G. Furnari, M. Cormaci & G. Giaccone

The benthic macroalgal flora of Italy: floristic and geobotanic considerations

Abstract

Furnari, G., Cormaci, M. & Giaccone, G.: The benthic macroalgal flora of Italy: floristic and geobotanic considerations. — Bocconea 16(1): 225-243. 2003. — ISSN 1120-4060.

Both floristic and geobotanic characteristics of the benthic macroalgal flora of Italy are discussed. The flora, obtained from literature records since 1950, consists of 869 (510 Rhodophyta, 205 Phaeophyta and 154 Chlorophyta) taxa accepted under current taxonomy. Ceramiales, Fucophyceae and Chlorophyceae of such a flora were separately compared with corresponding taxonomic lists of the following Mediterranean regions: Spain; France; Greece and Turkey; Libya, Egypt and Levant States (Syria, Lebanon and Israel); Morocco, Algeria and Tunisia. From that comparison it appears that the benthic macroalgal flora of the Italian coast is the richest in species, probably because it was the most studied especially in the last years. Hierarchical clustering of the above lists based on both floristic and phytogeographic characteristics were carried out and the results were expressed in dendrograms from which a noticeable floristic similarity among the lists can be drawn since the lists are linked above the 50% level of importance excepting those of the Libya, Egypt and Levant States (30 to 50%), which could represent a floristic discontinuity. However, such a discontinuity, due to the low number of species recorded in that area, could depend besides on the insufficient floristic knowledge, on both geomorphologic characteristics of coast and paleoclimatic events like sapropel crises. But, from dendrograms based on chorological spectra, it results a more marked degree of similarity among the lists that are linked above the 75% level of importance.

The first floristic knowledge of the benthic marine macroalgae of Italy is mainly due to papers published in the second half of the XIX century by C. Agardh (1822-23; 1828), J. Agardh (1842, 1851-1863), Ardissone (1883, 1886-87), Kützing (1849, 1854-69), Meneghini (1842-46).

Some more authors report , in their papers, algae from limited and/or particular areas: for example De Toni & Levi (1885-88), Hauck (1882-85), Naccari (1828), Schiffner (1914-26), Zanardini (1841, 1843, 1847,1858, 1860-71), report algae only from the Adriatic Sea; Solms-Laubach (1881), Delle Chiaje (1829), Reinke (1878), Berthold (1884), Valiante (1883), Falkenberg (1879, 1901), Mazza (1902), from the Gulf of Naples; others like Tornabene (1846), Philippi (1837), Langenbach (1873), Borzì (1886), Piccone (1889), Spinelli (1905), only from Sicilian coast.

Species quoted in the above papers, almost all reported in the huge Sylloge algarum by

De Toni (1889-1924), form the "historical" benthic macroalgal flora of the Italian coast. De Toni's Sylloge, which represents the compendium of the algal floristic knowledge to that date, marks the conclusion of the first season of algological studies of Italian coast. Then, one must wait the sixties for the beginning of a second season of algological studies dealing with Italian coast that has had and has still as main actors the present generation of Italian phycologists.

In fact, from 1925 to 1964, only few papers were published: by Schiffner & Vatova (1937) on algae from the Lagoon of Venice; by Levring (1942) on some algae from the Adriatic Sea, Sicily and the Gulf of Naples; by Funk (1927 and 1955) on the marine vegetation and on the benthic algal flora of the Gulf of Naples, respectively; by Molinier & Picard (1953) on some vegetational observations of the Sicilian coast; by Cavaliere (1957, 1959, 1960) on some algae from the Straits of Messina. Conversely, from 1962 to date very numerous algological papers were produced. Except for the paper by Pignatti (1962) on the Lagoon of Venice, such papers first dealt only with both northern and southern coast of Sicily: the Gulf of Palermo (Giaccone & De Leo 1966), the Island of Femmine (Palermo) (Giaccone & Sortino 1964), cape Zafferano (Palermo) (Giaccone 1965), Palma di Montechiaro (Agrigento) (Sortino 1967), the harbour of Licata (Agrigento) (Sortino 1968). Then, from 1970 to date, they dealt with eastern coast of Sicily (Furnari & Scammacca 1970a,b; 1971,1973; Cormaci & al. 1976, 1978; Cormaci & Furnari G. 1979a,b; Battiato & Ponte 1975,1978; Battiato & al. 1978), the Straits of Messina (Codomier & Giaccone 1972; Giaccone & Rizzi Longo 1976), the Straits of Sicily (Giaccone & al. 1972), the Island of Ustica and the Aeolian Islands (Giaccone 1971; Giaccone & al., 1985), the Island of Pantelleria (Giaccone & al. 1973), the Egadi Islands (Giaccone & Sortino 1974), the Island of Linosa (Cinelli & al. 1976), the Tuscanian coast (Tyrrhenian Sea) (Cinelli 1969,1971a; Papi & al. 1992; Pignatti & Rizzi 1972), the southern Tyrrhenian Sea (the Aeolian Islands and the Island of Ustica included) (Boudouresque & Cinelli 1971; Cinelli 1971b; Gargiulo & al 1985; Alongi & al. 1993; Cormaci & al. 1992), the Sardinia (Cossu & al. 1992; Solazzi 1969), the Liguran Sea (Benedetti-Cecchi & Cinelli 1992), the Adriatic Sea (the Tremiti Island included) (Giaccone 1978; Furnari & al. 1999; Solazzi 1965,1967; 1976), the high Ionian Sea (Cecere & al. 1991, 1996) and the Island of Lampedusa (Scammacca & al. 1993).

However, in spite of the publication of the above mentioned papers, the floristic knowledge of the benthic marine macroalgae of Italian coast is still irregular and not complete. In fact, while some areas resulted well studied (e.g. the Gulf of Naples, Sicily and adjacent islands, the high Adriatic Sea, the Tremiti Islands, the Gulf of Taranto), some others are still insufficiently studied (e.g. the Ligurian Sea, Sardinia, the coast of Latium, the coast of Calabria, etc.).

With a grant of the Italian Ministry of the Environment, Furnari & al. (2003) have compiled a check-list of the benthic macroalgal Italian flora. In order to give a picture as much corresponding as possible to the present composition, only references published since 1950 have been used. Over 600 papers were considered, in which a total of 1120 taxa at specific and infraspecific level were reported. Following a critical taxonomic and nomenclatural revision, apart from 56 *Cyanophyta*, 79 *taxa inquirenda* (the taxonomic value of which remains uncertain without a revision of herbarium specimens) and 31 *taxa excludenda* (the records of which are probably due to misidentifications since refer to species not present

in the Mediterranean Sea) not considered in this paper, the Italian flora resulted of 509 *Rhodophyta*, 208 *Phaeophyta* and 154 *Chlorophyta* for a total of 871 accepted taxa (Table 1). However, it should be noted that most species of the *Laurencia complex* and of non-geniculate Coralline algae were only tentatively included in the accepted taxa. In fact, because the taxonomy of such groups has recently undergone substantial reassessments, in absence of the study of herbarium specimens, the occurrence of most of such species should be confirmed.

Since the Italian coasts fall within the FAO fishering sectors 3 (Tyrrhenian Sea and adjacent basins), 4 (Adriatic Sea) and 5 (Ionian Sea), the floristic consistency of each sector was calculated. The flora of the sector 3 is the richest with 769 taxa (470 *Rhodophyta*, 169 *Phaeophyta* and 130 *Chlorophyta*), followed by that of the sector 5 with 702 taxa (444 *Rhodophyta*, 148 *Phaeophyta* and 110 *Chlorophyta*) and by that of the sector 4 that resulted the poorest with 577 taxa (340 *Rhodophyta*, 124 *Phaeophyta* and 113 *Chlorophyta*). The three sectors share 491 taxa (equal to 56.4%), while 90 taxa (10.3%) are present only in the sector 3, 39 taxa (4.5%) in the sector 4 and 52 taxa (6.0%) in the sector 5 (Table 1). In order to understand the phytogeographic characteristics of the Italian flora, a specific investigation of the areals of every species has been conducted. Following that study, each species was assigned to a distribution-group named according to Cormaci & al. (1982). Chorological spectra (Table 2 and Fig. 1) of the Italian flora and of floras of sectors 3 and 5 are characterised by a dominance of the Atlantic element, followed by the Mediterranean, Cosmopolitan, Indo-Pacific, Circumtropical and Circumboreal; only that of the sector 4 shows a different sequence of distribution groups with the dominance of the Atlantic element, followed by the Cosmopolitan, Mediterranean, Circumtropical, Indo-Pacific and Circumboreal.

