Sci. Annals, Fac. Phys. & Mathem., Univ. Thessaloniki, **21**, 263 (1981)

CONTRIBUTION TO THE STUDY OF THE MARINE FLORA OF CRETE ISLAND, GREECE

by

MICHAEL MOUSTAKAS

Botanical Institute, University of Thessaloniki, Thessaloniki. Greece.

Abstract: *The marine flora of the coasts of Crete island was studied. A total of 134 taxa (133 species, 76 genera) were identified in six biotopes. Some plant communities in the investigated medio-and infralittoral zones were recognized. According to Cheney (1977), the* $\frac{R+C}{P}$ *ratio and the flora elements classify the marine flora of Crete island into a mixed form of flora.*

INTRODUCTION

The morphology and taxonomy of marine flora of Greece are not completely known. On the island of Crete only a few collections have been made and the marine flora is even less known. Raulin (1869) mentions some algal species of the marine flora of Crete. Further survey is given by Politis (1932) and Rechinger (1943). Diannelidis (1950) gives a check-list of 76 algal species found by the previous three authors on the island. Pèrés and Picard (1958) and Giaccone (1968a, b) in their studies of deep water marine algae included four localities near Crete.

The purpose of the present study is to furnish a description on the benthic flora of Crete and to provide new information on the composition of the marine flora of the island. In addition, the character of the marine flora has been considered according to a new improved ratio for comparing seaweed floras (Cheney, 1977). The species list is going to help in a future research of Crete and also for comparisons with other regions of Greece.

MATERIALS AND METHODS

The collections took place along the coasts up to a depth of 5 m at six localities of the island, during the months May and September 1979. The marine flora of the mediolittoral and the upper infralittoral zones has been studied according to the zonation of Pèrés (1967).

Specimens were preserved in 5% formalin for later examination in the laboratory. The nomenclature used in this study follows that of Feldmann (1938), Parke and Dixon (1968), Giaccone (1968a), Gerloff and Geissler (1971), Coppejans (1974).

The ratio of Rhodophyta to Phaeophyta (R/P) (Feldmann 1938) has determined the type of marine flora up to present day. In this study a new ratio for comparing seaweed floras was used. The new ratio proposed by Cheney (1977) incorporates Chlorophyta as follows: $\frac{R+C}{P}$, Rhodophyta and Chlorophyta species to Phaeophyta. According to Cheney's type, values of less than 3 indicate a temperate or cold water flora, while values of 6 or greater indicate a tropical flora, intermediate values suggest a mixed flora.

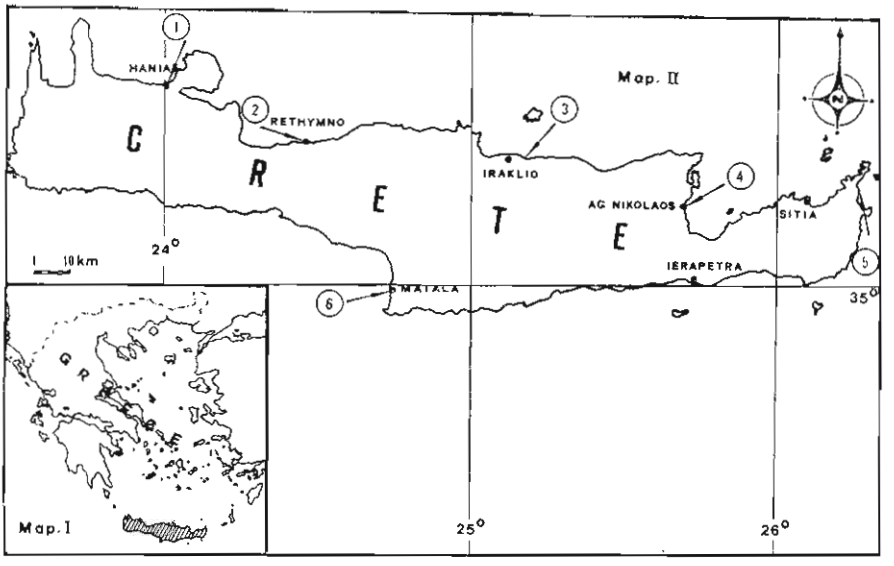
RESULTS

A total of 134 taxa (133 species, 76 genera) were collected during this study. These include 27 Chlorophyta, 27 Phaeophyta, 76 Rhodophyta, 3 Marine Phanerogams and 1 Blue-Green Alga.

