

# Mass development of some opportunistic macroalgae species during summer season along the Romanian Black Sea coast

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**ABSTRACT.** The ecological role of the phytobenthic communities is especially important, representing a feeding and breeding area for the zoobenthic communities, especially for fish, whose existence is conditioned by the presence of the algal associations. The mass developing of the opportunistic species along the Romanian Black Sea coast is a common phenomenon during the summer season as a consequence of environmental conditions (high water temperature, high amount of nutrients due to an increased influx of tourists). But, the phenomenon is temporary and decreases in intensity with the passage of the warm season. This paper presents the information from the period 2011-2014, based on 295 samples collected along the entire coastal zone from Pescărie to Vama Veche. During 2011-2012, the highest biomass (over 1,000 g/m<sup>2</sup>) was developed by *Cladophora* genus, and during 2013-2014, the situation change, genus *Ulva* being the dominant one. Among the red algae, *Ceramium virgatum* dominated the rocky substrate. After these mass development episodes, some deposits can be generated along the shore, creating discomfort to the tourists during summer season. However, these deposits represent a valuable raw material, applicable in various domains.

**KEYWORDS.** Macroalgae; opportunistic species; fresh biomass; Romanian Black Sea coast.

## I. INTRODUCTION

The submerged vegetation represents a major component of primary producers, which forms the existence and development basis of life in marine environment, a real engine for the marine ecosystem. It is well known that anthropogenic activities can produce the nutrient enrichment of coastal waters, a direct effect being the development of macroalgae opportunistic species and an indirect one, sometimes with long-term consequences, the reduction and disappearance of perennial sensitive species. Along the Romanian Black Sea coast this abundant development of a limited number of species is a seasonal phenomenon, conditioned by a high water temperature and an increased amount of nutrients due to an intense tourist activity during the summer season. It is well known that various anthropogenic activities (hydrotechnical constructions, accidental pollution with chemicals) have a negative influence, obviously first on the coastal algal belt [1], [2].

## II. METHODS

The data used in this report encompass the period 2011-2014. The samples were collected from 10 stations, along the coastal strip Pescărie - Vama Veche (Pescărie, Cazino Constanța, Agigea, Eforie Nord, Eforie Sud, Tuzla, Costinești, Mangalia, 2 Mai and Vama Veche) -

(Fig.1), at depths between 1 and 3 m from rocky substrate. Three samples per depth range, in three depth ranges (0-1 m, 1-2 m and 2-3 m) were sampled from infralittoral macroalgal communities at each sampling station, by means of a square frame with a side of 20 cm. The summer season was considered the sampling period (from June till September), the period of maximum development of opportunistic species. During 2011-2014 a total number of 295 samples were collected.