Table 1. The macroalgal italian flora: composition of the whole flora, of floras of each FAO sector (sector 3: Tyrrhenian Sea and adjacent basins; sector 4: Adriatic Sea; sector 5: Ionian Sea), of common species to all sectors as well as of sole species of each sector.

	Italy	sector 3	sector 4	sector 5	common species	sole species of sector 3	sole species of sector 4	sole species of sector 5
Rhodophyta	509	470	340	444	314	44	4	32
	58.4%	61.1%	58.9%	63.2%				
Phaeophyta	208	169	124	148	93	26	21	15
	23.9%	22.0%	21.5%	21.1%				
Chlorophyta	154	130	113	110	84	20	14	5
	17.7%	16.9%	19.6%	15.7%				
Total	**871**	**769**	**577**	**702**	**491**	**90**	**39**	**52**
		88.3%	66.2%	80.6%	56.4%	10.3%	4.5%	6.0%

Table 2. Chorological spectra of the whole macroalgal italian flora and of floras of each FAO sector.

Distribution groups	Italy	sector 3	sector 4	sector 5
Atlantic	390	342	253	302
	44.8%	44.5%	43.8%	43.0%
Mediterranean	238	204	132	180
	27.3%	26.5%	22.9%	25.6%
Cosmopolitan	156	147	137	145
	17.9%	19.1%	23.7%	20.7%
Indo-Pacific	40	33	20	32
	4.6%	4.3%	3.5%	4.6%
Circumtropical	33	31	24	29
	3.8%	4.0%	4.2%	4.1%
Circumboreal	14	12	11	14
	1.6%	1.6%	1.9%	2.0%
Total	**871**	**769**	**577**	**702**

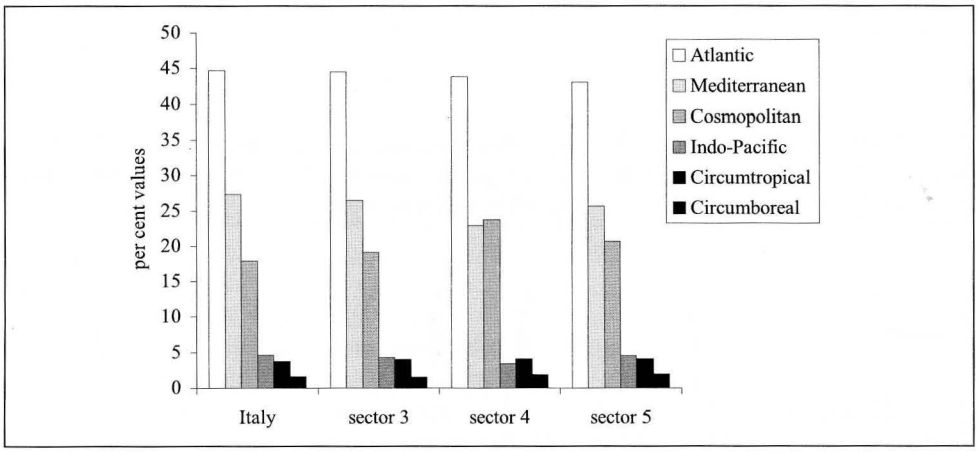

Fig. 1. Hystogram showing the percentages of species of the Italian flora and of floras of each FAO sector belonging to each distribution group.

The floras of the three sectors have been compared so as to establish the degree of both floristic and phytogeographic similarities among them, as expressed by Jaccard's (1932) and Kulczynski's (1927) similarity indices, respectively. A hierarchical clustering was then carried out with an agglomerative centroid method (Sokal & Sneath 1963). The results are

expressed in the dendrograms of Figs 2-3. The dendrogram of Fig. 2 shows a remarkable similarity between the floras of the Tyrrhenian Sea and the Ionian Sea being linked to a level of importance near to 80%, while that of the Adriatic Sea is linked to the previous group to a level of importance of about 65%. The same pattern of similarity, but with linkages at higher level of importance, is shown by the dendrogram based on chorological spectra (Fig. 3). In both cases the Adriatic flora could represent a discontinuity probably due to the lowest total number of species and to the lowest per cent value of the Mediterranean element, from a floristic and a phytogeographic point of view, respectively. The relatively low per cent value of the Mediterranean element in the Adriatic flora is probably due to the limited extension of the rocky circalittoral zone where Mediterranean element is generally dominant (Boudouresque 1973).

In the last years, three check-lists of Mediterranean Fucophyceae, Chlorophyceae and Ceramiales, based on references since 1950, were compiled by Ribera & al. (1992), Gallardo & al. (1993) and Gómez Garreta & al. (2001), respectively. From such papers we

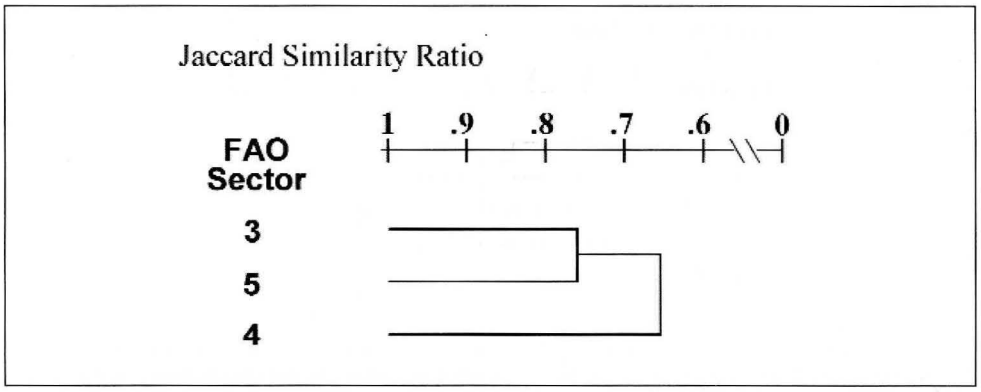

Fig. 2. Dendrogram depicting mutual floristic similarities of floras of the three FAO sectors.

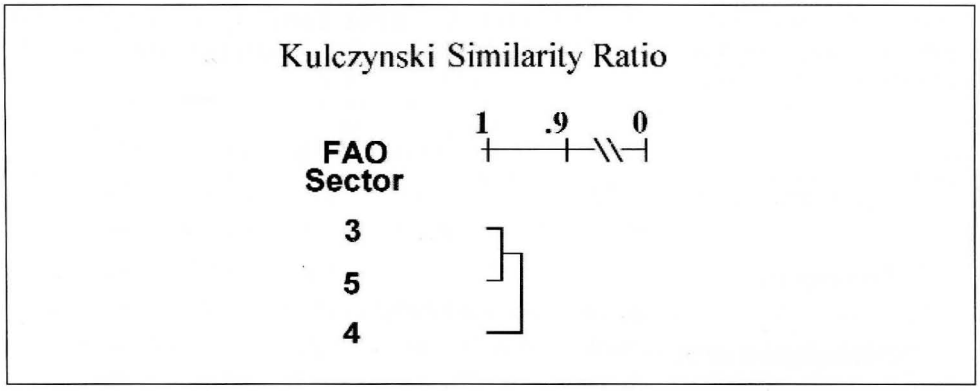

Fig. 3. Dendrogram depicting mutual chorological similarities of floras of the three FAO sectors.

drew lists of Fucophyceae, Chlorophyceae and Ceramiales of five Mediterranean areas delimited as follows: (SPA) Spain, (FRA) France, (GTR) Greece and Turkey, (LEL) Libya, Egypt and Levant States (Syria, Lebanon and Israel), (MAT) Morocco, Algeria and Tunisia. Then, the above lists were compared with the corresponding systematic lists of the Italian coast (ITA). From this comparison it resulted that the number of specific and infra-specific taxa accepted for the Mediterranean Sea is 243 Fucophyceae, 178 Chlorophyceae and 260 Ceramiales (Table 3). Italy and France resulted the richest in species areas with 215 (82.7%) and 214 *Ceramiales* (82.3%), 205 (84.3%) and 157 (64.6%) *Fucophyceae*, 154 (86.5%) and 122 (68.5%) *Chlorophyceae*, respectively. Conversely, the LEL area resulted the poorest in species with only 128 (49.2%) *Ceramiales*, 74 (30.4%) *Fucophyceae* and 72 (40.4%) *Chlorophyceae* (Table 3). Species common to all areas are 90 *Ceramiales* (34.6%), 54 *Fucophyceae* (22.2%) and 48 *Chlorophyceae* (29.9%) while very few resulted the sole ones: 12 (4.6%), 30 (12.3%), 21 (11.7%) at Italy; 3 (1.1%), 4 (1.6%) and 2 (1.1%) at Spain; 5 (1.9%), 11 (4.5%) and 6 (3.3%) at France; 2 (0.7%), 2