The localities from which algae were collected are shown in Map II and are numbered as follows: 1. Hania, 2. Rethymnon, 3. Amnissos, 4. Ag. Nikolaos, 5. Vai, 6. Matala.

The marine Phanerogams *Cymodocea nodosa* and *Posidonia oceanica* are noticed in several localities forming herbiers in various soft substrates. They are never exposed, even at low water and as such can be regarded as infra-littoral plants. *Cymodocea nodosa* usually appears in shallow, sandy and muddy inshored places while *Posidonia oceanica* is found at greater depths on sandy substrate. Numerous epiphytes, particularly on *Posidonia oceanica* are found in various localities. Finally, floating plants of the marine Phanerogam *Halophila stipulacea* were observed.

The Cyanophyceae *Rivularia atra* was found in the mediolittoral zone. Also, in the mediolittoral zone the community *Scytosiphon-Enteromorpha* was noticed.



Map I. Map of Greece showing the location of Crete Island.

Map II. Map of Crete Island showing the investigated localities. 1. Hania. 2. Rethymnon, 3. Amnissos, 4. Ag. Nikolaos, 5. Vai, 6. Matala.

The *Cystoseira fimbriata* community occurs quite regularly in places with more surf as well as near the water surface (20 to 80 cm depth). Other algae that are mingled with this community include: *Anadyomene stellata, Jania rubens, Corallina mediterranea, Laurencia obtusa, Dasycladus vermicularis.*

The algal community with *Cystoseira crinita,* which is coloured yellowish in vivo, forms a quite large band, starting just below *Cystoseira fimbriata* community and descending to 2.0-2.5 m depth where it is generally limited by a strip of «bare» rocks or by the community with *Cystoseira spinosa.* The yellowish *Cystoseira discors* replaces *Cystoseira spinosa* on rising rock out-crops. The most common epiphytes found on *Cystoseira crinita* are *Sphacelaria hystrix, Jania rubens, Cladophora* spp.

The algal community with *Dictyopteris membranacea* and *Dilophus* was frequent and well developed. *Dictyopteris membranacea* grows regularly in quite large groups, especially on horizontal and shelving slopes. The dominance of *D. membranacea* becomes less on steeper slopes and the other characteristic species become dominant on quite steep and vertical rock surfaces. These are: *Dictyota dichotoma, D. dichotoma var. implexa, D. linearis, Dilophus spiralis, D. fasciola, Jania rubens, Anadyomene stellata, Laurencia obtusa* and sometimes mingled with *Padina pavonica.*

The algal community with *Peysonnelia squamaria* was observed with the following characteristic species: *Peyssonnelia squamaria, Udotea petiolata* and *Halimeda tuna.* They are mingled with quite large amounts of *Peyssonnelia rubra, Halopteris filicina, Dictyota dichotoma Sargassum vulgare, Dictyopteris membranacea.*

The community with *Corallina mediterranea* is seldom deeper than 1.5 m and is generally limited by the community with *Lithophyllum byssoides* and *Tenarea undulosa* at the top.

In the species list that follows, the identified algae of the coasts of Crete are listed in alphabetical order in 3 classes.

SPECIES LIST

CHLOROPHYCEAE

1. *Acetabularia acetabulum* (L.) Silva
2. *Anadyomene stellata* (Wulfen) C. Agardh
3. *Bryopsis muscosa* Lamouroux

4. *Bryopsis plumosa* (Hudson) C. Agardh
5. *Caulerpa prolifera* (Forsskal) Lamouroux
6. *Chaetomorpha chlorotica* (Montagne) Kützing
7. *Chaetomorpha crassa* (C. Agardh) Kützing
8. *Chaetomorpha linum* (O. F. Müller) Kützing
9. *Cladophora albida* (Hudson) Kützing
10. *Cladophora dalmatica* Kützing
11. *Cladophora laetevirens* (Dillwyn) Kützing
12. *Cladophora lehmanniana* (Lindenberg) Kützing
13. *Cladophora pellucida* (Hudson) Kützing
14. *Cladophora prolifera* (Roth) Kützing
15. *Cladophora rupestris* (L.) Kützing
16. *Cladophora sericea* (Hudson) Kützing
17. *Codium bursa* (L.) C. Agardh
18. *Codium tomentosum* (Hudson) Stackhouse
19. *Dasycladus vermicularis* (Scopoli) Krasser
20. *Enteromorpha compressa* (L.) Greville
21. *Enteromorpha intestinalis* (L.) Link
22. *Enteromorpha linza* (L.) J. Agardh
23. *Halimeda tuna* (Ellis et Solander) Lamouroux
24. *Udotea petiolata* (Turra) Borgesen
25. *Ulva lactuca* L.
26. *Valonia macrophysa* Kützing
27. *Valonia utricularis* (Roth) C. Agardh

