ABSTRACT

The knowledge of phytoplankton taxonomic composition is central to the understanding of the optical variability of oceanic waters and therefore to the improvement of primary production estimates and ocean colour interpretation. Each algal class is expected to have a characteristic lightharvesting pigment composition as result of evolutionistic processes of adaptation, moreover during its life phytoplankton shows adaptation to light intensity variability by changes in intracellular pigment content and proportion of accessory pigments with respect to chlorophyll *a*. Pigment composition is an essential tool in phytoplankton taxonomy, being some pigments distinctive of algal classes (marker pigments). The accessory pigments have well-defined absorption bands in the visible region, and therefore it appears reasonably to assume that variations in pigment composition can affect the spectral shape of light absorption.

The aim of this study was to examine the relationships between spectral features of phytoplankton light absorption and its taxonomic composition. Experiments on monoclonal cultures and field measurements were planned for the following purposes:

- to determine spectral differentiation of light absorption between taxonomic groups;
- to assess specific modifications of spectral light absorption under different growth irradiances;
- to assess quantitative relationships between the spectral contribution of a given species and its abundance within mixed algal assemblages whose taxonomic structure was defined;
- to estimate the phytoplankton taxonomic composition of unknown Mediterranean assemblages using light absorption features.

In vivo absorption spectra for nine cultured species acclimated to one irradiance value tended to be well differentiated among the different taxonomic groups and main differentiations were discernible for the absorption wavelengths of the marker pigments. Furthermore, spectral similarity analysis performed by SAM algorithm (*Spectral Angle Mapper*) showed a good discrimination among examined species.

Influence of light intensity on spectral absorption and pigment composition was evaluated for each species grown under three irradiances. Main findings showed that spectral shape for a species tended to greatly vary according to the cellular content of the marker pigment, but the spectral similarity analysis highlighted that 20% was the maximum variation of spectra for acclimated cells in comparison with the average of the three light conditions. The absorption spectra obtained from this experiment were well differentiated among species and therefore they were used as reference spectra for each phytoplankton taxonomic group.

Five cultured species, acclimated to one irradiance value, were used to obtain 26 assemblages with mixed composition in order to assess quantitative relations between the absorption contribution of a species and its abundance in a mixed assemblage. Desired taxonomic structures were obtained varying the chlorophyll *a* contribution of one species at a time, from 0% to 100% (20% steps) with the Chl *a*-contribution of the other ones decreasing at the same rate. Similarity analysis between spectra of these mixed assemblages and reference spectrum for a species significantly increased according both to its relative abundance and to the concentration of the marker pigment within the mixed assemblage, proving that the modification of absorption spectra could be used for retrieve the taxonomic contribution of phytoplankton groups.

Hence, we attempted to use the same procedures for phytoplankton assemblages of offshore Mediterranean waters. Marker pigments and absorption spectra of 120 natural assemblages of Mediterranean Sea, split in two independent sub-sets, were analysed. To develop a quantitative model discriminating the contribution of algal groups, a similarity analysis between reference spectra of taxonomic groups and absorption spectra of natural assemblages was performed in one of the data set. Similarity indices linearly increased with the concentration of each marker pigment.

The comparison with the second independent subset also supported the application of the model. The good results obtained from this research show that it is possible to retrieve phytoplankton taxonomic composition from its optical properties, particularly the light absorption spectra.

Therefore the analysis and the knowledge of the phytoplankton light absorption spectra variations become an essential and refining tool for remote sensing monitoring improvement.