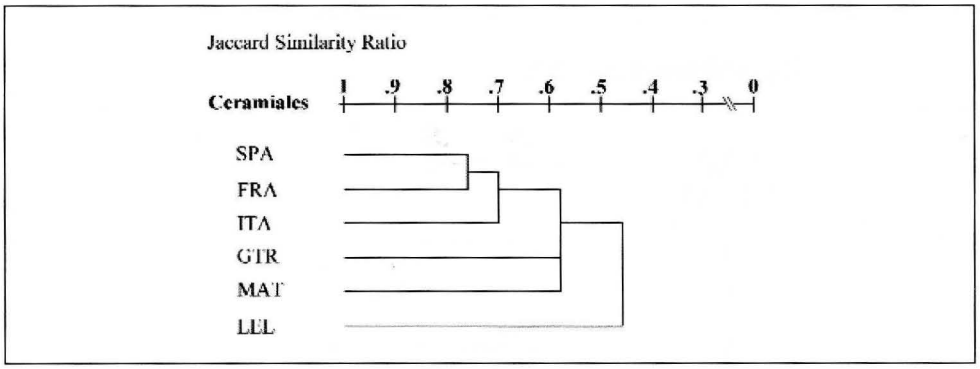

Fig. 4. Dendrogram depicting mutual floristic similarities of *Ceramiales* of the six floras investigated.

Table 3. Composition of the six Mediterranean macroalgal floras investigated. ITA (Italy), SPA (Spain), FRA (France), GTR (Greece and Turkey) LEL (Libya, Egypt and Levant States), MAT (Morocco, Algeria and Tunisia). In brackets the total number of species recorded from the Mediterranean Sea.

	ITA	SPA	FRA	GTR	LEL	MAT
Ceramiales (260)	215	205	214	175	128	174
	82.7%	78.8%	82.3%	67.3%	49.2%	66.9%
Fucophyceae (243)	205	134	157	120	74	119
	84.4%	55.1%	64.6%	49.4%	30.5%	49.0%
Chlorophyceae (178)	154	120	122	95	72	90
	86.5%	67.4%	68.5%	53.4%	40.4%	50.6%

Table 4. Number of common species to all Mediterranean floras investigated as well as of sole species of each flora. In the second line per cent values.

	Common species to all floras	Sole species per flora					
		ITA	SPA	FRA	GTR	LEL	MAT
Ceramiales	90	12	3	5	2	4	1
	34.6%	4.6%	1.1%	1.9%	0.7%	1.5%	0.3%
Fucophyceae	54	30	4	11	2	3	3
	22.2%	12.3%	1.6%	4.5%	0.8%	1.2%	1.2%
Chlorophyceae	48	21	2	6	2	5	2
	29.9%	11.7%	1.1%	3.3%	1.1%	2.8%	1.1%

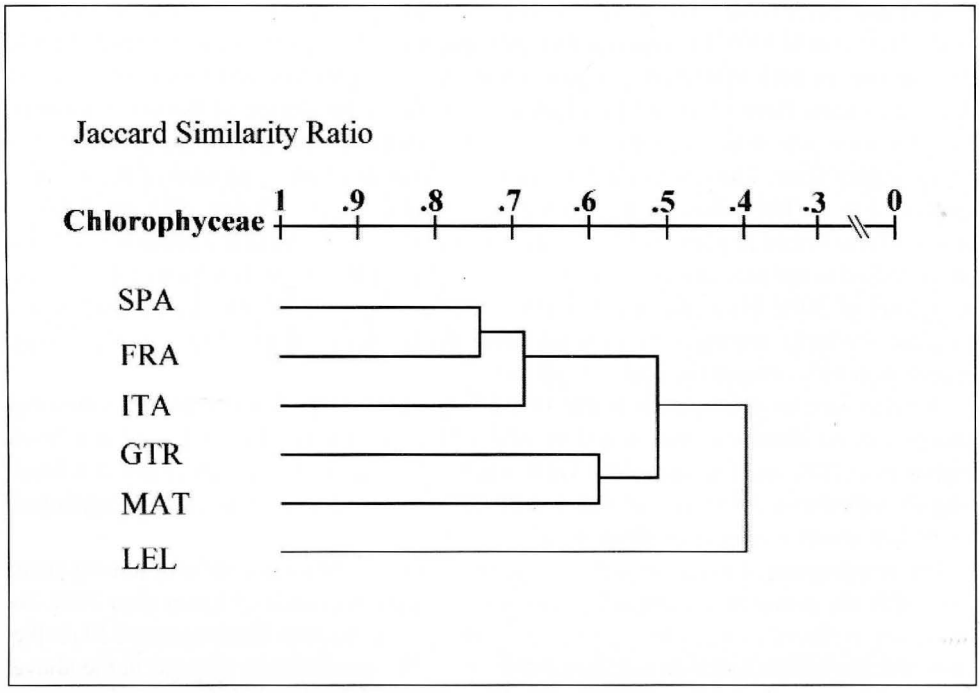

Fig. 5. Dendrogram depicting mutual floristic similarities of *Chlorophyceae* of the six floras investigated.

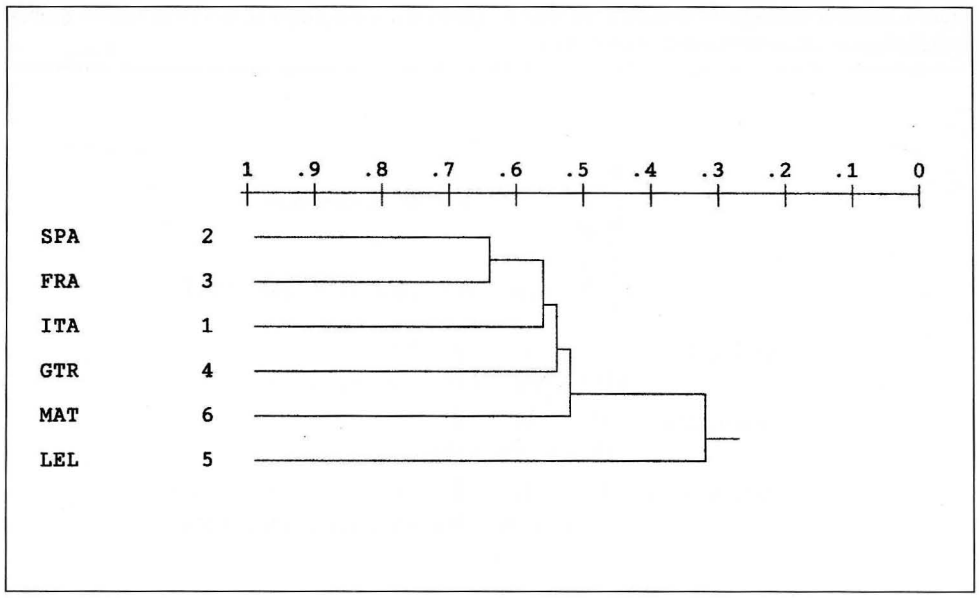

Fig. 6. Dendrogram depicting mutual floristic similarities of *Fucophyceae* of the six floras investigated.

(0.8%) and 2 (1.1%) at GTR; 4 (1.5%), 3 (1.2%) and 5 (2.8%) at LEL; 1 (0.3%), 3 (1.2%) and 2 (1.1%) at MAT of *Ceramiales*, *Fucophyceae* and *Chlorophyceae*, respectively (Table 4). The lists of each systematic group (*Ceramiales*, *Fucophyceae* and *Chlorophyceae*) of the above areas have been compared so as to establish the degree of floristic similarity between each pair of the six areas, using the same methodology as for comparisons within the Italian flora. The results dealing with the *Ceramiales* are expressed in the dendrogram of Fig. 4. The following groups can be identified: that including SPA and FRA to which ITA is linked at a level of importance higher than 70% and that including GTR and MAT, linked to the previous one at a level slightly higher than 60%, to which LEL is linked at a level of 50%. From the dendrogram, the following conclusions can be drawn: the floristic similarity among areas is remarkable being all linked to a level of importance higher than 60%, except the LEL one (50%).

A rather similar dendrogram is that of *Chlorophyceae* (Fig. 5) in which the following groups can be identified: that including SPA and FRA to which ITA is linked at a level higher than 70% and that including GTR and MAT linked to the previous one at a level slightly superior to 50%. Also in this dendrogram LEL seems rather isolated being linked to the last group at a level of about 40%.

The dendrogram of *Fucophyceae* (Fig. 6) shows a lower floristic similarity among areas since only the group SPA and FRA can be identified linked at a level lower than 70%. To this group is linked ITA at a level lower than 60%. As in previous dendrograms LEL is the area with the lowest value of linkage (about 30%). The discontinuity showed in the above three dendrograms by LEL area, due to the low number of species in each systematic group,

Table 5. Chorological spectra of Ceramiales of the Mediterranean Sea and of each Mediterranean flora investigated.