PHAEOPHYCEAE

1. *Colpomenia sinuosa* (Mertens in Roth) Derbès et Solier
2. *Cutleria multifida* (Smith) Greville
3. *Cystoseira amentacea* Bory
4. *Cystoseira barbata* (Good. et Wood.) J. Agardh
5. *Cystoseira corniculata* (Wulfen) Zanardini em. Hauck
6. *Cystoseira crinita* (Desfontaines) Bory
7. *Cystoseira discors* (L.) C. Agardh em. Sauvageau
8. *Cystoseira fimbriata* (Desfontaines) Bory
9. *Cystoseira spicata* Ercegovic
10. *Cystoseira spinosa* Sauvageau
11. *Cystoseira stricta* (Montagne) Sauvageau
12. *Dictyopteris membranacea* (Stackhouse) Batters
13. *Dictyota dichotoma* (Hudson) Lamouroux

14. *Dictyota dichotoma* var. *implexa* (Desfontaines) J. Agardh
15. *Dictyota linearis* (C. Agardh) Greville
16. *Dilophus fasciola* (Roth) Howe
17. *Dilophus spiralis* (Montagne) Hamel
18. *Ectocarpus arctus* Kützing
19. *Halopteris filicina* (Grateloup) Kützing
20. *Halopteris scoparia* (L.) Sauvageau
21. *Padina pavonica* (L.) Thivy ex Taylor
22. *Sargassum acinarium* (L.) C. Agardh
23. *Sargassum hornschuchii* C. Agardh
24. *Sargassum vulgare* C. Agardh
25. *Scytosiphon lomentarius* (Lyngbye) Link
26. *Sphacelaria cirrosa* (Roth) C. Agardh
27. *Sphacelaria hystrix* Suhr in Reinke

RHODOPHYCEAE

1. *Acrosymphyton purpuriferum* (J. Agardh) Sjoestedt
2. *Amphiroa cryptarthrodia* Zanardini
3. *Amphiroa rigida* Lamouroux
4. *Antithamnion cruciatum* (C. Agardh) Naegeli
5. *Antithamnion plumula* (Ellis) Thuret in Le Jolis
6. *Bangia fuscopurpurea* (Dillwyn) Lyngbye
7. *Boergeseniella fruticulosa* (Wulfen) Kylin
8. *Botryocladia botryoides* (Wulfen) Feldmann
9. *Callithamnion corymbosum* (Smith) Lyngbye
10. *Callithamnion granulatum* (Ducluzeau) C. Agardh
11. *Ceramium ciliatum* (Ellis) Ducluzeau
12. *Ceramium diaphanum* (Roth) Harvey
13. *Ceramium echionotum* J. Agardh
14. *Ceramium fastigiatum* Harvey
15. *Ceramium rubrum* (Hudson) C. Agardh
16. *Ceramium strictum* (Kützing) Harvey
17. *Ceramium tenuissimum* (Lyngbye) J. Agardh
18. *Chondria dasyphylla* (Woodward) C. Agardh
19. *Chondria tenuissima* (Goodenough et Woodward) C. Agardh
20. *Chylocladia squarrosa* (Kützing) Le Jolis
21. *Chylocladia verticillata* (Lightfoot) Bliding
22. *Corallina granifera* Ellis et Solander
23. *Corallina mediterranea* Areschoug in J. Agardh

