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Preliminary results on Macroalgae distribution in destructive processes

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Abstract

*It has been shown that the destruction of the coastal strip in the region affected by Mikhailovsky landslides has resulted in changes in species structure and dominant species in photophilous *Cystoseira barbara* and sciophylous *Gracilaria verrucosa*. In accordance with increasing amounts of sediment in sea water the biomass and the morpho-functional parameters of the photophilous species are reducing, while in the sciophylous are growing. Progressive epiphytism is observed in algal populations in the southern part of the researched region which it is possible to consider as a response reaction, leading to increase in a synthesizing surface. Decreasing physiological activity is compensated for by growth of the total surface of macrophytes. The increase of sea water sediments leads to a lowering ratio of the long and shortwave pigment level of ATP-ase activity and raising the concentration of the total sum of pigments in thalli.*

Keywords: Landslide, Algae macrophytes, Suspended sediment, Water transparency, Morphophysiological parameters, Reduced specific surface, Macrophytes.

Introduction

Biological and phytocenological characteristics and influence of water pollution on floristic structure and macroalgae distribution have been thoroughly investigated in recent years (KALUGINA-GUTNIK, 1975; KOSTENKO, 1990; MIRONOV *et al.*, 1999). Functioning of macrophytes and animals is usually examined within the framework of the ecosystematic approach, but algae have been given less attention.

Our work reflects the one important issue of the majority of Black Sea coastal regions

- the influence of erosive processes on the diversity, allocation and morpho-physiological characteristics of macroalgae.

Materials and Methods

The region of Cape Tolsty chosen for research is characterized by the destructive processes of coastal line erosion, abrasion and landslippage (ALEKSEYVA *et al.*, 1999). This results in an increase of deposits and a reduction of water transparency. The area

affected by the Mikhailosky landslide covers a large part of Cape Tolsty. The main body of the landslide is located at a distance of 300-400m from a housing estate. Since the sites are found along a fault line this increases land slippage. It has been observed that, within a year, about 1m of a fertile layer has been carried away by landslides. As it slides down from a height of 25m to a supralittoral level this soil becomes mixed with yellow clays.

As a result of abrasion this mixture passes into coastal waters and is distributed according to hydrological conditions, dropping as a deposit. The southern part of the researched region has a breakwater, the northern part is bounded by a small cape, where the operative range of the Bartenevsky landslide begins. The prevailing northern current carries fluidized substances, that lead to increased amounts of deposits in water from 0.17 g/l in the southern part up to 0.52 g/l in the northern. The infiltration of soil waters accelerates the destruction of the coastal strip and the desalination of coastal waters. We should note that as a result of leakage to this part of the coastal strip, not less than 170m³ of fresh water per day is poured the sea (VELIMIROV *et al.*, 1977).

Depending on the level of sea water transparency, sampling sites were allocated at a distance of 30m from the coast and 50m from each other. The first site was characterized by minimum amounts of deposit, the last site by maximum. Samples of phyto-benthos were selected from a depth of 3-4m within a size frame 50x50cm. Five tests were taken on each site. The research was carried out in July-August 1998 and July-August 1999.

Water transparency in the researched region was determined by a Secchi disk, the amount of deposit in the water found by means of filtration and weighing of a filter. The following habitual-morphological parameters were determined: reduced spe-

cific surface of thallus S_0 , equal to the ratio of a square root from an area of a thallus surface to a cubic root of its volume, number of crossings of thallus branches on a horizontal plane, sent through the middle of a thallus K, number of lateral branches per unit of length. The physiological parameters were as follows: ATP-ase activity (POLEVOY, MAKSIMOV, 1978), contents and interrelation of the basic pigments (LEE, 1978). Macroalgal biomass was determined on sampling sites in terms of wet weight per unit area.

Results

The materials of morpho-physiological analyses of more frequently meeting species in the researched region are given in Table 1. The representatives of *Phaeophyta* that have a tendency to lowering of a splitting rate on the assimilatory surface in accordance with increase of water transparency is observed. Whereas the representatives of *Rhodophyta* have the opposite tendency with an adaptive response of an algal pigmental mechanism to variations in illumination. A correlative dependence between amount of sediment and S_0 in *Chlorophyta* has not been observed. It might concern a higher stability regarding pollution factors in *Chlorophyta*. It is shown (Table 1) that with an increase of a deposit amount in sea water in the investigated thalli the level of ATP-ase activity is noticeably reduced. The ratio of basic pigments changes to short-wave ones and the total of pigment concentration grows. Distribution data for the mass species macrophyte algae dependent on the amount of deposit are given in Figure 1. Analysing curve 4, we can assume that the distribution of algae such as *Phaeophyta* is limited by amount of deposit. In cases where the amount of a deposit in sea water is more than 0.46 g/l there are some specimens of *C. barbata*, which attach themselves to rocks rising over a soft sea bottom deposit.