Distribution groups	Mediterranean Sea	ITA	SPA	FRA	GTR	LEL	MAT
Atlantic	125	105	101	103	94	69	86
	48.1%	48.8%	49.2%	48.1%	53.7%	53.9%	49.4%
Cosmopolitan	31	26	27	29	25	24	25
	11.9%	12.0%	13.1%	13.5%	14.2%	18.7%	14.3%
Circumboreal	1	1	0	1	1	0	1
	0.3%	0.4%	0%	0.4%	0.5%	0%	0.5%
Indo-Pacific	15	12	8	12	8	7	7
	5.7%	5.5%	3.9%	5.6%	4.5%	5.4%	4.0%
Mediterranean	80	65	61	61	39	21	49
	30.7%	30.2%	29.7%	28.5%	22.2%	16.4%	28.1%
Circumtropical	8	6	8	8	8	7	6
	3.0%	2.7%	3.9%	3.7%	4.5%	5.4%	3.4%

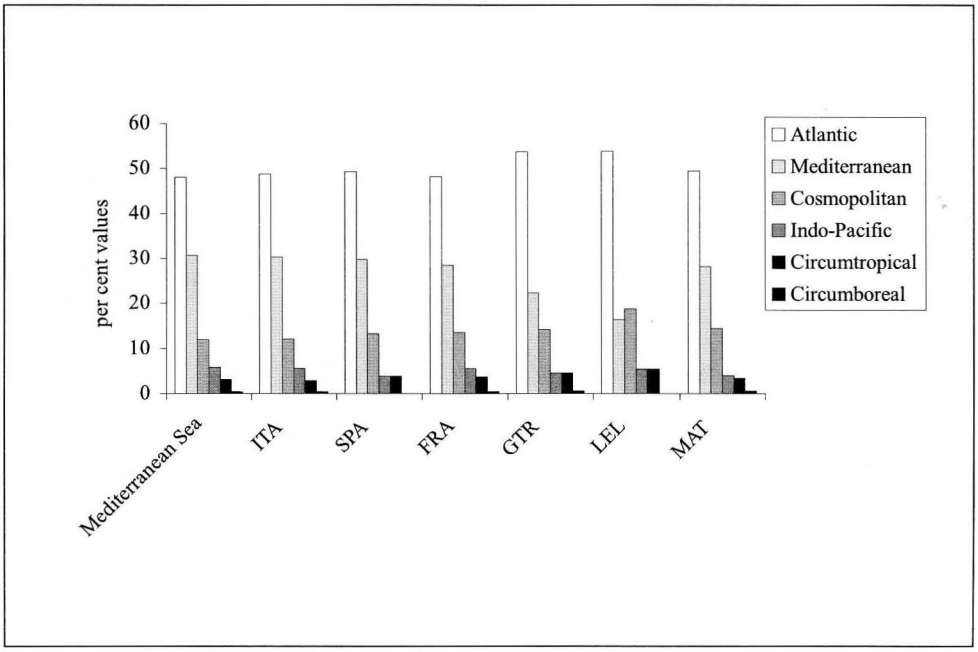

Fig. 7. Hystogram showing the percentages of *Ceramiales* of the six floras investigated belonging to each distribution group.

Table 6. Chorological spectra of Fucophyceae of the Mediterranean Sea and of each Mediterranean flora investigated.

Distribution groups	Mediterranean Sea	ITA	SPA	FRA	GTR	LEL	MAT
Atlantic	102	79	53	57	42	20	48
	41.9%	38.5%	39.5%	36.3%	35.0%	27.0%	40.3%
Cosmopolitan	35	35	33	31	30	26	30
	14.4%	17.0%	24.6%	19.7%	25.0%	35.1%	25.2%
Circumboreal	5	4	4	5	3	1	2
	2.0%	1.9%	2.9%	3.1%	2.5%	1.3%	1.6%
Indo-Pacific	13	8	4	9	4	5	5
	5.3%	3.9%	2.9%	5.7%	3.3%	6.7%	4.2%
Mediterranean	83	74	37	52	38	18	31
	34.1%	36.0%	27.6%	33.1%	31.6%	24.3%	26.0%
Circumtropical	5	5	3	3	3	4	3
	2.0%	2.4%	2.2%	1.9%	2.5%	5.4%	2.5%

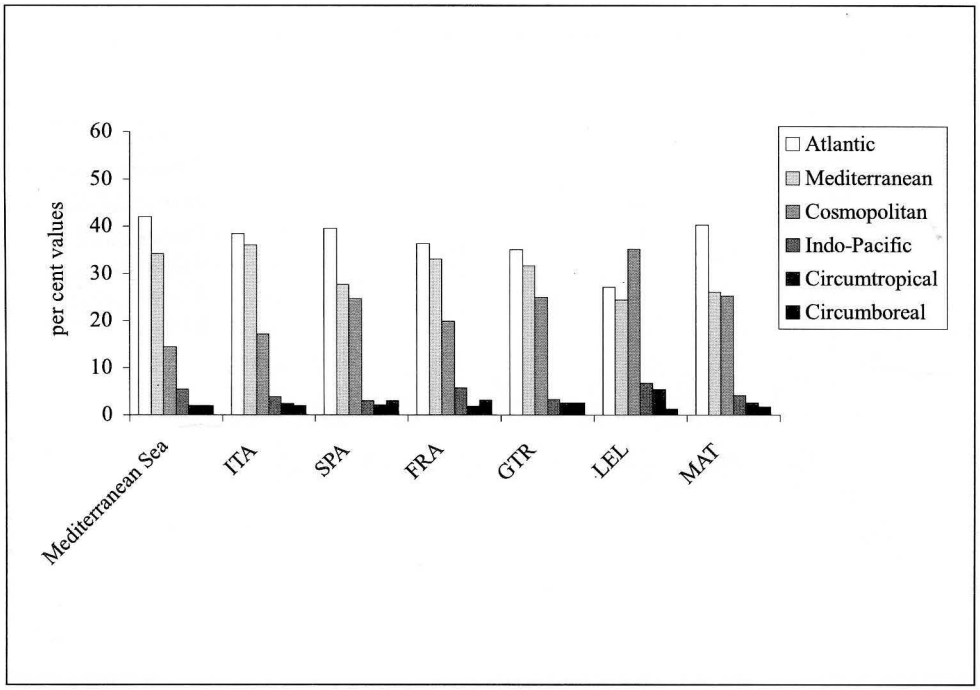

Fig. 8. Hystogram showing the percentages of *Fucophyceae* of the six floras investigated belonging to each distribution group.

Table 7. Chorological spectra of Chlorophyceae of the Mediterranean Sea and of each Mediterranean flora investigated.

Distribution groups	Mediterranean Sea	ITA	SPA	FRA	GTR	LEL	MAT
Atlantic	79	68	53	52	40	25	36
	44.3%	44.1%	44.1%	42.6%	42.1%	34.7%	40.0%
Cosmopolitan	42	42	33	35	32	22	29
	23.5%	27.2%	27.5%	28.6%	33.6%	30.5%	32.2%
Circumboreal	2	1	1	2	2	1	1
	1.1%	0.6%	0.8%	1.6%	2.1%	1.3%	1.1%
Indo-Pacific	12	7	7	4	4	8	5
	6.7%	4.5%	5.8%	3.2%	4.2%	11.1%	5.5%
Mediterranean	29	24	17	20	9	7	9
	16.2%	15.5%	14.1%	16.3%	9.4%	9.7%	10.0%
Circumtropical	14	12	9	9	8	9	10
	7.8%	7.7%	7.5%	7.3%	8.4%	12.5%	11.1%