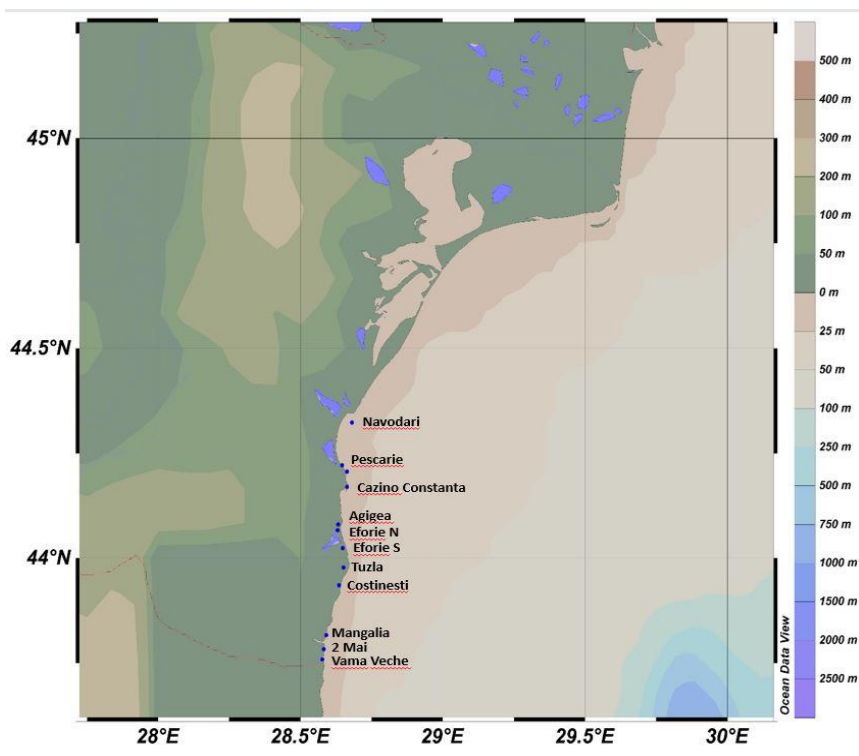


Fig. 1. Macroalgae sampling map

Samples were placed in labeled bags (the name of the station, sampling date and depth is noted), brought into laboratory and submitted to qualitative (species identification, species list preparation) and quantitative analysis (weighing of samples and biomass estimation by multiplying with the coefficient 25, in order to report the value at square meter).

### III. RESULTS AND DISCUSSIONS

During 2011-2014 at Pescărie, Cazino Constanța, Agigea, Eforie Nord, Eforie Sud, Tuzla and Costinești the submerged vegetation was characterized by a simplified patchy structure, sometime with a monospecific character. Only along the coastal line Mangalia - 2 Mai - Vama Veche was noticed a higher specific diversity, compared to other profiles. This was due to the presence of perennial species phytobenthic communities – brown alga *Cystoseira barbata* and marine phanerogam *Zostera noltei* - species with a particular ecological value for the marine environment (Fig.2). These species form stable communities in the southern part of the Romanian seashore, a shelter for a diversified associated fauna. The zoobenthic communities and the local ichthyofauna depend on their development of the existence of these phytobenthic communities.

