https://doi.org/10.22364/iarb.2023.02

MACROPHYTE *FUCUS VESICULOSUS* AS HABITAT FORMING SPECIES IN THE GULF OF RIGA, BALTIC SEA

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Abstract. In the Gulf of Riga the long-term studies of macrophyte communities and related environmental parameters started at 1999 till 2021. This is first research monitoring combining both species identification, productivity, by SCUBA diving and ecological mapping of two different subregions in the Gulf of Riga. The *Fucus vesiculosus* as habitat forming key species in relation to environment factors described.

Key words: the Gulf of Riga, macrophyte communities, *Fucus vesiculosus*

Introduction

The macrophyte studies in the Gulf of Riga have been performed fragmentary by scientists already from the middle of 19th century (Eichwald, 1852, Skuja, 1924, Kumsare et al., 1974, Kirejeva, 1960). During this period different methods and approaches have been used by researchers to find out the species composition of the underwater vegetation of the Latvian part of the Gulf of Riga. In the 1999 in a frame of Nordic Council Programme "The Gulf of Riga" for the first time phytobenthic communities were sampled using SCUBA techniques on transects from shoreline to macrophyte depth limits. (Kautsky et al., 1999).

From 1999, after first Guidelines for monitoring of phytobenthic plant and animal communities in the Baltic Sea (Annex for HELCOM COMBINE programme, 26 March 1999) appeared, the laboratory of Marine Ecology started long-term research monitoring and ecological studies of macrophyte communities at different eutrophication impact.

The aim of this study was to quantify the macroalgal assemblages on a Gulf of Riga scale on a long-term base.

Material and methods

Two core transects, with two additional (for species diversity) for every transect, were chosen in the Gulf of Riga with different eutrophication impact. One transect was located

on the west coast of the Gulf "Mērsrags", the second – at the eastern part of the Gulf – "Saulkrasti" with three river (Lielupe, Daugava, Gauja) inflow impact. According to guidelines for macrophytes following core variables were measured by SCUBA diver: site position; transect depth profile; substrate; depth distribution of important plant species; composition of plant species; coverage of plant species; temperature; water transparency; salinity. As main parameters were nutrients in the water, algae belt distribution, macrophyte biomass (g dry weight/m^2). The productivity of every species in macrophyte communities are measured as biomass (g dry weight/m^2) by drying in the thermostat at 60° C temperature till the weight of the species is invariable (ICES, 2008) The samples on transects were sampled every second year (1999–2009), later on every year (2009–2021). The Mērsrags site transect belongs to the ILTER (International Long-Term Ecological Research) site, registered as Engure-marine site. The expeditions were organized always in August/early September, when macrophytes reach their physiological/growth maximum. The distance from the shore line to the max depth of Mērsrags transect was 3000 m, for the Saulkrasti transect – 2000 m.

Results and discussion

The Mērsrags core transect (Fig. 1) according to ecological mapping survey is characterized by coverage of plant species. The shallow coastal area (0.1–4 m) more than 75% of the hard substrate (boulders, large stones) is covered by benthic vegetation. The vegetation of hard substrates of upper vegetation zone (0.1–1 m) almost 100% consist of *Cladophora glomerata*. Another green algae *Enteromorpha intestinalis* was abundant only on few bigger boulders at depth of 1.5–2 m. Partial absence of vegetation on small stones is typical for large areas of the coastal zone of the Gulf of Riga. Even bigger stones (40 cm diameter) might be bare in more shallow parts of the coastal zone. It mostly depends on sediment flow and waves in the shallowest part of the coastal waters. The hard bottoms of the shallower part are covered by green algae *Cladophora glomerata*, which dominates above the depth of 2.5 m.

