Biomarker pigment divinyl chlorophyll *a* as a tracer of water mass

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The ecological preferences of different phytoplankton types drive their temporal and spatial distributions, reflecting their dependence on certain temperature ranges, light levels, nutrient availability and other environmental gradients. Hence, some phytoplankton taxa can be used as water mass tracers (biotracers).

In order to determine the biotracers of targeted Adriatic water masses, eight sampling campaigns have been conducted in the southern Adriatic (Albanian shelf, May 2009) and the middle Adriatic (November 2011, February, March, May and August 2012, February and July 2013) (**Fig. 1.**). The surveyed area is greatly influenced by the Levantine Intermediate Water (LIW) and East Adriatic Current (EAC). The warm and saline LIW represents a part of the EAC and enters the Adriatic from the Ionian Sea spreading northwards at the intermediate level, usually at depths between 100 and 600 m, with the core from 200 to 400 m. The spatial and temporal distribution, as well as the phytoplankton community composition was investigated in relation to the encountered environmental parameters (temperature (TEMP), salinity (SAL), density (Sigma T), nitrates (NO_3^-), nitrites (NO_2^-), ammonia (NH_4^+), silicates (SiO_4^{4-}) and phosphates (PO_4^{3-}). A combination of several taxonomical techniques; flow cytometry (FC) and high-performance liquid chromatography (HPLC) pigment analysis, allowed us to investigate phytoplankton community composition across all size fractions.

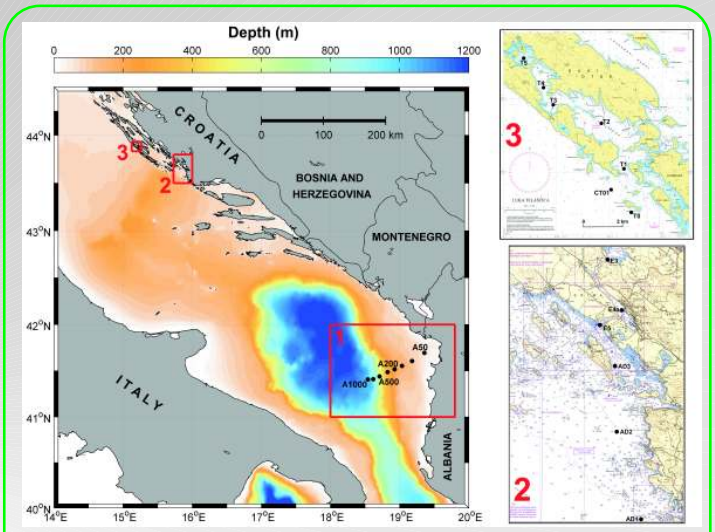

Fig. 1. Oceanographic surveys and sampling points. **1** - Albanian shelf, May 2009; **2** - Middle Adriatic, February and July 2013; **3** - Telašćica bay, middle Adriatic, October 2011, February, March, May and August 2012.

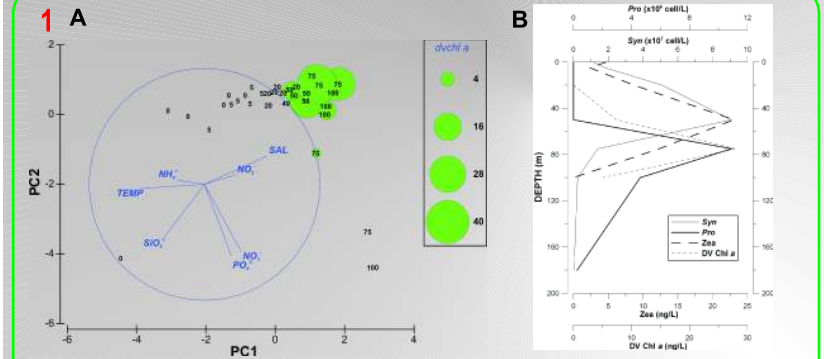

Fig. 2. Middle Adriatic, Stations AD1, AD2, AD3, February and July 2013. **A.** PCA analysis of physico-chemical parameters overlayed with pigment biomarker *dvchl a* concentration. *Dvchl a* was detected within the layer of LIW intrusion which is indicated by higher salinity values. **B.** *Dvchl a* as a good biomarker of *Prochlorococcus* presence in the water column was confirmed by flow-cytometry analysis.

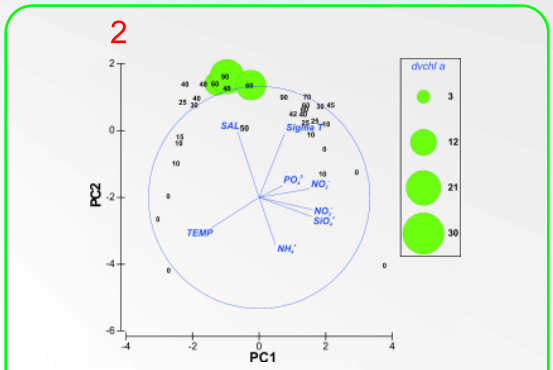

Fig. 3. Albanian shelf, May 2009. PCA analysis of physico-chemical parameters overlayed with pigment biomarker *dvchl a* concentration. *Dvchl a* was detected within the layer of LIW intrusion which is indicated by higher salinity and density values.