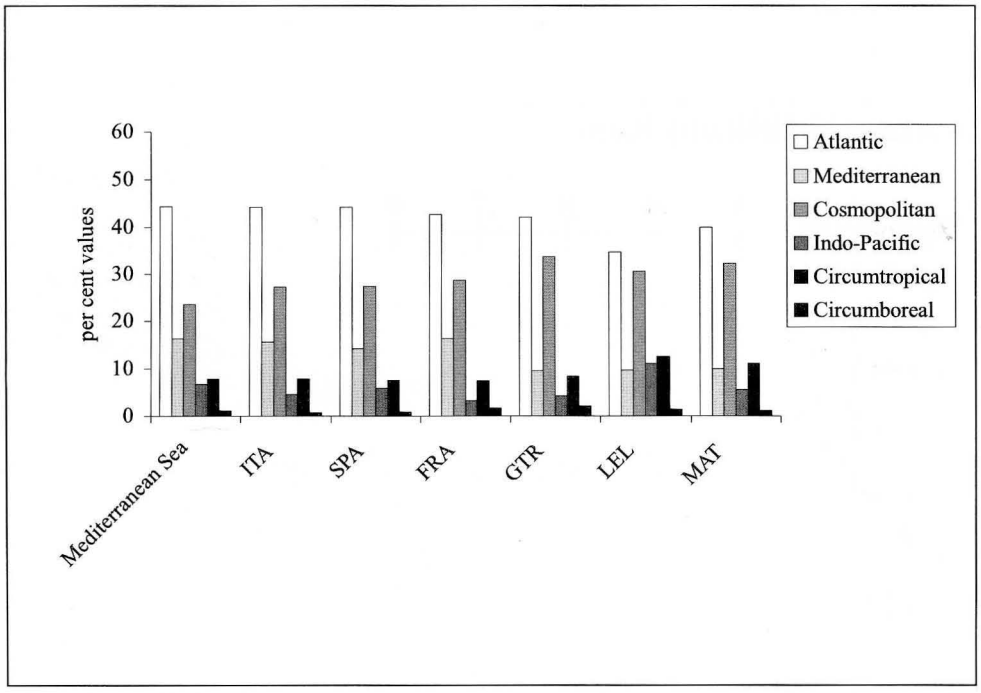

Fig. 9. Hystogram showing the percentages of *Chlorophyceae* of the six floras investigated belonging to each distribution group.

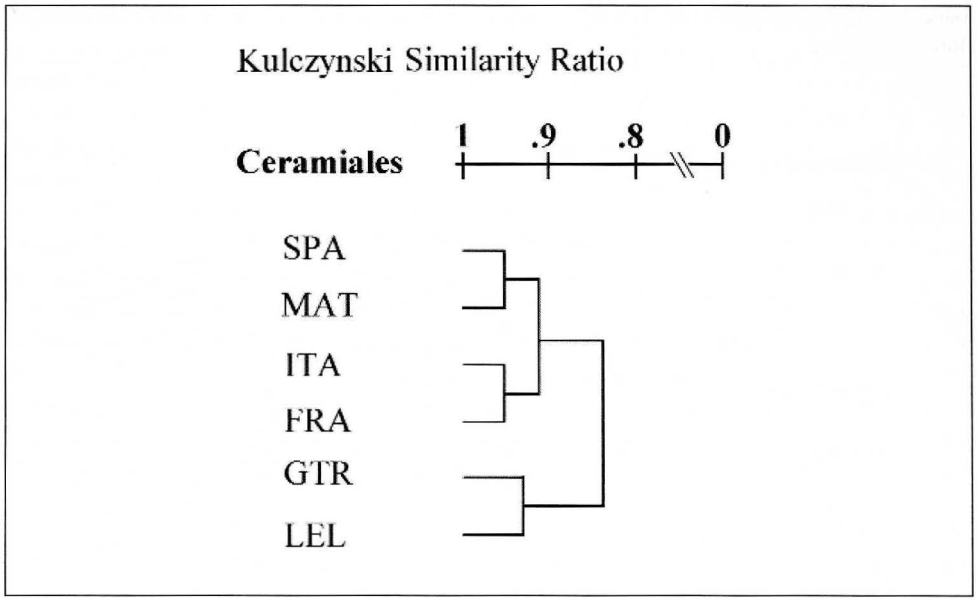

Fig. 10. Dendrogram depicting mutual chorological similarities of *Ceramiales* of the six floras investigated.

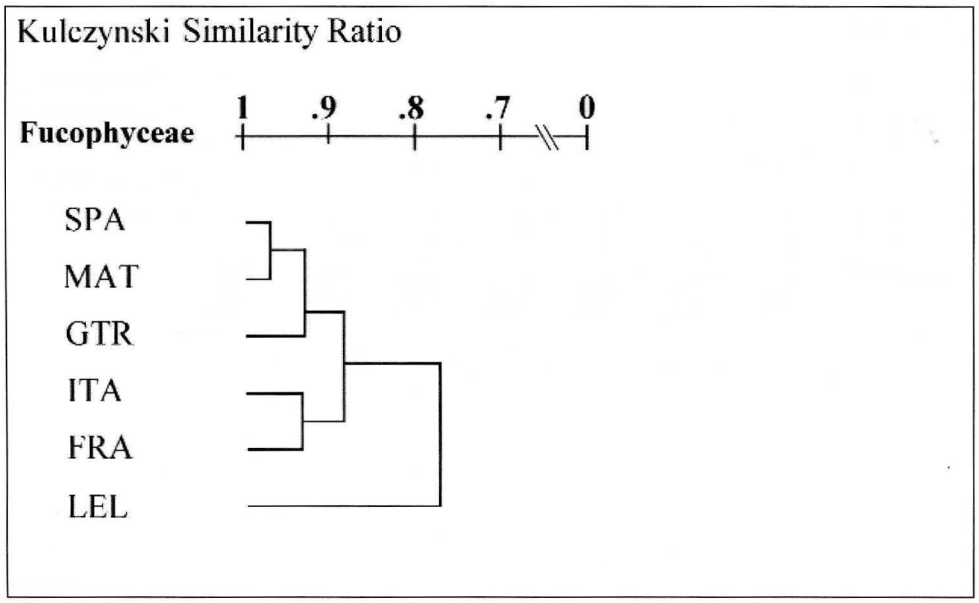

Fig. 11. Dendrogram depicting mutual chorological similarities of *Fucophyceae* of the six floras investigated.

could depend besides on the insufficient floristic knowledge of that area, also on both geomorphologic characteristics of its coast (with rather reduced traits of rocky shores) and paleoclimatic events like sapropel crises (Giaccone & al. 1997). In order to understand the phytogeographic characteristics of different areas, following a specific investigation of the areals of every species, the chorological spectrum of *Ceramiales* (Table 5 and Fig. 7), *Fucophyceae* (Table 6 and Fig. 8) and *Chlorophyceae* (Table 7 and Fig. 9) of each area was calculated. On this basis, the phytogeographic similarity among different areas has been established and a hierarchical clustering has been carried out using the same methodology as for phytogeographic comparisons within the Italian flora. In the dendrogram of *Ceramiales* (Fig. 10), the following groups can be identified: SPA-MAT and ITA-FRA linked at a level higher than 90% and GTR-LEL linked to the first two groups at a value higher than 80%. Such a dendrogram is very similar to that of *Fucophyceae* (Fig. 11) in which the following groups can be detected: SPA-MAT at a level of importance of about 95% to which GTR is linked at a level of about 93% and ITA-FRA at a level of about 93% linked to the previous group at about 90%. The LEL area is linked to both the previous groups at a level of about 75%. In the dendrogram of *Chlorophyceae* (Fig. 12) areas are always linked at high level of importance (the lowest value is higher than 80%), but the resulting groups (ITA and SPA with FRA linked at a level of importance higher than 95%; GTR and MAT linked to the previous group at a level of about 90% and LEL linked to the previous groups at a level of about 85%) are different from those identifiable in the previous dendrogram.

From the above comparisons it resulted that from a phytogeographic point of view the Mediterranean areas here considered have a higher degree of similarity than that shown from

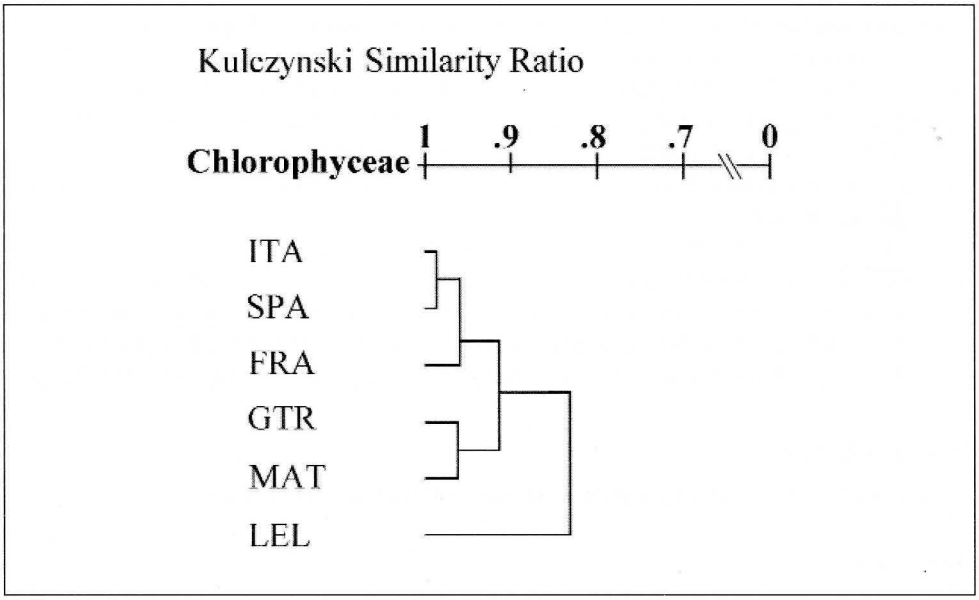

Fig. 12. Dendrogram depicting mutual chorological similarities of *Chlorophyceae* of the six floras investigated.

a floristic point of view. No marked discontinuities, at least at large scale, resulted even though in limited areas chorological spectra can show peculiar characteristics [e.g. the Straits of Messina with marked Atlantic characteristics (Giaccone & Rizzi Longo 1976); the banks of the Straits of Sicily with marked Mediterranean characteristics (Cinelli 1981), etc.].