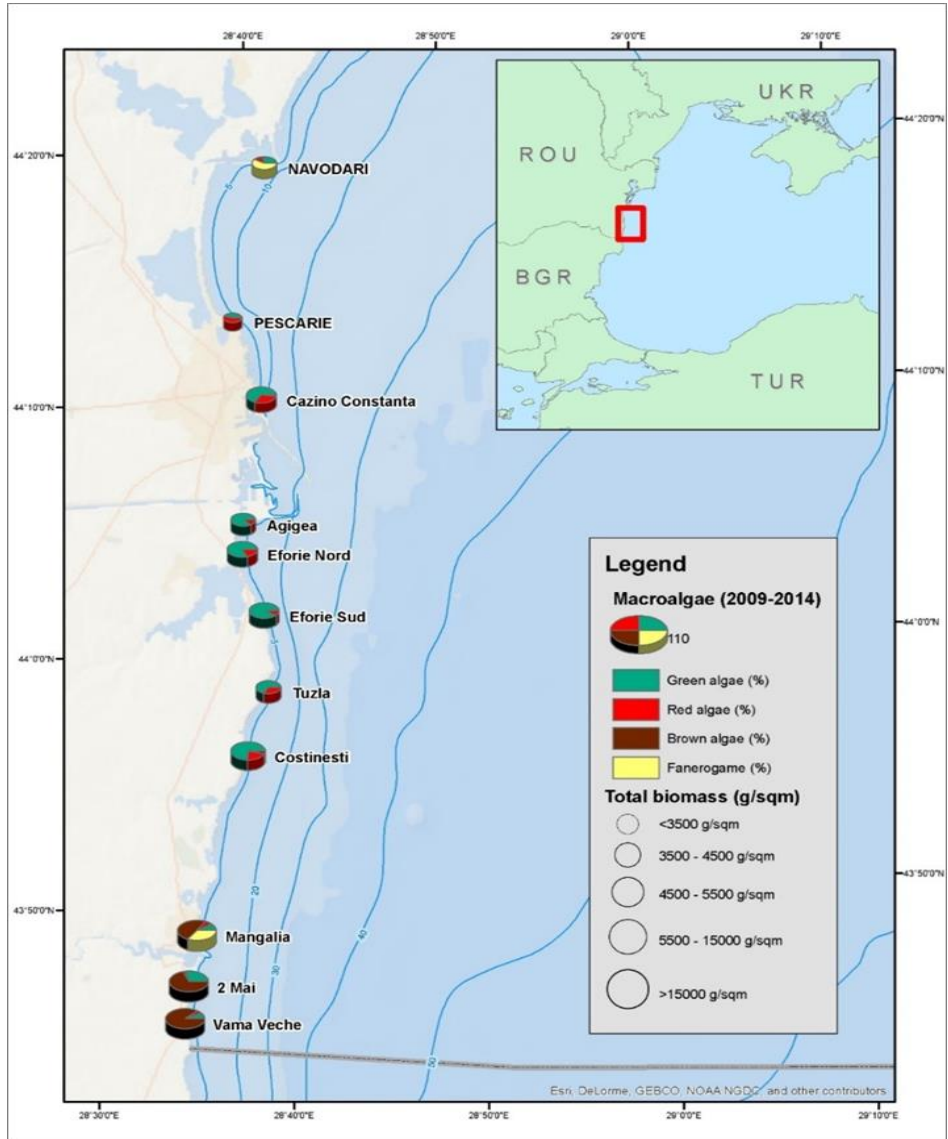


Fig. 2. Biomass proportion for the green, red, brown algae and marine phanerogams along the Romanian Black Sea coast (2009-2014)

During 2011-2014, the clear quantitative dominance of the green algae from Pescărie to Costinești can be noticed, a tendency maintained along the Romanian Black Sea coast during summer season in the past years. This fact is due to a proliferation of a small number of species characterized by a high reproductive capacity and a highly degree of opportunism, namely for *Ulva*, *Cladophora* and *Ceramium*. In fact, the dominant association was the photophilic *Ulva* - *Cladophora* – *Ceramium*. These species were also the ones that generated algal deposits along the shore during the summer season, creating discomfort to tourists. The present study is focused on both qualitative and quantitative analysis of *Cladophora* sp., *Ulva* sp., *Ceramium* sp. (Fig.3).

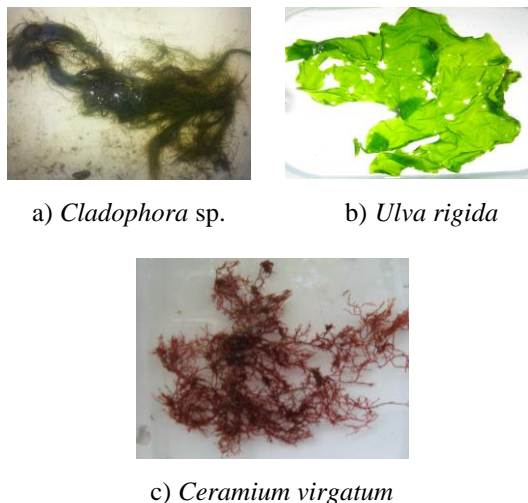


Fig. 3. Opportunistic species – details from the qualitative analysis

The algal mass biomass is generated along the Romanian Black Sea coast by a limited number of species with a very high reproductive capacity: *Cladophora* sp., *Ulva* sp. and *Ceramium* sp. The biomass decreased gradually with the depth. Thus, for the Romanian shore, the highest fresh biomass was recorded between 0 and 3 m depth. This is a normal response of benthic vegetation to summer season environmental conditions - high water temperature, large amount of nutrients and favourable water transparency.

Regarding the dominant species, *Ulva* species are among the first macrophytes to colonize the substrate from coastal waters with a high content of nutrients. This may due to their simple morphology and remarkable reproductive capacity [3]. So, along all the study period, *Ulva rigida* was a constant presence, both in the northern and in the southern part. Regarding the red algae, the biomass was almost entirely owed to *Ceramium* species (*C. virgatum*, *C. diaphanum* var. *elegans*, *C. diaphanum*), with *C. virgatum* the dominant species. This can be explained by the fact that *Ceramium* species have a high capacity of both asexual and sexual reproduction, so they can easily and quickly populate the rocky bottom, sometimes even completely [4].

