

Contribution to the Knowledge of Macro-algae of the Coastal Area of the Island of Hvar

Nikola Koletić (1), Nikola Hanžek (1), Dorotea Polović (1), Ivana Kovarik (1), Maja Mejdandžić (1), Marina Linardić (1), Anita Slana (1)

(1) Biology Students Association – “BIUS”, Faculty of science, Division of biology, Zagreb, Croatia

nickoletic@gmail.com

Abstract

*Hvar, an island in the Adriatic Sea, is the longest and the sunniest Croatian island, famous for its pleasant Mediterranean climate. There is great biodiversity of algal flora in the coastal area of the island because of the high range of different conditions, considering the environment and external influences. The island of Hvar is interesting to study because of the presence of the two invasive green macro-algae in the Mediterranean – *Caulerpa taxifolia* and *Caulerpa racemosa* – which has a major impact on the entire marine ecosystem.*

Algae play an important role in a marine ecosystem because they are indicators of pollution and they can show us the general state of an ecosystem. Due to the extreme beauty and biodiversity of the island, in 2011 Biology students association – “BIUS” conducted a biodiversity research project. The Algal section made a significant contribution to the data on biodiversity of coastal macro-algae of the island considering the default parameters. The methodology was reduced to listing macro-algae from a given surface and a certain depth considering the substrate and the external influences. Anthropogenic impact and touch of fresh underground water have an important impact on the algological composition in a certain area. Listing the species was carried out in a transect of 10 meters at the same depth within 1 square meter. The research was conducted on 11 different locations on the island. The locations were selected on the basis of the greater diversity of ecological conditions. By listing the species, we were able to follow the percentage of the general appearance of algae species groups in a particular area. Since the project took place in two terms the results were analyzed considering the two growing seasons, mid-spring and early autumn.

The obtained results showed us that the algological flora of the island Hvar is rather varied and that there are differences in the algal composition, considering the environment conditions. The data on the distribution of species in the coastal part of the island has showed us that there is great biodiversity of the algal flora and that it highly depends on anthropogenic impact.

Keywords: *macro-algae, biodiversity, marine ecosystem, environmental conditions, anthropogenic impact*

Introduction

Algae are wide group of organisms that inhabit water and wet areas. They can be found in various forms, shapes and sizes. Marine algae are divided into two large groups : microalgae and macroalgae, the latter of which is also known as seaweeds. Coastal algae can be recognised as green, red and

brown algae. The interest of our research were the coastal marine macroalgae. They are great indicators of pollution, but they can be indicators of clean water as well, and finally, they can serve as indicators for the whole ecosystem. This kind of research is important for advancing the knowledge of the ecological conditions in this part of the Adriatic Sea, especially since the human impact is quite significant along the coast.

The island of Hvar belongs to a group of middle Adriatic islands and is influenced by the open sea in the west and south and with coast in the east and north. Famous for its pleasant Mediterranean climate, Hvar is an island with most sunny days in a year. Due to the extreme beauty and biodiversity of the island, in 2011 Biology students association – “BIUS” conducted a biodiversity research project. The Algal section made a significant contribution to the data on biodiversity of coastal macro-algae of the island. During the research the Section referred to/consulted the work of Ante Ercegović Ercegović – « Komparativni studij plitkovodne i dubinske vegetacije Srednjeg Jadrana » (1980., Acta Adria, 21 : 11 - 40.), which contains information on algal flora.

Methods

The purpose of the research within the project « Biodiversity research of the island of Hvar 2011 » gives an insight into the diversity of coastal macroalgae considering to the default parameters. The methodology is reduced to listing of macroalgae found on a particular surface and depth considering to the substrate and the external conditions. External conditions are determined by the inflow of fresh water and the human impact. Monitoring of macroalgae is based on the percentage of occurrence of species of a general group of algae in different periods of growing season. Macroalgae monitoring was conducted during May and September. Of particular interest were the sites around Jelsa, Ivan Dolac and Stari Grad on the island of Hvar (Figure 1.). Fieldwork included determining the locations where representative samples of algae could be found. We chose 11 stations around the island with representative substrate, sea current and anthropogenic influence (Table 1.). The locations were selected on the basis of the greater diversity of ecological conditions such as the inflow of the underground fresh water which increases biodiversity of marine algae in that area. These results can now be used in monitoring of particular areas of anthropogenic pollution. This pollution is due to proximity of residential areas.