In conclusion, from this study it resulted a noticeable similarity among the six Mediterranean areas here considered from both floristic and phytogeographic point of views with the only exception, as above mentioned, of the LEL area. Moreover, it should be pointed out that the benthic macroalgal flora of Italy is the richest in species. That is due, besides the high number of phycological studies carried out along its coasts (especially in the last years), also because Italy has a noticeable extension of rocky shores that are, moreover, washed by three seas: Tyrrhenian, Ionian and Adriatic.

Finally, it should be pointed out that, even though algal lists taken into consideration are based on references since 1950 in order to represent as well as possible the present composition, for some areas they can be already considered as "historical". In fact, very recent studies have shown noticeable changes in the floristic composition in some areas occurred in the last decades: for example, at the Tremiti Islands (Adriatic Sea, Italy), from a floristic study carried out in the year 1997 and published in 2000 (Cormaci & al. 2000) it resulted that of 275 species reported in literature between the late '60s and early '70s, 108 species (about 40% of that flora) were not found. Conversely, 153 species (about 47% of the present flora) were newly reported.

At Maddalena Peninsula (near Syracuse, Italy), from a study by Marino & al. (1999) it resulted that of 305 macroalgal species reported in literature up to 1980, 70 species (about 23% of that flora) were not found. Conversely, 164 species (about 41% of the present flora) were newly reported.

At the Ciclopi Islands (near Catania, Italy), from an unpublished study carried out in the year 2000 (Serio, personal communication), it resulted that of 364 species reported in literature between 1969 and 1989, 135 species (37% of that flora) were not found while 46 species (about 17% of the present flora) were newly reported. It is probable that similar changes, that are verifying in different areas of the Mediterranean Sea, are due to different factors like the increasing of the average temperature of the seawater, the increasing of discharge of both chemical pollutant and/or of inert material causing a noticeable increasing of water turbidity, etc.

Therefore, the drawing of check-lists, like those of *Fucophyceae*, *Chlorophyceae*, *Ceramiales* of the Mediterranean Sea, and/or floras, like that of Italy here discussed, assume, in our opinion, a particular value. In fact, on one hand they testify which species were present in a certain historical period in different areas of the Mediterranean Sea, on the other they represent a starting point letting to check possible changes as they happen.

Acknowledgements

This work was supported by a grant of the University of Catania (ex 60%).

References

Agardh, C. A. 1822-1823: Species algarum. vol. 1 part 2. — Lund.
— 1828: Species algarum. vol. 2. — Lund.

Agardh, J. G. 1842: Algae maris mediterranei et adriatici. — Ed. Masson, Paris.
— 1851-1863: Species genera et ordines algarum. Volumen secundum: algas Florideas complectens. — Pars prior (1851) 1-336 + I-XII; Pars secunda (1852) 337-786; Pars tertia (1863) 787-1291 (Pp 1139-1158 omitted). — Lundae [Lund].
Alongi, G., Pizzuto, F., Scammacca, B. & Giaccone, G. 1993: La flora sommersa dell'isola di Vulcano (Isole Eolie). — Boll. Acc. Gioenia Sc. Nat. Catania **26:** 273-291.
Ardissone, F. 1883: Phycologia Mediterranea. Parte prima. Floridee. — Mem. Soc. Crittog. Ital. **1:** 516 Pp.
— 1886-1887: Phycologia Mediterranea. Parte seconda. Oosporee-Zoosporee-Schizosporee. — Memorie della Società Crittogamologica Italiana **2:** 1-128 (1886), 129-325 (1887).
Battiato, A., Duro, A. & Galluzzo G. 1978: Flora sommersa della Baia di Brucoli (Siracusa). Secondo contributo con osservazioni preliminari sui Briozoi. — Boll. Acc. Gioenia Sc. Nat. Catania **13:** 105-117.
— & Ponte, A. 1975: Flora sommersa della Baia di Brucoli (Siracusa). Primo contributo. — Atti Acc. Gioenia Sc. Nat. Catania **7:** 93-99.
— & — 1978: Osservazioni preliminari sulla flora algale di Pozzillo (Sicilia orientale). — Boll. Acc. Gioenia Sc. Nat. Catania **13:** 71-80.
Benedetti Cecchi, L. & Cinelli, F. 1992: Canopy removal experiments in *Cystoseira*-dominated rockpools from the Western coast of the Mediterranean (Ligurian Sea). — J. Exp. Mar. Biol. Ecol. **155:** 69-83.
Berthold, G. 1884: Die Cryptonemiaceen des golfes von Neapel. Fauna und Flora des golfes von Neapel **12**. — Lipsia.
Borzì, A. 1886: Nuove Floridee Mediterranee. — Notarisia **1:** 70-72.
Boudouresque, Ch. F. 1973: Recherches de bionomie analytique, structurale et expérimentale sur les peuplements benthiques sciaphiles de Méditerranée occidentale (fraction algale). Les peuplements sciaphiles de mode relativement calme sur substrats durs. — Bull. Mus. Hist. Nat. Marseille **33:** 147-225.
— & Cinelli, F. 1971: Le peuplement algal des biotopes sciaphiles superficiels de mode battu de l'Ile d'Ischia (Golfe de Naples, Italia. Pubbl. Staz. Zool. Napoli **39**: 1-43.
Cavaliere, A. 1957: Algologia dello stretto di Messina. Nota preliminare. — Boll. Pesca Piscic. Idrobiol. **11**: 281-282.
— 1959: Ricerche sulla flora algologica dello stretto di Messina. I contributo. — Boll. Ist. Bot. Univ. Catania, ser. II, **1:** 155-179.
— 1960: Ricerche sulla flora algologica dello stretto di Messina. II contributo. — Boll. Ist. Bot. Univ. Catania, ser. II, **3:** 78-88.
Cecere, E., Cormaci, M. & Furnari, G. 1991: The marine Algae of Mar Piccolo, Taranto (Southern Italy): A re-assessment. — Botanica Marina **34:** 221-228.
— , —, —, Petrocelli, A., Saracino, O. & Serio, D. 1996: Benthic algal flora of Cheradi islands (Gulf of Taranto, Mediterranean Sea). — Nova Hedwigia **62:** 191-214.
Cinelli, F. 1969: Primo contributo alla conoscenza della vegetazione algale bentonica del litorale di Livorno. — Pubbl. Staz. Zool. Napoli **37:** 545-566.
— 1971a: Biologia delle secche della Meloria (Mar Tirreno) IV. Contributo alla conoscenza della vegetazione bentonica marina. — Boll. Pesca Piscic. Idrobiol. **26:** 5-20.
— 1971b: Alghe di profondità raccolte alla Punta S. Pancrazio nell'isola di Ischia (Golfo di Napoli). — Giorn. Bot. Ital. **105:** 207-236.
— 1981: Biogeography and ecology of the Sicily channel. I. The algae of the banks. — Pp: 234-240 in: Levring, T. (ed.), Xth International Seaweed Symposium. Walter de Gruyter and Co. — Berlin.
— , Drago, D., Furnari, G., Giaccone, G., Scammacca, B., Solazzi, A., Sortino, M. & Tolomio, C.

1976: Flora marina dell'isola di Linosa (Arcipelago delle Pelagie). — Mem. Biol. Mar. Ocean. **6:** 141-172.

Codomier, L. & Giaccone, G. 1972: Sur quelques algues du Détroit de Messine et des environs de la Sicile. — Giorn. Bot. Ital. **106:** 339-349.

Cormaci, M., Duro, A. & Furnari, G. 1982: Considerazioni sugli elementi fitogeografici della flora algale della Sicilia. — Atti 13° Congresso SIBM. Il Naturalista Siciliano **6 (Suppl.):** 7-14.