During 2011 – 2014 the average biomass of these opportunistic genera varies between 50 g/m<sup>2</sup> and 1,340 g/m<sup>2</sup>, with higher values recorded in the northern part of the Romanian shore, comparing with the southern part, where the dominant were the perennial species *Cystoseira* and *Zostera*, as mentioned above (Fig.4).

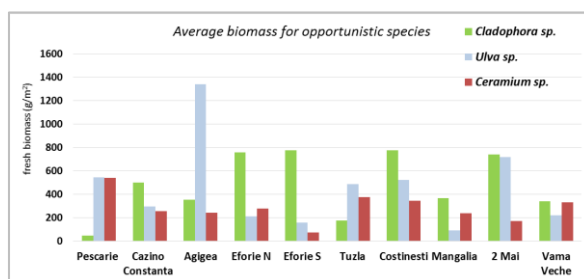


Fig. 4. Average fresh biomass variation for the opportunistic genera along the Romanian Black Sea coast during 2011-2014

The distribution of biomass medians and standard deviations pointed-out the lowest values for *Ceramium* sp., among all of the opportunistic species (Fig.5).

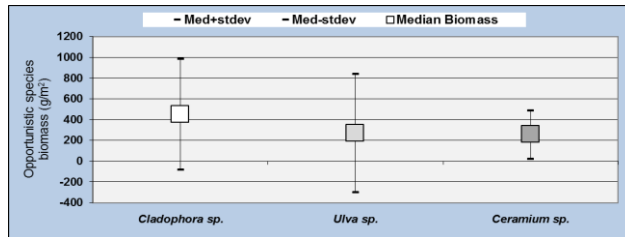


Fig. 5. Biomass variation for the dominant genera along the Romanian Black Sea coast during 2011-2014

At the beginning of the study period (2011-2012) the dominant phytobenthic genus was *Cladophora*. The maximum fresh biomass values were high, over  $1,000 \text{ g/m}^2$  -  $1,770 \text{ g/m}^2$  in 2011 at Costinești and  $1,776 \text{ g/m}^2$  in 2012 at Eforie Sud. The great development of *Cladophora* species can be considered as a consequence of abnormal environmental conditions during summer 2010, with very high water temperatures and anoxic phenomena that have led to mass fishing mortality. So, starting with 2010 until 2012, this genus had a particularly intense development, covering, at some profiles even completely, the hard substrate at depths between 0 and 5 m, generating algal deposits along the shore, affecting the beach aesthetics and sanitation (Fig.6).



Fig. 6. Macroalgae deposits along the shore (*Cladophora* and *Ulva*, main components)

Even if in 2011 *Cladophora* biomass registered the above mentioned maximum values (almost 2,000 g/m<sup>2</sup>), the biomass gradually decreased over the years, and in 2014 the biomass did not exceed 600 g/m<sup>2</sup> (Fig.7).

Starting with 2013, the situation change, *Ulva* being the dominant genus (Fig.7), with *U. rigida* a constant presence at all sampling stations and a principal component of the deposits. *Ulva* fresh biomass was higher compared to the one developed by *Cladophora*, with a maximum of 2,400 g/m<sup>2</sup> at Agigea (in 2014). Comparing this situation with the one observed in the previous years, it is noticed that the *Ulva* maximum biomass in 2011 was only 200 g/m<sup>2</sup> (Fig. 7).

Regarding the red algae, the fresh biomass developed by these species was lower compared to green algae. High biomass value was recorded only by *Ceramium* species in 2014, at Pescărie – 785 g/m<sup>2</sup> (Fig. 4., Fig.5). Some annual maximum values are: 730 g/m<sup>2</sup> (in 2011, at Vama Veche), 550 (in 2012, at Costinești), 320 g/m<sup>2</sup> (in 2013, at Tuzla) and 785 g/m<sup>2</sup> (in 2014, at Pescărie).