Table 1. Locations and stations on the island of Hvar, where coastal marine algae were monitored

Locations	Stations	Toponym	Coordinate
Stari Grad (Hvar)	ST-1	Cove Stari Grad	43°11'8.45"N ; 16°35'10.37"E
	ST-2		43°11'23.84"N ; 16°34'48.24"E
	ST-3	Cape Fortin	43°11'0.61"N ; 16°35'8.71"E
	ST-4		43°10'53.44"N ; 16°34'55.14"E
Jelsa (Hvar)	ST-5	Cove Maslinica	43°10'52.38"N ; 16°33'44.96"E
	JL-1		43°10'18.58"N ; 16°41'26.37"E
	JL-2	Cove Vrboska	43°10'23.91"N ; 16°41'12.07"E
	JL-3		43° 9'58.26"N ; 16°42'16.26"E
Ivan Dolac (Hvar)	JL-4	Cove Grebišće	43° 9'34.24"N ; 16°42'40.75"E
	ID-1		43° 7'39.33"N ; 16°37'58.72"E
	ID-2	Cove Paklina	43° 7'35.50"N ; 16°38'25.37"E

At each station, a metal frame of s size of one square meter was placed at a certain place at a random place into the sea. The depht varied from 0,5 and 1,5 meter, depending on the tides and time of the day. Macroalgal species were listed at the same depth in a parimeter line of 10 meters along the shore. The species were listed only in the area of one square meter that a metal frame covered. The banks with numerous bays and inlets, as well as those with inflow of underground fresh water were of interest for this research. Significant amounts of underwater inflow emerges in the cove Stari Grad, Vrbovska cove and Paklina cove (Figure 1).

The same methodology was performed in May and September on stations in Stari Grad, Jelsa and Ivan Dolac. The comparison of the results from all stations pointed to changes in the composition of algae in that areas. Statistical analysis shows the dependence of anthropogenic impacts on biodiversity, changes in the composition of the general group of coastal algae and the algal diversity considering platform of growth.

Figure 1. Locations and stations on the island of Hvar, where coastal marine algae were monitored



Results

The list of algal taxa indentified in the treatment of certain stations in one square meter at all stations along the shore in Stari Grad, Jelsa and Ivan Dolac on island of Hvar (Table 2.). All algal taxa are listed under the international code and verified on the online database algaebase.org. Marine macroalgae can be dived into three general groups, green algae – Chlorophyta, brown algae – Phaeophyta and red algae – Rhodophyta.

Table 2. List of all algae taxa found in the coastal area of the island of Hvar (C – Chlorophyta, P – Phaeophyta, R – Rhodophyta)

1.	<i>Acetabularia acetabulum</i> (Linnaeus) P.C.Silva 1952	C
2.	<i>Acrosymphyton purpuriferum</i> (J.Agardh) Sjöstedt 1926	R
3.	<i>Amphiroa rigida</i> J.V.Lamouroux 1816	R
4.	<i>Anadyomene stellata</i> (Wulfen) C. Agardh	C
5.	<i>Catenella caespitosa</i> (Withering) L.M.Irvine in M. Parke & P.S. Dixon 1976	R

