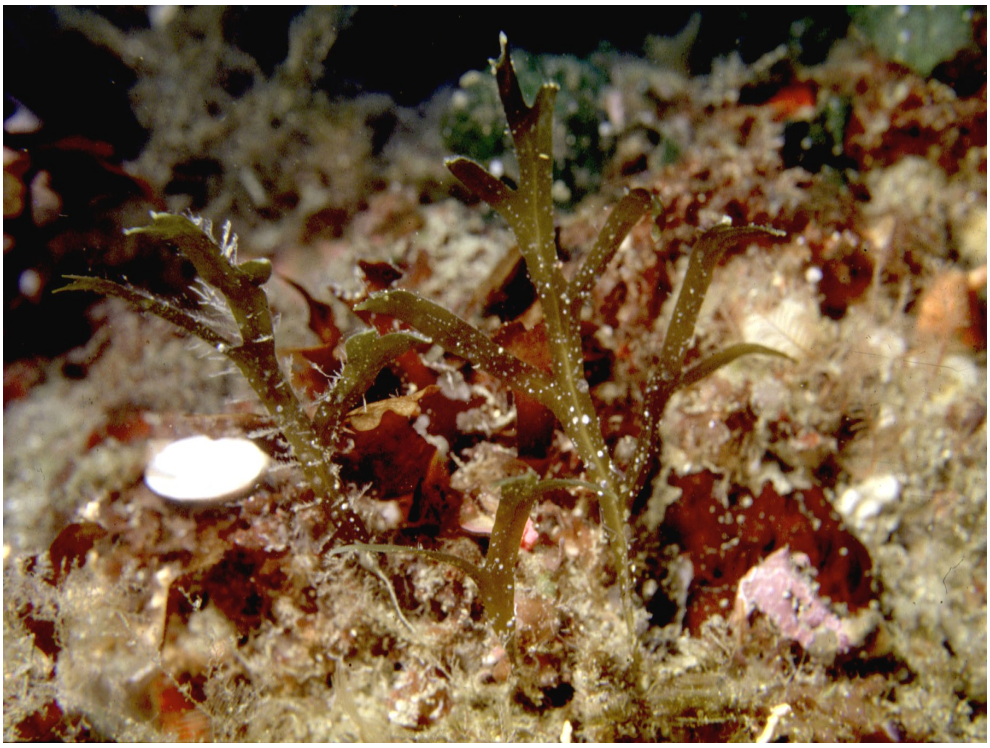

Fig. 6. *Cystoseira dubia* (Photo by B. Scammacca)

Till the end of eighties, the above zonation of photophilic communities was recorded in almost all rocky stations studied [e.g. the Tremiti Islands (Rizzi Longo, 1972, Rizzi Longo *et al*., 1976, Pignatti *et al*., 1967), Pantelleria Island (Giaccone *et al*., 1972), the Egadi Islands (Giaccone & Sortino, 1974), Linosa Island (Cinelli *et al.,* 1976a,b),]. But, studies carried out in the first years of this century in the same localities by Cormaci *et al*. (2000, 2001), Alongi *et al*. (2004), Serio *et al*. (2006), Catra *et al*. (2006) at the Tremiti Islands, Pantelleria Island, Linosa Island and the Egadi Islands respectively, showed meaningful changes of phytobenthic communities. They interested both the specific composition and the structure of communities. In fact, the complex and well structured communities with *Cystoseira* spp. (stenoecious species that don't tolerate change in environmental conditions) were substituted by simpler and less structured communities with Sphacelariales and Dictyotales. Such changes were related on one hand to the increase of water turbidity due to human activities on the other, mainly in localities not subject to anthropogenic effects, to climatic global change that caused a water temperature increase.