24. *Corallina officinalis* L.
25. *Crodelia expansa* (Philippi) Kylin
26. *Dasya pedieellata* (C. Agardh) C. Agardh
27. *Galaxaura oblongata* (Ellis et Solander) Lamouroux
28. *Gelidium crinale* (Turner) Lamouroux
29. *Gelidium latifolium* (Greville) Bornet et Thuret
30. *Gigartina acicularis* (Wulfen) Lamouroux
31. *Gigartina teedii* (Roth) Lamouroux
32. *Goniotrichum alsidii* (Zanardini) Howe
33. *Gymnogongrus griffithsiae* (Turner) Martens
34. *Halopitys incurvus* (Hudson) Batters
35. *Herposiphonia secunda* (C. Agardh) Ambronn
36. *Hypnea musciformis* (Wulfen) Lamouroux
37. *Jania longifurca* Zanardini
38. *Jania rubens* (L.) Lamouroux
39. *Laurencia obtusa* (Hudson) Lamouroux
40. *Laurencia paniculata* (C. Agardh) J. Agardh
41. *Laurencia papillosa* (Forsskal) Greville
42. *Liagora viscida* (Forsskal) C. Agardh
43. *Lithophyllum byssoides* (Lamouroux) Foslie
44. *Lithophyllum incrustans* Philippi
45. *Lithophyllum trochanter* (Bory) Huvé
46. *Lithothamnion crispatum* Hauck
47. *Lithothamnion lenormandii* (Areschoug) Foslie
48. *Melobesia farinosa* Lamouroux
49. *Mesophyllum lichenoides* (Ellis) Lemoine
50. *Nemalion helminthoides* (Velley in Withering) Batters
51. *Neogoniolithon notarissii* (Dufour) Setchell et Mason
52. *Neomonospora furcellata* (J. Agardh) G. Feldman et Meslin
53. *Petroglossum nicaeense* (Lamouroux ex Duby) Schotter
54. *Peyssonelia polymorpha* (Zanardini) Schmitz
55. *Peyssonelia rubra* (Greville) J. Agardh
56. *Peyssonelia squamaria* (Gmelin) Decaisne
57. *Polysiphonia opaca* (C. Agardh) Zanardini
58. *Polysiphonia sertularioides* (Grateloup) J. Agardh
59. *Polysiphonia tenerrima* Kützing
60. *Polysiphonia sp.*
61. *Porphyra leucosticta* Thuret in Le Jolis
62. *Porphyra purpurea* (Roth) C. Agardh

63. *Porphyra umbilicalis* (L.) J. Agardh
64. *Pterocladia capillacea* (Gmelin) Bornet et Thuret
65. *Rhodochorton purpureum* (Lightfoot) Rosenvinge
66. *Rhodymenia ardissonei* (Ardissone) J. Feldmann
67. *Rytiphlaea tinctoria* (Clemente) C. Agardh
68. *Schyzimenia dubyi* (Chauvin ex Duby) J. Agardh
69. *Scinaia furcellata* (Turner) Bivona
70. *Seirospora seirosperma* (Harvey) Dixon
71. *Spermothamnion flabellatum* Bornet in Bornet et Thuret
72. *Sphaerococcus coronopifolius* (Goodenough etWoodward) Stackhouse
73. *Spyridia filamentosa* (Wulfen) Harvey in Hooker
74. *Tenarea undulosa* Bory
75. *Vidalia volubilis* (L.) J. Agardh
76. *Wrangelia penicillata* C. Agardh

CYANOPHYCEAE

1. *Rivularia atra* (Roth) Bornet et Flahault

MARINE PHANEROGAMS

1. *Cymodocea nodosa* (Ucria) Ascherson
2. *Halophila stipulacea* (Forsskal) Ascherson
3. *Posidonia oceanica* Delile

DISCUSSION

In the literature only 76 earlier records of marine algae of the coasts of Crete island were found (Diannelidis 1950). These include 18 Chlorophyta, 20 Phaeophyta and 38 Rhodophyta.

In the present study 27 Chlorophyta, 27 Phaeophyta and 76 Rhodophyta were identified. There might be more algae on the island upon which a further detailed future research of the marine flora of Crete could cast light.

Despite the above expressed view, the total number of the observed and identified 134 taxa in the six localities of Crete island characterize the marine flora as rather rich. The quantitative abundance of the benthic marine algae in all the investigated localities in comparison with other regions of Greece was obvious.

Most localities of the coasts of Crete are covered mainly with the phylomorphous large Phaeophyceae species, e.g. *Cystoseira, Dictyopte-*

ris, Sargassum. There are biotopes where the main members of the phytocommunities are Rhodophyceae, while the Phaeophyceae are accompanying species.

Another characteristic of the marine flora is the abundance of calcareous algae such as the families Corallinaceae and Helminthocladiaceae i.e.: *Lithophyllum, Lithothamnion, Corallina, Melobesia, Jania, Liagora,* etc. This may be due, besides other reasons, to the proper calcareous substrate. The rocky calcareous localities certainly have the richest vegetation while the soft substrates are the main background for the marine Phanerogams.