6.	<i>Ceramium</i> sp.	R
7.	<i>Chaetomorpha</i> sp.	C
8.	<i>Cladophora</i> sp.	C
9.	<i>Codium bursa</i> (Olivi) C.Agardh 1817	C
10.	<i>Colpomenia sinuosa</i> (Mertens ex Roth) Derbès & Solier in Castagne 1851	P
11.	<i>Corallina elongata</i> J.Ellis & Solander 1786	C
12.	<i>Corallina officinalis</i> Linnaeus 1758	C
13.	<i>Cutleria multifida</i> (Turner) Greville 1830	P
14.	<i>Cutleria</i> sp.	P
15.	<i>Cystoseira spicata</i> Ercegović 1952	P
16.	<i>Cystoseira</i> spp.	P
17.	<i>Dasycladus vermicularis</i> (Scopoli) Krasser in Beck & Zahlbruckner 1898	C
18.	<i>Dictyopteris polypodioides</i> (A.P.De Candolle) J.V.Lamouroux 1809	P
19.	<i>Dictyota dichotoma</i> (Hudson) J.V.Lamouroux 1809	P
20.	<i>Dictyota dichotoma</i> var. <i>intricata</i> (C.Agardh) Greville 1830	P
21.	<i>Dictyota fasciola</i> (Roth) J.V.Lamouroux 1809	P
22.	<i>Dictyota spiralis</i> Montagne 1846	P
23.	<i>Dictyota</i> spp.	P
24.	<i>Ectocarpus</i> sp.	C
25.	<i>Falkenbergia</i> sp.	R
26.	<i>Flabellia petiolata</i> (Turra) Nizamuddin 1987	C
27.	<i>Halimeda tuna</i> (J.Ellis & Solander) J.V.Lamouroux 1816	C
28.	<i>Halopteris scoparia</i> (Linnaeus) Sauvageau 1904	P
29.	<i>Jania longifurca</i> Zanardini 1844	R
30.	<i>Jania rubens</i> (Linnaeus) J.V.Lamouroux 1816	R
31.	<i>Laurencia</i> spp.	R
32.	<i>Nemalion helminthoides</i> (Volley) Batters 1902	R
33.	<i>Nitophyllum punctatum</i> (Stackhouse) Greville 1830	R
34.	<i>Padina pavonica</i> (Linnaeus) Thivy in W.R. Taylor 1960	P
35.	<i>Peyssonnelia rubra</i> (Greville) J.Agardh 1851	R
36.	<i>Peyssonnelia</i> sp.	R
37.	<i>Phymatolithon</i> sp.	R
38.	<i>Plocamium cartilagineum</i> (Linnaeus) P.S. Dixon	R
39.	<i>Sargassum</i> sp.	P
40.	<i>Schottera nicaeensis</i> (J.V.Lamouroux ex Duby) Guiry & Hollenberg 1975	R
41.	<i>Taonia atomaria</i> (Woodward) J.Agardh 1848	P
42.	<i>Taonia</i> sp.	P
43.	<i>Titanoderma</i> sp.	R
44.	<i>Ulva rigida</i> C.Agardh 1823	C
45.	<i>Valonia utricularis</i> (Roth) C.Agardh 1823	C
46.	<i>Wrangelia penicilata</i> (C.Agardh) C.Agardh 1828	P
47.	<i>Zanardinia typus</i> (Nardo) P.C.Silva in W.Greuter 2000	P

Figure 2. shows the « the number of of recorded species of algae identified in the coastal area of the island. Unlike the individual sites, the ration the general group does not show too much difference in

the number of taxa. According to data from Ante Špan and his work « Sastav i zonacija bentoske flore i vegetacije otoka Hvara » (1980., Adria Acta, 21 :169-194) these results are satisfactory. The chart is based on the 47 indentified species of coastal macroalgae.

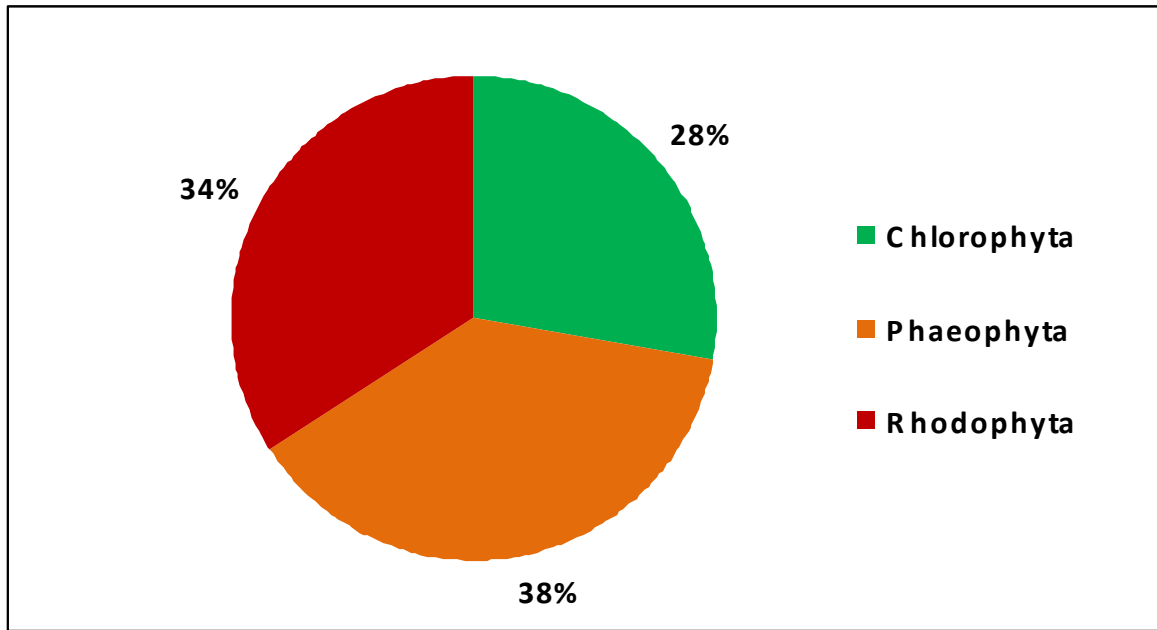


Figure 2. The relation between general algal group of total number of macroalgal taxa found in coastal area of the island of Hvar (N=47)

In Figure 3. the research sites provide comparative data that shows the ratio of change in general macroalgal species during the vegetation season between May and September on selected stations. The present results show larger deviations, which depending on the location of stations as a result of the substrate on which algae growth and enviromental effects such as human impact or unferground fresh water inflow.