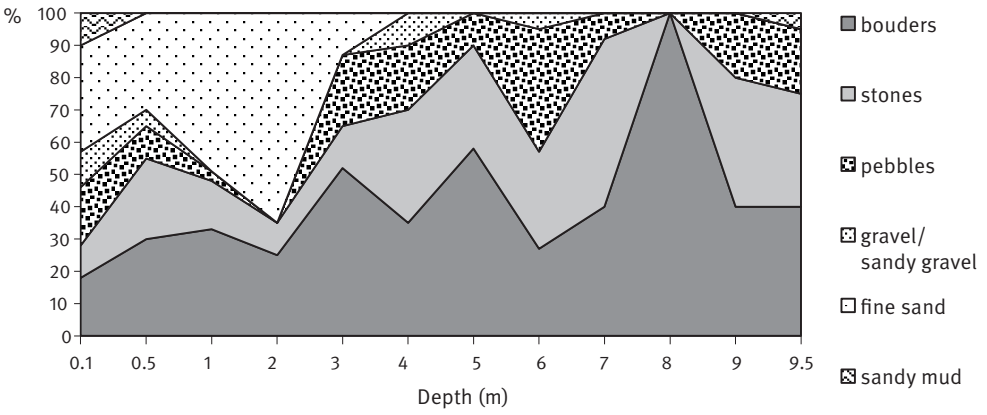


Figure 1. The composition of the substrate on the transect Mērsrags

At depth of 2.5 to 4 m brown algae *Fucus vesiculosus* reaches its maximum that equals to 30–40% of the total plant coverage. In some years its coverage reaches up to 90% of the total vegetation.

At depth of 4 m the abundance of red algae *Ceramium tenuircornis* increases up to 25–30%, down to 5 m *Ceramium* species become in dominance and cover about 60% of the suitable substrate and *Fucus vesiculosus* coverage still remains 5–10% of total plant coverage at this depth.

At the depth of 8.2 m the last shot of red algae *Furcelaria lumbricalis* was observed and brown algae *Sphacelaria arctica* observed on transect already from 1.5 m stays as the only algae reaching lowest limit of the photic zone at depth of 10 m.

The Saulkrasti core transect (Fig. 2) according to ecological mapping survey on a long-term aspect is characterized by following features: the shallow coastal area (0.1–3 m) all of the hard substrate is completely covered by vegetation. The difference in plant coverage on boulders and stones is much less pronounced as it was observed in Mērsrags. The influence of the long-shore sediment flow on the vegetation is less effective in Saulkrasti. However, the causes of the sand scraping were clearly seen in the shallower parts of the monitored area. The green algae *Cladophora glomerata* is dominating species above the depth of 3 m: 75% of the suitable substrate, respectively. *Fucus vesiculosus* occurs on 20% of available bottom at this depth. The coverage of other species living on the hard substrate (*Ceramium* sp., *Sphacelaria artica*, *Furcelaria lumbricalis*) is not more than 5%.

At depth of 3–4 m the coverage of *Cladophora glomerata* has decreased to 30% of the suitable substrate and *Fucus vesiculosus* has declined down to 10%. In contrary, *Sphacelaria artica* covers 35% of the available bottom and becomes a dominating species at this depth. Also red algae *Ceramium* sp. has its increase in coverage up to 20% and below 4 m depth *Sphacelaria artica* becomes an only dominating species. At the depth of 5.2 m the lower limit of distribution of macroalgae was reached. It is likely limited by low light intensity, which may be caused by high degree of dissolved material in water column or high density of the phytoplankton values. Most of the pebbles in Saulkrasti are concentrated at 1–3 m depth (10–20% of the hard bottom).