Table 1

Some morpho-physiological characteristics of mass species of algae from coastal areas with the various contents of sediments in sea water: A (ATP-ase activity, mkg of phosphorus / min x mg of protein); a/b, a/c, a/ph (the ratio of long and short-wave pigments); Ca + b, Ca + c, Ca + ph (the sum of basic pigments, %, of wet weight); Cc- concentration of carotenoids. The average values are given, number of retests are more than five.

Species	No of plafor m	Sedim ent,g/l	A	a/b	Ca/b	a/c	Ca+c	a/ph	Ca+ph	Cc	Biomass sm2	So of specimen	Species number	Species number at 1m ²
Cystoseira barbata (Phaeophyta)	1	0,11	0,76			1,9	1,14			0,05	1,08	28,10	39	28
	2	0,18	0,71			1,81	1,28			0,06	1,07	9,80	36	22
	3	0,27	0,66			1,63	1,32			0,07	0,90	7,90	21	13
	4	0,46	0,59			1,51	1,56			0,07	0,17	6,90	12	2
	5	0,52	0,40			1,42	1,64			0,08	0,05	6,60	10	1
Gracilaria verrucosa (Rodophyta)	1	0,11	-					-	-	-	-	-	-	-
	2	0,18	-					-	-	-	-	-	-	-
	3	0,27	0,11					1,13	1,69	0,02	0,004	2,90	24	2
	4	0,46	0,08					1,20	1,73	0,03	0,200	3,49	348	209
	5	0,52	0,03					1,15	1,88	0,03	0,400	5,82	243	146
Ulva rigida (Chlorophyta)	1	0,11	0,42	1,84	1,23					0,05	0,0060	8,40	15	9
	2	0,18	0,40	1,71	1,41					0,05	0,0020	11,86	12	7
	3	0,27	0,36	1,59	1,52					0,07	0,0010	6,77	12	7
	4	0,46	0,21	1,48	1,57					0,08	0,0008	6,30	8	2
	5	0,52	0,11	1,30	1,60					0,08	0,0008	6,72	6	1
Enteromorpha interstitialis (Chlorophyta)	1	0,11	0,74	1,80	3,40					0,08	0,0002	6,91	6	4
	2	0,18	0,62	1,66	3,44					0,1	0,0002	7,20	8	2
	3	0,27	0,58	1,58	3,52					0,11	0,0003	7,38	12	7
	4	0,46	0,47	1,44	3,63					0,16	0,0620	9,03	159	95
	5	0,52	0,38	1,31	3,88					0,17	0,0520	7,14	220	194

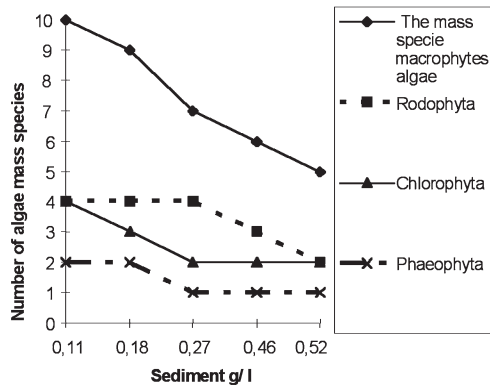


Fig. 1: Dependence of a number of algae mass species on transparency of water. Mean values of two periods (July-August 1998, 1999).

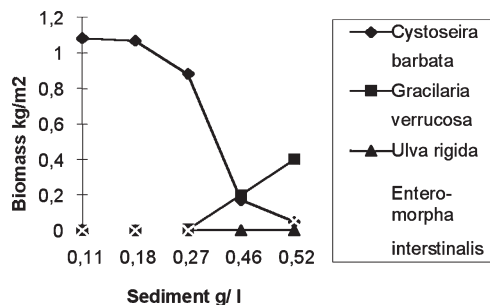


Fig. 2: Changes of an algae biomass (wet weight) on sample sites dependent on transparency of water. Mean values of two periods (July-August 1998, 1999).

Phaeophyta exist in a number of species. The species composition of *Chlorophyta* (curve 3) is more numerous whereas *Rhodophyta* has a dominant position and is characterized by rather homogeneous allocation (curve 2). The total number of species greatly increases in proportion to increase in water transparency from 3.8m to to 5.0m, thus the maximum number of species, with *C.barbata* dominant is found on the first site.