— & Furnari, G. 1979a: Flora algale della penisola della Maddalena (Siracusa). — Thalassia Salentina **9:** 3-18.

— & — 1979b: Flora algale marina della Sicilia orientale: "*Rhodophyceae*, *Phaeophyceae* e *Chlorophyceae*". — Inform. Bot. Ital. **11:** 221-250.

— , —, Alongi, G., Catra, M., Serio, D. 2000: The benthic algal flora on rocky substrata of the Tremiti Islands (Adriatic Sea). — Plant Biosystems **134:** 133-152.

— , — & Scammacca, B. 1976: Su alcune specie interessanti della flora algale della Sicilia orientale. — Boll. Pesca Piscic. Idrobiol. **31:** 177-186.

— , — & Scammacca, B. 1978: Ricerche floristiche sulle alghe marine della Sicilia orientale. Terzo Contributo. — Boll. Acc. Gioenia Sc. Nat. Catania **13:** 27-44.

— , —, —, Serio, D., Pizzuto, F., Alongi, G. & Dinaro, R. 1992: La vegetazione marina di substrato duro dell'isola di Salina (Isole Eolie). — Boll. Acc. Gioenia Sc. Nat. Catania **25:** 115-144.

Cossu, A. Gazale, V. & Baroli, M. 1992: La flora marina della Sardegna: inventario delle alghe bentoniche. — Giorn. Bot. Ital. **126:** 651-707.

Delle Chiaje, S. 1829: Hydrophytologia Regni Neapolitani. — Neapoli.

De Toni, G. B. 1889: Sylloge Algarum omnium hucusque cognitarum. Vol. I. *Chlorophyceae*. Sectio I-II. — Patavii: 1315.

— 1895: Sylloge Algarum omnium hucusque cognitarum. Vol. III. *Fucoideae*. — Patavii III: 638.

— 1897: Sylloge Algarum omnium hucusque cognitarum. Vol. IV. *Florideae*, Sectio I. — Patavii IV: 388.

— 1900: Sylloge Algarum omnium hucusque cognitarum. Vol. IV. *Florideae*, Sectio II. — Patavii IV: 387-776.

— 1903: Sylloge Algarum omnium hucusque cognitarum. Vol. IV. *Florideae*, Sectio III. — Patavii IV: 775-1525.

— 1905: Sylloge Algarum omnium hucusque cognitarum. Vol. IV. *Florideae*. Sectio IV. — Patavii IV: 1523-1973.

— 1924: Sylloge Algarum omnium hucusque cognitarum. Vol. VI. *Florideae*, Sectio V, Additamenta. — Patavii VI: 767.

— & Levi, D. 1885: Flora algologica della Venezia. Parte prima. Le Floridee. — Tip. Antonelli, Venezia.

— & — 1886: Flora algologica della Venezia. Parte seconda. Le Melanoficee. — Tip. Antonelli, Venezia.

— & — 1888: Flora algologica della Venezia. Parte terza. Le Cloroficee. — Tip. Antonelli, Venezia.

Falkenberg, P. 1879: Die Meeres-Algen des Golfes von Neapel. Nach beobachtungen in der Zool. Station während der Jahre 1877-78 zusammengestellt. — Mitteilungen der Zoologischen Station zu Neapel **1:** 218-277.

— 1901: Die Rhodomelaceen des Golfes von Neapel und der angrenzenden Meeres-abschnitte. — Fauna und Flora des Golfes von Neapel, Monographie **26**. — Berlin.

Funk, G. 1927: Die Algenvegetation des Golfs von Neapel. — Pubbl. Staz. Zool. Napoli **7** (suppl.).

— 1955: Beitrage zur kenntnis der Meeresalgen von Neapel. — Pubbl. Staz. Zool. Napoli **25** (suppl.).

Furnari, G., Cormaci, M. & Serio, D. 1999: Catalogue of the benthic marine macroalgae of the Italian coast of the Adriatic Sea. — Bocconea **12:** 5-214.

— , Giaccone, G., Cormaci M., Alongi G. & Serio D. 2003 : Biodiversità marina delle coste italiane: catalogo del macrofitobenthos. — Biol. Mar. Medit. **10(1):** 3-483.

— & Scammacca, B. 1970a: Ricerche floristiche sulle alghe marine della Sicilia orientale. —Boll. Acc. Gioenia Sc. Nat. Catania **10:** 215-230.

— & Scammacca, B. 1970b: Flora algale dell'isola Lachea (Golfo di Catania). — Giorn. Bot. Ital. **104:** 137-164.

— & Scammacca, B. 1971: Nuovi ed interessanti ritrovamenti algologici nel litorale della Sicilia orientale. — Boll. Acc. Gioenia Sc. Nat. Catania **10:** 656-662.

— & Scammacca, B. 1973: Ricerche floristiche sulle alghe marine della Sicilia orientale. Nuovo contributo. — Boll. Acc. Gioenia Sc. Nat. Catania **11:** 1-22.

Gallardo, T., Gómez Garreta, A., Ribera, M. A., Cormaci, M., Furnari, G., Giaccone, G. & Boudouresque, C. F. 1993: Check-list of Mediterranean Seaweeds. II. *Chlorophyceae* Wille *s. l.* — Bot. Mar. **36:** 399-421.

Gargiulo, G.M., De Masi F. & Tripodi G. 1985: A study on *Gracilaria dendroides* sp. nov. (*Gigartinales*, *Rhodophyta*) from the Bay of Naples. — Br. Phycol. J. **20:** 357-364.

Giaccone, G. 1965: Le fitocenosi marine nel settore rosso di Capo Zafferano (Palermo). — Lav. Ist. Bot. Giard. Col. Palermo **22:** 3-34.

— 1971: Contributo allo studio dei popolamenti algali del basso Tirreno. — Ann. Univ. Ferrara, sez. IV Botanica **4:** 17-43.

— 1978: Revisione della flora marina del mare Adriatico. — Annuario del WWF. Parco Marino di Miramare Trieste **6:** 5-118.

— , Alessi, M.C. & Toccaceli M. 1985: Flora e vegetazione marina dell'Isola di Ustica. — Boll. Acc. Gioenia Sc. Nat. Catania **18:** 505-536.

— , De Leo, A. 1966: Flora e vegetazione algale del golfo di Palermo. II contributo. — Lav. Ist. Bot. Giard. Col. Palermo **22:** 1-69.

— , Di Martino, V. 1997: Syntaxonomic relationship of the mediterranean phytobenthos assemblages: paleoclimatic bases and evolutive tendencies. — Lagascalia **19:** 129-144.

— , Rizzi Longo L. 1976: Revisione della flora dello Stretto di Messina (note storiche, bionomiche e corologiche). — Mem. Biol. Mar. Ocean. **6:** 69-123.

— , Scammacca, B., Cinelli, F., Sartoni, G. & Furnari, G. 1972: Studio preliminare sulla tipologia della vegetazione sommersa del canale di Sicilia e isole vicine. — Giorn. Bot. Ital. **106:** 211-229.

— , Sortino, M. 1964: Flora e vegetazione algale dell'isola delle Femmine. — Lav. Ist. Bot. Giard. Col. Palermo **21:** 1-25.

— & — 1974: Zonazione della vegetazione marina delle isole Egadi. — Lav. Ist. Bot. Giard. Col. Palermo **25:** 166-183.

— , —, Solazzi, A. & Tolomio, C. 1973: Tipologia e distribuzione estiva della vegetazione sommersa dell'isola di Pantelleria. — Lav. Ist. Bot. Giard. Col. Palermo **25:** 103-119.

Gòmez Garreta, A., Gallardo, T., Ribera, M.A., Cormaci, M., Furnari, G., Giaccone, G. & Boudouresque, Ch.F. 2001: Check-list of Mediterranean Seaweeds III. *Rhodophyceae* Rabenhorst. 1. Ceramiales Oltmanns. — Botanica Marina **44**: 425-460.

Hauck, F. 1882-1885: Die meeresalgen Deutschlands und Oesterreichs. — Pp. 1-112 (1882); Pp. 113-320 (1883); Pp. 321-512 (1884); Pp. 513-575 (1885) in: Dr. L. Rabenhorst's Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz. Zweite Auflage. **2.** — Leipzig.

Jaccard P., 1932. Die statistische-floristische Methoden als Grundlage der Pflanzensoziologie. — Pp. 165-202 in: Abderhalden E., Handbuch der biologischen Arbeitsmethoden, **11(5)**.