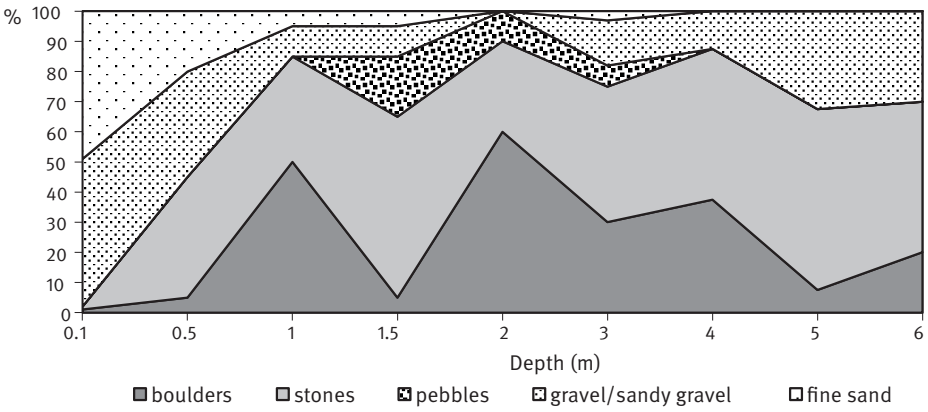


Figure 2. The composition of the substrate on the transect Saulkrasti

The macrophyte communities in the Gulf of Riga represent three main groups close connected with their location along the transects. As dominant species in shallow waters (littoral zone 1–2 m depth) are green algae Chlorophyta, in sublittoral zone (2.5–4 m) brown algae Phaeophyta are prevailing, but in deeper parts red algae Rhodophyta biomass appears more remarkable (Fig. 3).

The dominant species of Chlorophyta *are Cladophora glomerata, Cladophora rupestris, Enteromorpha intestinalis,* of Phaeophyta*: Fucus vesiculosus, Sphacellaria arctica, Pilayella litoralis,* of Rhodophyta – *Ceramium tenuicorne, Polysiphonia fucoides, Polysiphonia fibrillosa* (Boikova et al., 2003, Dekere et al., 2008).

The strong difference between biomass values on both transects for all three macrophyte groups relates with Secchi depth, salinity, nutrient levels. Secchi depth is related to water clarity and is a measure of how deep the light can penetrate into the water. At Mērsrags transect at 3 m depth in the average it was from 2.7 to close 3 m depth, at Saulkrasti transect – 2.1 m. Also, salinity differs at both transects: 5.20 and 4.80 PSU respectively. The average values of total nitrogen (NH_4, NO_2, NO_3) for Mērsrags transect after 2012 slighty lowered in parallel with Cladophora biomass. On Saulkrasti transect this was not observed.

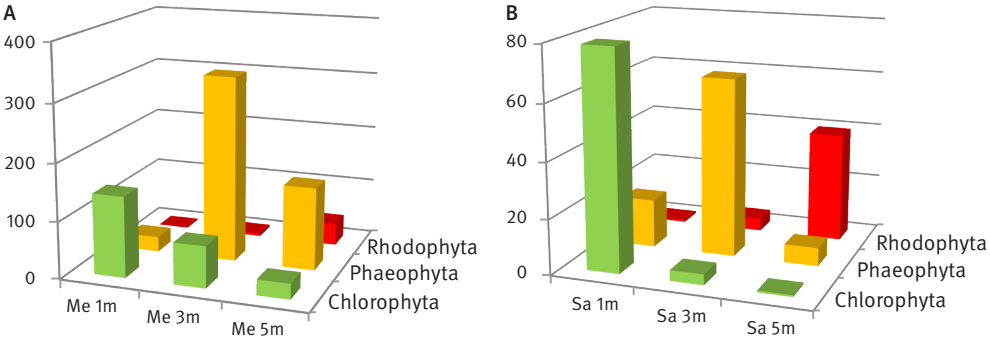


Figure 3. The average biomass (g dry weight/m^2) of macrophyte communities at Mērsrags transect (A), Saulkrasti transect (B) 1999–2021