Finally, mainly in studies aiming at evaluate environmental conditions, also thionitrophilous vegetation was studied (Cormaci *et al*., 1986; Cormaci & Furnari, 1991; Ghirardelli *et al*., 1973; Giaccone & Rizzi Longo, 1974; Rizzi Longo & Giaccone, 1974; Giaccone, 1978*b*; Giaccone *et al*., 1980; Giaccone *et al*., 1988). This kind of vegetation is established in environments that have been altered and/or are subject to organic pollution and in which the edaphic factors are of greater importance than the climatic ones. The vegetation, that represents a regressive stage of phytobenthic communities occurring in not polluted habitats, is mainly characterized by nitrophilous [like *Ulva* spp. and *Pterocladiella capillacea* (S.G. Gmelin) Santelices et Hommersand (fig. 7)]

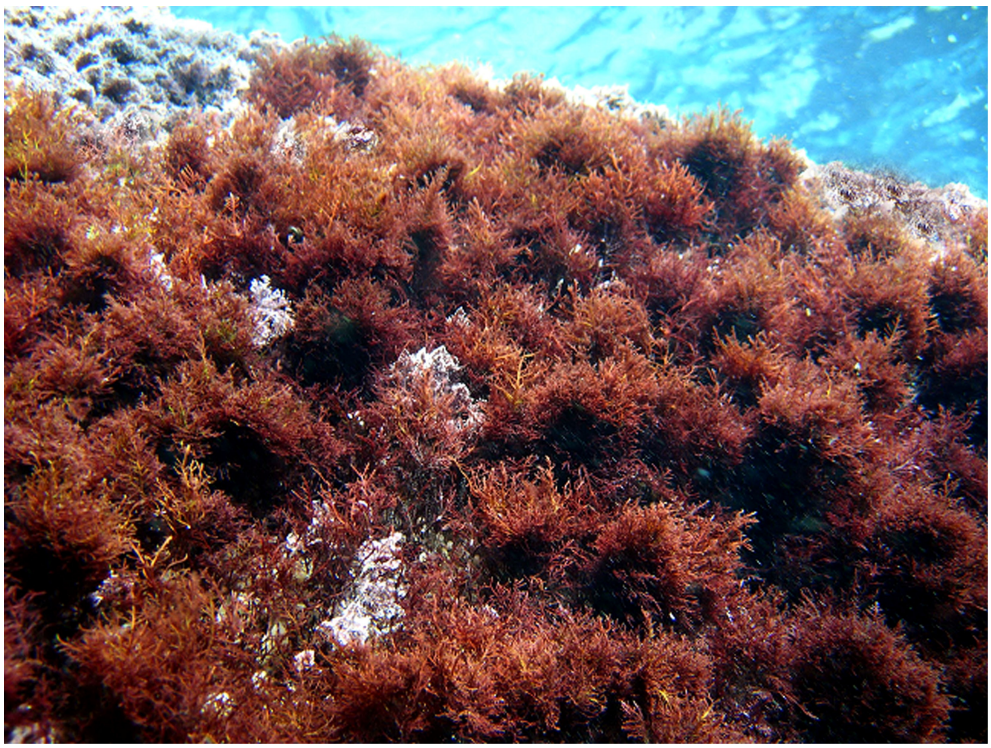

Fig. 7. *Pterocladiella capillacea* (Photo by M. Catra)

and/or opportunist species [like *Cladophora* spp., *Colpomenia sinuosa* (Mertens ex Roth) Derbès et Solier, *Chondracanthus acicularis* (Roth) Fredericq, *Petalonia fascia* (O.F. Müller) Kuntze, etc.].

CONCLUSIONS

Notwithstanding all studies carried out on macrophytobenthos of Italian coast, much remains still to do. For example, the phytobenthos of many traits of coast of Calabria, Liguria, Sardinia, Sicily and of the Adriatic Sea is still poorly known. They should be studied also in order to obtain data on the quality of coastal waters on the basis of phytobenthic communities there occurring. Moreover, they could allow to find new introduced species the behaviour of which should be studied in order to protect indigenous communities and especially those of priority habitats.

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