Kulczynski, S., 1927: Die Pflanzenassoziationen der Pieninen. — Bull. intern. Acad. Polon. Sci. Lett. Cl. Sci math. et nat. sér. B. Sci Nat., suppl. **2:** 57-203.
Kützing, F. T., 1849: Species algarum. VI. Pp. 922. — Lipsiae.
— 1854: Tabulae phycologicae oder Abbildungen der Tange. Vol. 4 — Nordhausen.
— 1855: Tabulae phycologicae oder Abbildungen der Tange. Vol. 5 — Nordhausen.
— 1856: Tabulae phycologicae oder Abbildungen der Tange. Vol. 6 — Nordhausen
— 1858: Tabulae phycologicae oder Abbildungen der Tange. Vol. 8 — Nordhausen.
— 1860: Tabulae phycologicae oder Abbildungen der Tange. Vol. 10 — Nordhausen.
— 1862: Tabulae phycologicae oder Abbildungen der Tange. Vol. 12 — Nordhausen.
— 1863: Tabulae phycologicae oder Abbildungen der Tange. Vol. 13 — Nordhausen.
— 1864: Tabulae phycologicae oder Abbildungen der Tange. Vol. 14 — Nordhausen.
— 1865: Tabulae phycologicae oder Abbildungen der Tange. Vol. 15 — Nordhausen.
— 1866: Tabulae phycologicae oder Abbildungen der Tange. Vol. 16 — Nordhausen.
— 1869: Tabulae phycologicae oder Abbildungen der Tange. Vol. 19 — Nordhausen.
Langenbach, G., 1873: Die Meeresalgen der Inseln Sizilien und Pantelleria. — Berlin.
Levring, T. 1942: Meeresalgen aus dem Adriatischen Meer, Sizilie und dem Golf von Neapel. Kungl. — Fysiogr. Soellsk. Foerhandl. **12:** 25-41.
Marino, G., Di Martino, V. & Giaccone, G. 1999: Diversità della flora della Penisola Maddalena (Siracusa, Sicilia S-E): cambiamento ventennale ed evoluzione. — Boll. Accad. Gioenia Sci. Nat. Catania **31:** 289-315.
Mazza, A. 1902: Flora marina del Golfo di Napoli. Contribuzione I. — Nuova Notarisia **13:** 125-152.
Meneghini, G. 1842: Alghe Italiane e Dalmatiche. — Padova 1842 Fasc. I: 1-80. Fasc. II: 81-160. Fasc. III: 161-255.
— 1843: Alghe Italiane e Dalmatiche. — Padova 1843 Fasc. IV: 257-352.
— 1846: Alghe Italiane e Dalmatiche. — Padova 1846 Fasc. V: 353-385.
Molinier, R. & Picard, J. 1953: Notes biologiques à propos d'un voyage d'étude sur les côtes de Sicile. — Ann. Inst. Océanogr. **28:** 163-188.
Naccari, F.L. 1828: Algologia Adriatica. — Stamperia Cardinali e Friuli, Bologna.
Papi, I., Pardi, G., Lenzini, S., Benedetti Cecchi, L. & Cinelli, F. 1992: Benthic marine flora in the Tuscan Archipelago. A first contribution: Isles of Capraia, Elba, Formiche di Grosseto, Giglio, Scoglio d'Africa, Montecristo and Giannutri. — Giorn. Bot. Ital. **127:** 797-819.
Philippi, P. 1837: Sulle coralline di Sicilia osservate durante gli anni 1830-1832.
Piccone, A. 1889: Noterelle ficologiche. — Notarisia **4:** 664-671.
Pignatti, S. 1962: Associazioni di alghe marine sulla costa Veneziana. — Mem. Ist. Veneto Sci., Lett. Arti, Cl. Sci. Mat. Nat. **32:** 1-134.
— & Rizzi, L. 1972: Raccolte di alghe bentoniche nelle acque dell'Arcipelago Toscano. — Atti Ist. Veneto Sci., Lett. ed Arti Cl. Sci. Mat. e Nat. Venezia **130:** 313-327.
Reinke, J. 1878: Entwickelungsgeschichtliche Untersuchungen uber die Cutleriaceen des Golfs von Neapel. — Nova Acta Ac. Caes. Leop. Car. XL. Dresden.
Ribera, M. A., Gomez Garreta, A., Gallardo, T., Cormaci, M., Furnari, G. & Giaccone, G. 1992: Check-list of Mediterranean Seaweeds. I. *Fucophyceae* (Warming, 1884). — Botanica Marina **35:** 109-130.
Scammacca, B., Giaccone, G., Pizzuto, F. & Alongi, G. 1993: La vegetazione marina di substrato duro dell'isola di Lampedusa (Isole Pelagie). — Boll. Acc. Gioenia Sc. Nat. Catania **26:** 85-126.
Schiffner, V. 1914: Ueber einige neue und interessante algen aus der Adria. — Nuova Notarisia **25:** 181-183.
— 1916: Studien uber algen des Adriatischen meers. — Wiss. Meeresuntersuch., Abt. Helgoland. **11**: 129-198.

— 1926: Beiträge zur Kenntnis der Meeresalgen. III. Einige algen von Riccione bei Rimini. — Hedwigia **66**: 311-312.
— 1926: Beiträge zur Kenntnis der Meeresalgen. IV. Über einige Algen der Adria und von Helgoland. — Hedwigia **66**: 312-318.
— & Vatova, A. 1937: Le Alghe della Laguna di Venezia. — Estratto dalla Monografia: La Laguna di Venezia, vol. III, parte V, Tomo IX: 174pp. + 57 tavv. — Officine Grafiche Ferrari, Venezia.
Sokal, R.R. & Sneath, P.H.A. 1963: Principles of numerical taxonomy. — London.
Solazzi, A. 1965 1964: Primi dati sulle alghe della scogliera "I travi" di Portonovo (Ancona). — Giorn. Bot. Ital. **71:** 253-257.
— 1967: Studio ecologico sulla vegetazione algale bentonica (macrofite) della riviera del Monte Conero. — Mem. Biogeogr. Adriat. **7**: 159-192.
— 1969: Su alcuni ritrovamenti interessanti di alghe in Puglia e in Sardegna. — Giorn. Bot. Ital. **103:** 163-167.
— 1976: Le alghe della costa Marchigiana. — Giorn. Bot. Ital. **110:** 419-425.
Solms-Laubach, H. 1881: Die Corallinenalgen des Golfes von Neapel und der angrenzenden Meeres-Abschnitte. — Fauna und Flora des Golfes von Neapel, Monographie 4. — Leipzig.
Sortino, M. 1967: Flora e vegetazione terrestre e marina del litorale di Palma di Montechiaro (Agrigento). — Lav. Ist. Bot. Giard. Col. Palermo **23:** 1-112.
— 1968: Flora e vegetazione portuale della costa meridionale della Sicilia. I. Flora sommersa del porto di Licata (Agrigento). — Lav. Ist. Bot. Giard. Col. Palermo **24:** 1-20.
Spinelli, V. 1905: Le alghe marine della Sicilia orientale. — Atti Accad. Gioenia Sc. Nat. Catania **18:** 1-55.
Tornabene, F. 1846: Saggio di geografia botanica per la Sicilia. — Atti VII Riun. Sc. It. in Napoli. Napoli.
Valiante, R. 1883: Le Cystoseirae del golfo di Napoli. Fauna und Flora des Golfes von Neapel **7**. — Lipsia.
Zanardini, G. 1841: Synopsis algarum in Mari Adriatico hucusque Collectarum cui accedunt monographia siphonearum nec non generales de algarum vita et structura disquisitiones cum tabulis auctoris manu ad vivum depictis. — Mem. Reale Accad. Sci. Torino, ser. 2, **4:** 105-255.
— 1843: Saggio di classificazione naturale delle *Ficee*. — Venezia.
— 1847: Notizie intorno alle cellulari marine delle lagune e de' litorali di Venezia. — Atti Reale Ist. Veneto Sci., Lett. Arti., ser. 1, **6:** 185-262.
— 1858: Catalogo delle piante crittogame raccolte finora nelle provincie venete. — Atti Reale Ist. Veneto Sci. Lett. Arti., ser. 3, **3:** 205-300.
— 1860: Iconographia Phycologica Adriatica ossia scelta di *Ficee* nuove o più rare del Mare Adriatico. Vol. I. — Antonelli, Venezia.
— 1865: Iconographia Phycologica Adriatica ossia scelta di *Ficee* nuove o più rare del Mare Adriatico: Vol. II. — Antonelli, Venezia.
— 1871: Iconographia Phycologica Adriatica ossia scelta di *Ficee* nuove o più rare del Mare Adriatico: Vol. III. — Antonelli, Venezia.

Addresses of the authors:
G. Furnari, Mario Cormaci & Giuseppe Giaccone, Dipartimento di Botanica dell'Università di Catania, via A. Longo 19, I-95125 Catania, Italy.