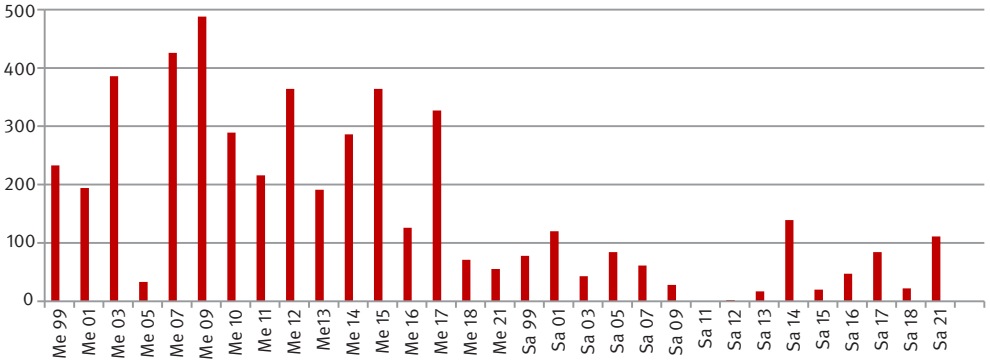
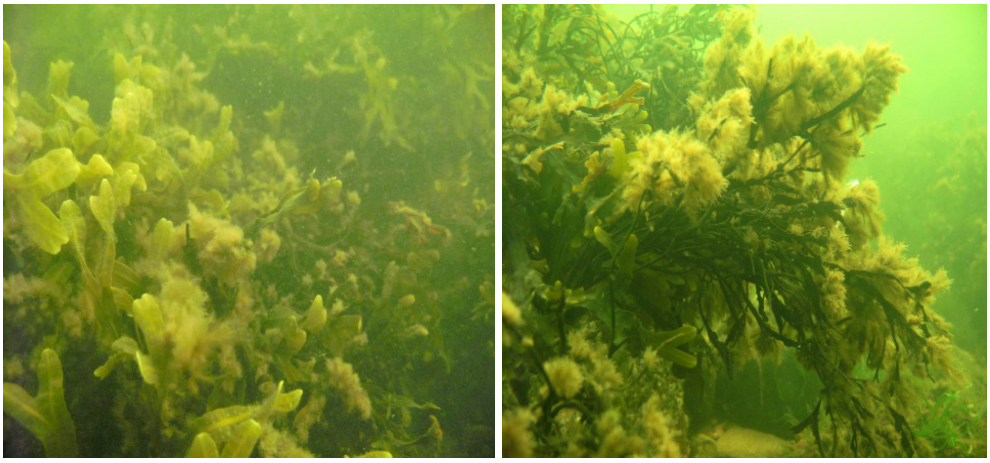


Figure 4. The long-term biomass (g dry weight/m^2) of *Fucus vesiculosus, Mersrags* (west coast) and Saulkrasti (east coast) transects (1999–2021)



A Mērsrags habitat **B** Saulkrasti habitat

Figure 5. Fucus vesiculosus at Mērsrat Mērsrags (A) and Saulkrasti habitats (B) at 3 m depth

The coverage of brown algae *Fucus vesiculosus* reaches the maximum in the depth interval from 2.5 to 4 m and long-term biomass data illustrates this species as a key species in the Gulf of Riga sublittoral zone. Nethertheless, there is remarkable difference in productivity between studied transects: at the Mērsrags transect with the average biomass 253 g dry weight/m^2 and at the Saulkrasti transect only 53 g dry weight/m^2. There was not observed any positive trend in key species *Fucus vesiculosus* and other macrophyte depth distribution as it was described by Kirejeva (1960), where macrophytes reaches 15 m vertical distribution.

Although the Gulf of Riga belongs to eutrophic area in comparison with some other Baltic Sea subregions there are local distribution patterns in relation to environmental variables (Fig. 4).

The *Fucus vesiculosus* habitats are different at both transects not only by substrate type, salinity, Secchi depth, partly by nutrients, but also there is a strong impact of epiphyts on *Fucus* at Saulkrasti transect (Fig. 5).

Still no positive distribution of macrophyte habitats, especially at Saulkrasti coast could be partly explained by possible new pollution elements/climate change.

Acknowledgements

This study was supported by "Littoral project" from the Nordic Council, "Long-term environment and ecological research in Latvia" and University of Latvia project "Biodiversity of different ecosystems". We are thankful to divers Mg. sc. Nauris Petrovics, Andris Vilks for excellent underwater photo and video files, to Vjaceslavs Kulikovs for safety work at the sea.

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