The communities of *Cystoseira fimbriata* and *Cystoseira crinita* are present on practically all coasts of the island. It is worth mentioning that the habit of *Cystoseira fimbriata* changes with ecological conditions: it is 30-60 cm long, richly branched and bladdered in sheltered places. On exposed coasts it is reduced to a rosette of flattened, pinnately divided branches.

The observed floating plants of the marine Phanerogam *Halophila stipulacea,* which is an example of a successful immigration, give a new record on the occurrence of the plant in the Mediterranean. *Halophila stipulacea,* one of the first seagrasses to be named, was described by Forsskal (1775) from the Red Sea. Nearly two and a half decades after the opening of the Canal, in July 1894, J. Nemetz collected some marine plants in Rhodes island and sent them to Pr. C. Fritsch who identified *Halophila stipulacea* among them. Fritsch (1895) reported the occurrence of the *H. stipulacea* fragment in the Mediterranean and concluded that it reached Rhodes carried by a ship from the Red Sea via the Suez Canal. Later Politis (1926) for the first time recorded the occurrence of established populations of *H. stipulacea* at depths of 8-12 m in the Mediterranean (Cyclades isles). In Rhodes, which is near Crete, it has been frequently mentioned since then: Forti (1927), Issel (1928a,b), Tortonese (1947), Diannelidis (1951), Diannelidis (1963), Diannelidis et al. (1971), Tsekos et al. (1972), Den Hartog (1962), Lipkin (1975b). In the nearby island of Crete *H. stipulacea* has been mentioned by Pérès and Picard (1958) at a depth of 5-6m. Giaccone (1968a) mentions it on Dia island (North of Crete) at a depth of 10m. Pérès and Picard (1958) suggested that the plant had possibly been living in the Mediterranean prior to the opening of the Suez Canal. According to Lipkin (1975a) this view cannot be accepted and probably *Halophila stipulacea* has been transferred from the Red Sea into the Mediterranean via the Suez Canal,

many times on board small vessels, intermingled in fishing nets or similar gear.

The character of the marine flora of Greece was always a problem as it was outlined in a recent paper (Diannelidis et al. 1977). They concluded that the values of the R/P ratios for the Greek coasts given by several authors differ because the various species lists are incomplete or more reasons can exist for the differences of the character of the marine flora of Greece in comparison with the other regions of the Mediterranean.

Using Cheney's type the comparison of the marine floras of Greece with other regions of the Mediterranean is extremely characteristic since all values are greater than 3 (in preparation).

For the list of species of the present paper the $\frac{R+C}{P}$ ratio is 3.8 which characterizes the marine flora of the coasts of Crete as a mixed one. Yet from the species list we can see that the flora of Crete includes both boreal and tropical floral elements.

Concluding we can say that the type of flora and the flora elements classify the marine flora of Crete island into a mixed form of flora, characteristic of regions belonging to these geographical latitudes.

ACKNOWLEDGEMENTS

I wish to thank Prof. Dr. Ioannes Tsekos for his encouragement and the critical reading of the manuscript. Thanks are also due to Mr. A. Zoumbos for his drawings and to Mrs. A. Kiratzidou for the secretarial help.

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ΠΕΡΙΛΗΨΗ

ΣΥΜΒΟΛΗ ΣΤΗ ΜΕΛΕΤΗ ΤΗΣ ΘΑΛΑΣΣΙΑΣ ΧΛΩΡΙΔΑΣ ΤΗΣ ΝΗΣΟΥ ΚΡΗΤΗΣ

ὑπὸ

Μ. ΜΟΥΣΤΑΚΑ

('Εργαστήριο Βοτανικῆς Πανεπιστημίου Θεσσαλονίκης)

Μελετήθηκε ἡ θαλάσσια χλωρίδα τῶν ἀκτῶν τῆς νήσου Κρήτης. 'Αναγνωρίσθηκαν καὶ ταξινομήθηκαν 134 taxa (133 εἴδη, 76 γένη) ἀπὸ ἕξη βιοτόπους. Στὴ μεσοπαράλιο καὶ ὑποπαράλιο ζώνη ἀναγνωρίσθηκαν ὁρισμένες φυτοκοινωνίες. Σύμφωνα μὲ τὸν Cheney (1977), ἀπὸ τὴν τιμὴ τοῦ λόγου $\frac{R+C}{P}$ καὶ τὰ χλωριδικὰ στοιχεῖα συμπεραίνεται ὅτι ἡ θαλάσσια χλωρίδα τῆς νήσου Κρήτης ἀνήκει στὸ μικτὸ τύπο χλωρίδας.