The macroalgae biomass distribution depending on water transparency is shown

in Figure 2. The biomass value decreases from 1.9 kg/m² in the most turbid water. We suppose that suspended sediments by suppressing light and changing its spectral characteristics, depress macroalgae growth and promote change of a species structure. Thus, *G.verrucosa* (0.4 kg/m²) tolerant of evaporating water and lack of light (ROMANYUK, OSKOLSKAYA, 1991) dominates in the fifth site and *C.barbata* (1.08 kg/m²) dominates in the first site. The maximum frequency of occurrence was observed in *P.subulifera* (100%). The total reduced

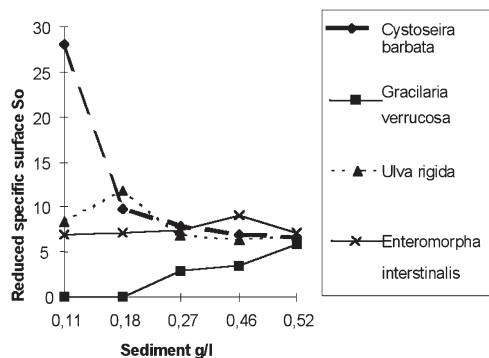


Fig. 3: Change of given reduced specific surface S_o of algae on sample sites dependent on transparency of water. Mean values of two periods (July-August 1998, 1999).

specific surface of investigated algae reaches value 38.6 in the first site and is more than three times less of the fifth site (Fig. 3). It is possible to explain this tendency by more intensive development of the apical parts of the thalli in the optimum conditions which the first site meets. *C. barbata* ($S_o=42.5$) reaches its highest splitting rate there. Similar tendencies were observed in coefficient K value growth (from 20 at the fifth site to 60 at the first) and the number of lateral branches (from 90 to 200 accordingly). The ATP-ase activity and the ratio of long and short wave pigments is reduced 2-3 times from the first site to the fifth, which indicates decrease of the level of assimilation processes. It was influenced by the biomass amount and habitual parameters (Table 1). In the researched region endemic *L. coronopus* is widely presented (KALUGINA-GUTNIK, 1975). From obtained data it follows that this species is well adapted to deselinated water conditions and high rates of suspended deposits. Its frequency occurrence reaches 80%.

Discussion

The tendency towards an adaptive response of an algal pigmentative device to

water transparency described above corresponds to that observed by other authors (VLADIMIROV *et al.*, 1986; OSKOLSKAYA, 1989; TITLYANOV, LEE, 1977; BRITTING, CHAPMAN, 1993). It is also conforms to Grinikh's data (GRINIKH, 1965). It was there reported that when algal thalli experienced a high rate of slushing and visual photosynthesis was reduced, algae became gradually atrophied (GRINIKH, 1965). Beside that, experimental data concerning decrease of a hydrobiontes active surface as a result of absorption of organic substances were received (POKROVSKY, SAVENKO, 1994; ZULLIG, MORSE, 1988).

The investigated algae can be divided into two groups according to their reaction to light. The photophilous group of algae preferred more transparent waters and was characterized by almost complete absorption of the red part of the light spectrum, whereas the sciophillous group's development in shade conditions was marked by shortwave ray absorption. (KALUGINA-GUTNIK, 1975). Changes in studied algae as response to environment variability were confirmed in Minicheva (MINICHEVA, 1991).

The parameter of a specific surface (S/W) is widely used in the study of macro-

phytes' morphology, where S is algae surface area, W is algae weight (MINICHEVA, 1991; FIRSOV, KHAILOV, 1979). To estimate functioning of algae species of different taxons we elaborated (OSKOLSKAYA, 1989) and applied for the first time in the present work the morphological parameter S_0 . Using S_0 , an algae surface areas and its volume can be found geometrically. To calculate a ratio S/W , algae surface areas were found mathematically and their weight by weighing. Weighing wet thalli, the values of water weights were added to the algal weights. When a temperature rose above 20°C thalli dried and lost weight. A weighting error can increase from a thalus splitting rate and a decrease in its biomass. Thus, we can assume that the parameter S_0 more exactly determines an algal surface development.

Conclusions

1. Destruction of a coastal strip in the Mikhailovskaya landslide area leads to change in species structure and changes to dominant species such as photophilous *C.barbata* which reaches maximal density (28 sp/m²) in the southern part of the researched region with the minimum sediment content of sea water (0.17 g/l) while sciophilous *G.verrucosa* reached maximum density (87 sp/m²) in the northern part of the region with a raised sediment content in sea water (0.52 g/l).

2. Biomass and the all investigated morpho-functional parameters of photophilous species have a common tendency to decrease in proportion to increase of sediment amount, whereas sciophilous species have the opposite tendency.

3. Increasing suspended sediments in sea water cause the ratio of long and short wave pigments to be reduced about two-fold, ATPase activity falls two and three fold, however, the total value of pigments grows, which compensates for the decrease in physiological activity.

4. For preservation of the ecosystem and diversity of the phytobenthos in the Black

Sea coastal zone it is extremely necessary to realize a complex of coastal reinforcing works directed decreasing landslippage.

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