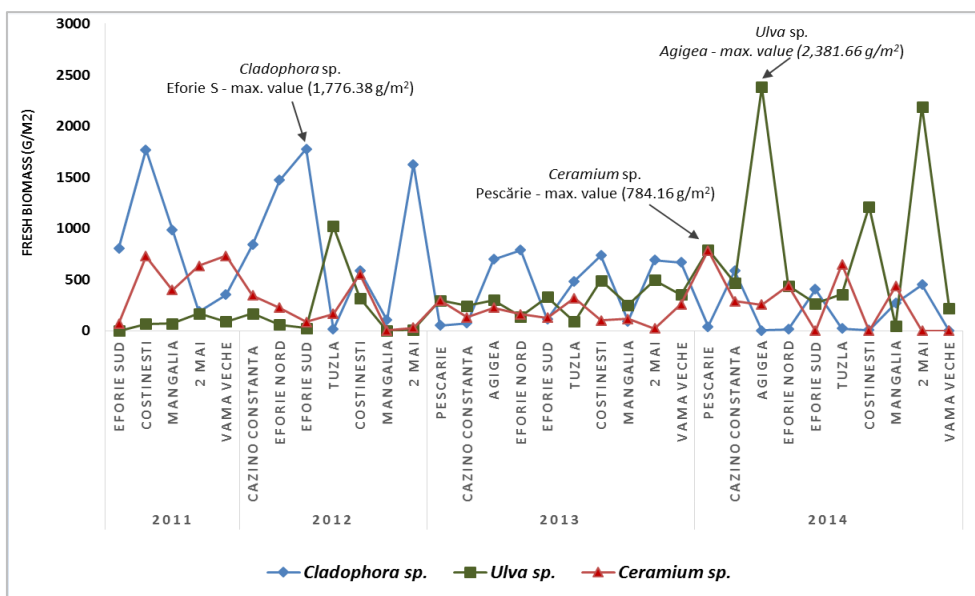


Fig. 7. Fresh biomass variation for the opportunistic genera along the Romanian Black Sea coast during 2011-2014

Analyzing the data collected from 2011 - 2014, a high similarity between the sampling stations was noticed. This aspect is due to the clear dominance of the same phyto-benthic community (*Cladophora* sp. - *Ulva* sp. - *Ceramium* sp.) during summer season and to the similar average biomass. A high similarity was noticed between Costinești and 2 Mai, due to the fact that both in 2011 and 2012, *Cladophora* species developed intensively in these areas, with a similar biomass of approximately 1,700 g/ m<sup>2</sup> between 0-3 m depth (1,770 g/m<sup>2</sup> at Costinești and 1,600 g/m<sup>2</sup> at 2 Mai). Also *Ceramium* biomass was similar in these area (720 g/m<sup>2</sup> at Costinești, 630 g/m<sup>2</sup> at 2 Mai).

The same similarity was also noticed between Cazino Constanța and Eforie Nord, due to the similar biomass of the opportunistic species – approx. 400 g/m<sup>2</sup> for *Ulva* sp. (471.3 g/m<sup>2</sup> at

Cazino Constanța, respectively 439.7 g/m<sup>2</sup> at Eforie Nord) and *Ceramium* sp. (346.1 g/m<sup>2</sup> at Cazino Constanța, respectively 440.9 g/m<sup>2</sup> at Eforie Nord) (Fig.8).