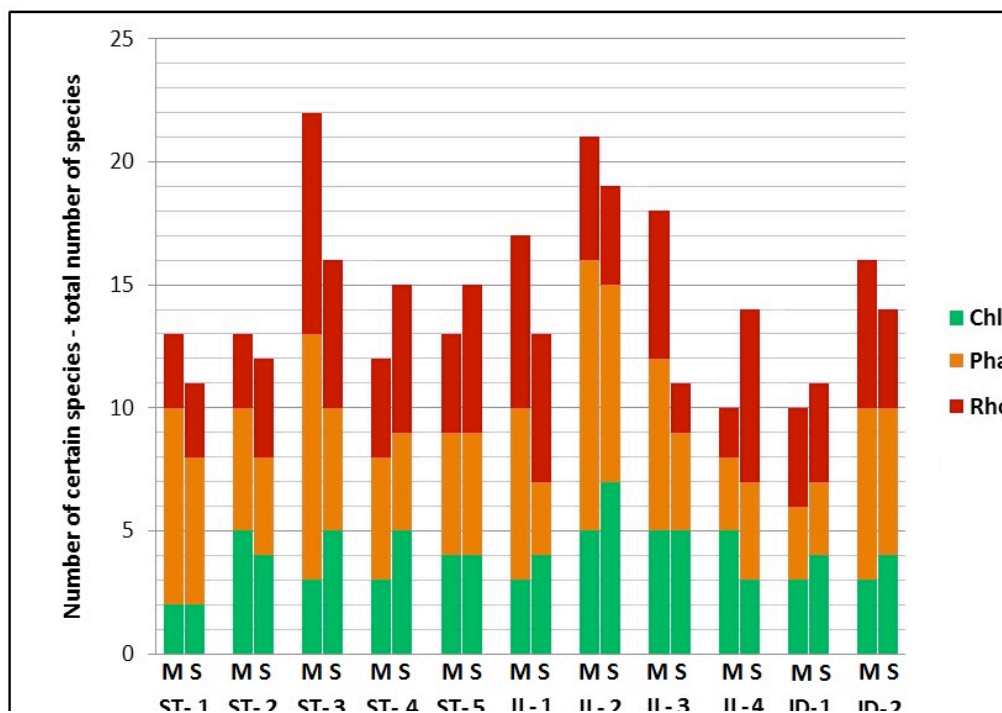


Figure 3. Comparative results of the stations along the island with percentage of the general groups of marine algae in each station in May and September.

Discussion

The results show that the biodiversity of coastal macroalgae of the island Hvar is great. Even though the biodiversity of coastal macroalgae of island of Hvar is great in general point of view, the results have shown that the biodiversity decreases as we go nearer to the populated location. The percentage of the general groups along the island shows that brown algae dominate in the coastal area along with red algae which are often indicators of anthropogenic pollution. Green algae are the least represented because they are the most affected by pollution. This can be explained by nearness of ferry port in Stari Grad and Vrboska cove.

The percentage of general groups of coastal macroalgae on each station show us that brown algae dominate along the island bay. Red algae dominate in the late spring, while green algae dominate in the late summer.

In our monitoring of island bay we did not occur with the two invasive marine algae – *Caulerpa taxifolia* and *Caulerpa racemosa* because their areal is placed in deeper waters. Nevertheless, they affect the ecosystem significantly.

Conclusion

The list of coastal macroalgal flora of the island in certain locations and on the certain surface gave us insight into the diversity of algal flora of the island of Hvar. The statistical analysis of data provide us with informations of prevalence and diversity of marine macroalgae of the coastal areas of the island of Hvar. With a detailed list of the coastal species of algae we completed the list containing information about the rich flora of the island.

The obtained results showed us that the algological flora of the island Hvar is rather varied and that there are differences in the algal composition, considering the environment conditions. The data on the distribution of species in the coastal part of the island has showed us that there is great biodiversity of the algal flora and that it highly depends on anthropogenic impact.

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