PHOTOSYNTHETIC PIGMENTS IN MUCILAGE AGGREGATES AND SURROUNDING WATER IN THE NORTHERN ADRIATIC

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Abstract

Massive amounts of mucilage aggregates have been observed in different marine environments worldwide but the northern Adriatic seems to be most severily affected. Our observations indicated that the phenomenon passed through a characteristic “life cycle” and variable phytoplankton composition assessed by pigment biomarkers (HPLC). The number of phytoplankton groups decreased as the aggregates aged and diatoms increased in relative biomass (up to 92.7 %). Phytoplankton biomass in seawater was similar in years with and without mucilage. Significantly higher contributions to the total biomass of 19 ’-hexanoyloxyfucoxanthin-containing phytoplankton (prymnesiophytes) were found in the upper 10 m preceding the mucilage phenomenon, followed by prevalence of diatoms in summer.

Keywords: Adriatic Sea, Mucus Aggregates, Phytoplankton, Pigments

Introduction

Several types of aggregates are observed in the northern Adriatic. Occasionally, masses of mucilage remained suspended in the water column of the northern Adriatic for up to several months during the summer stratified season (from May to September). Calm weather favours aggregation, whereas intense mixing during strong north-easterly winds can cause a decay of the event during its early phase. Eventually, mucilage accumulates on the shores and bottom and generally disappears by autumnal vertical mixing although recently it was observed also in other seasons. The main goal of our research was to elucidate and quantify the composition of the phytoplankton assemblages in the different types of macroaggregates.

Methods

Samples of mucilage aggregates were collected in the eastern part of the Gulf of Trieste during summers 1997 and 2000, on the surface and in the water column. Seawater samples for a time course of pigments in ambient water were taken monthly (from May to September 1997 and 2000) at 6 different depths. Water samples were filtered through GF/F filters, mucilage samples were concentrated, and both immediately frozen until analysed. Observations of the evolution of mucilage phenomenon were carried out weekly by SCUBA divers, who recorded the phenomenon. Using HPLC (High Performance Liquid Chromatography) pigment analysis we determined the phytoplankton community structure.

Results

Several kinds of mucilaginous aggregates were observed during this study. Different forms of mucilage may co-exist in the water column. Phytoplankton biomass in the mucilage samples was very high (from 7.9 µg/g to 390.8 µg/g of chlorophyll a per unit of dry mass of mucilage). Generally, chlorophyll a per dry mass was lower in loose networks of mucilage in the layer above the thermocline compared to its concentration in the mucilage clouds and compact yellowish-brown mucilage found predominantly in, and below the thermocline layer. As the aggregates aged diatoms increased in relative biomass (up to 92.7 %). Cluster analysis of mucilage data indicated three, rather distinct mucilaginous groupings: (1) mucilage at the sea surface, (2) mucilage from the water column around the thermocline layer, and (3) “aged” mucilage samples collected deeper and later in the season. The surface group appears to be more similar to the deepest group than to the intermediate group located between the surface and deep groups. PCA performed with the contribution of seven phytoplankton groups in different mucilage samples from 2000, was used to determine the course of mucilage development. An ordination plot produced showed the progression of fresh mucilaginous aggregates (with prymnesiophytes and silicoflagellates), to intermediate mucilaginous stages (heterogeneous phytoplankton community), and to aged mucilaginous aggregates (with prevalence of diatoms). Comparisons of the succession of phytoplankton groups in the water column showed differences between mucilaginous and non-mucilaginous years. The former were characterised by a higher contribution of prymnesiophytes in spring, and the prevalence of diatoms in summer. The single pigment index, F_p, used to capture the trophic status of an ecological province [1], showed a clear difference between mucilaginous and non-mucilaginous years. In April-May (1997 and 2000), before the appearance of mucilage, F_p ratios were lower compared to the non-mucilaginous years. In contrast, when mucilage occurred in June-August, F_p ratios were higher than during non-mucilaginous years. A similar pattern was observed in year 2005, when the F_p index was very low (0.20±0.07) during April-May due to the high contribution of 19'-hexanoyloxyfucoxanthin-containing phytoplankton - prymnesiophytes. Later on (in June) we observed the beginning of mucilage formation, but due to the weather conditions that followed, with summer storms and strong winds, the mucilage phenomenon did not develop.

Discussion and conclusions

The mucilage phenomenon shows an evolution [2]. Weekly or more frequent observations during the summers of 1997, 2000, 2002 and 2004 indicated that the phenomenon passed through a characteristic “life cycle”. Phytoplankton composition in loose mucilaginous aggregates above the thermocline at different periods was very similar, indicating that fresh mucilage may form in the upper water column over a period of several weeks to months. The loose, web-like mucilage that developed earlier in the sequence of mucilage formation seemed, therefore, to be a favourable microenvironment for the development of autotrophs, resulting in higher chlorophyll a per dry mass in the more compacted mucilage clouds found deeper in the water column. Overall, the fucoxanthin concentrations revealed that diatoms were the main contributor to phytoplankton biomass in the mucilaginous aggregates. In contrast, phytoplankton biomass in seawater during a mucilage event did not significantly differ from years when mucilage did not occur. These findings indicate that the development of macroaggregates did not significantly affect the phytoplankton biomass in surrounding seawater. Our results suggest that the role of prymnesiophytes and other small flagellated forms in the initiating of mucilage development are crucial, and indicate the F_p index during spring as possible predictor of mucilage appearance.

References

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