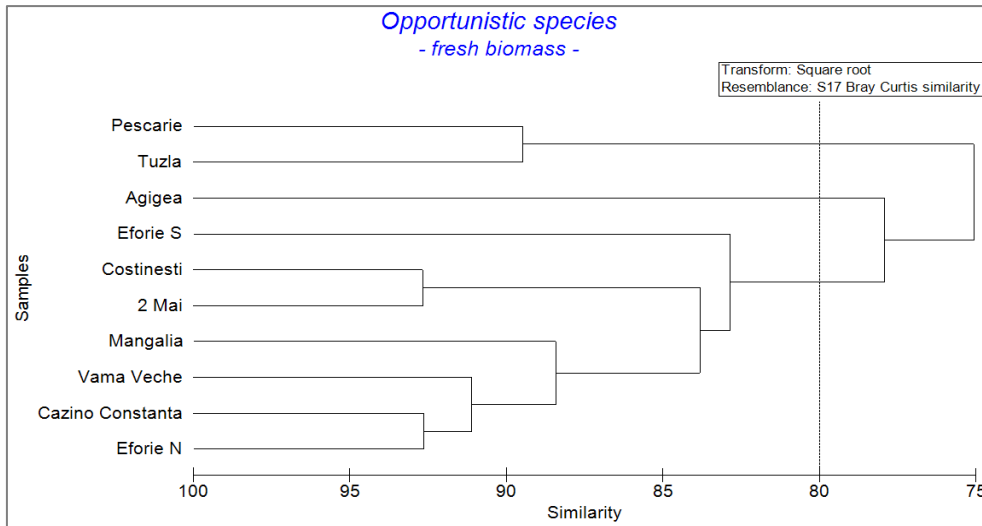


Fig. 8. Bray\_Curtis similarity based on macroalgae biomass

It is necessary to know the structure of the phytobenthic communities, the capacity of certain species to develop a considerable biomass under certain conditions, and the areas where algal deposits can be generated, because some species can be considered as sources of raw material exploitable in various domains. Thus, between 2011-2014, for the three opportunistic species, some areas have been highlighted where these species developed notable biomass (Fig. 4):

- *Cladophora* sp. – Eforie N, Eforie S, Costinești
- *Ulva* sp. – Agigea, Tuzla, 2 Mai (where the key association *Ulva rigida* - *Cystoseira barbata* exists)
- *Ceramium* sp. – Pescărie, Tuzla, Costinești

The literature offers various information regarding the valorification potential of certain species, including the species presented in this study. These species can be regarded as a source of raw material, applicable in various fields, a possible answer to some of the society problems. Thus, *Ulva* and *Cladophora* species can be used in agriculture as an organic fertilizer. They also contain bioactive substances capable of being chemically and pharmacologically valuable: vitamins, antibiotic substances, etc. Also the red algae (eg. *Ceramium* sp.) contain vitamins, carotenoid pigments, antimicrobial agents, applicable in many domains [5].

Due to their nutritional characteristics, the macroalgae from the Black Sea coast represent a natural resource important as fodder to animals, in agriculture as fertilizer, as ingredients in food and cosmetics industries, as source for substances with pharmacodynamics actions [6].

Maritime spatial planning provides information regarding the coastal activities that may have an impact on this important marine environmental component. Certain anthropogenic activities (tourist activities, consolidation of cliffs, etc.) can endanger the submerged vegetation, a component with a great ecological importance for the marine environment. Due to the fact that the phytobenthic communities are located in the coastal area, the anthropogenic activities have a strong impact and the algal vegetation will respond accordingly - by reducing the area of perennial sensitive species and through an abundant development of opportunistic species, as a result of the increased amount of nutrients.

#### IV. CONCLUSIONS

- The submerged vegetation creates the basis of life in marine environment
- During 2011-2014 along Pescărie, Casino Constanța, Agigea, Eforie North, Eforie South, Tuzla, Costinești the submerged vegetation was characterized by a simplified patchy structure, with monospecific character
- The clear quantitative dominance of the green algae was noticed during the period 2011-2014
- The dominant association was the photophilic *Ulva - Cladophora – Ceramium*
- The average biomass for the opportunistic genera varies between 50 g/m<sup>2</sup> and 1,340 g/m<sup>2</sup>.
- During 2011-2012 – the dominant genus was *Cladophora*, with a maximum fresh biomass of 1,776 g/m<sup>2</sup> at Eforie Sud, in 2012.
- Starting with 2013, the situation change, *Ulva* being the dominant genus, with a maximum fresh biomass of 2,400 g/m<sup>2</sup> at Agigea, in 2014.
- Among the red algae, *Ceramium* developed a considerable biomass, with a maximum fresh biomass of 785 g/m<sup>2</sup> at Pescărie, in 2014.
- Between 2011-2014 for the three opportunistic species, some areas have been highlighted where these species developed notable biomass: *Cladophora* sp. (Eforie N, Eforie S, Costinești), *Ulva* sp. (Agigea, Tuzla, 2 Mai), *Ceramium* sp. (Pescărie, Tuzla, Costinești)
- *Ulva, Cladophora, Ceramium* – a source of raw material, applicable in various fields, a possible answer to some of the society problems.

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