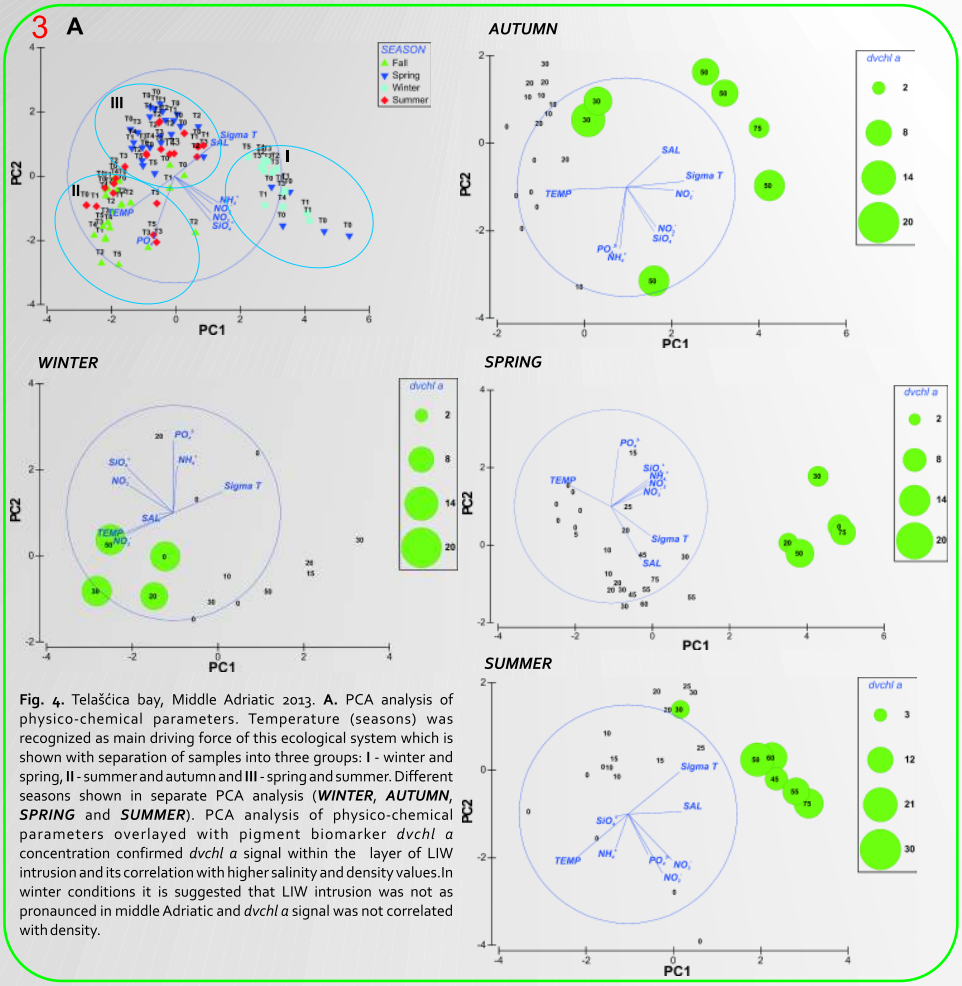

Fig. 4. Telašćica bay, Middle Adriatic 2013. **A.** PCA analysis of physico-chemical parameters. Temperature (seasons) was recognized as main driving force of this ecological system which is shown with separation of samples into three groups: **I** - winter and spring, **II** - summer and autumn and **III** - spring and summer. Different seasons shown in separate PCA analysis (***WINTER***, ***AUTUMN***, ***SPRING*** and ***SUMMER***). PCA analysis of physico-chemical parameters overlayed with pigment biomarker *dvchl a* concentration confirmed *dvchl a* signal within the layer of LIW intrusion and its correlation with higher salinity and density values. In winter conditions it is suggested that LIW intrusion was not as pronounced in middle Adriatic and *dvchl a* signal was not correlated with density.

The overall phytoplankton spatial distribution demonstrated high patchiness. However, in certain seasons, divinyl chlorophyll *a* (*dvchl a*), a pigment specific for the prokaryote *Prochlorococcus*, was found in high concentrations below 50 m – the portion of the water column in which LIW was frequently detected. The presence of *Prochlorococcus* was confirmed by flow cytometry, corroborating its important role in the formation of the deep chlorophyll maximum (**Fig. 2 - 4.**).

Based on these results, we hypothesize that the picophytoplanktonic prokaryote *Prochlorococcus*, that is easily detectable in the water column owing to its specific pigment structure, can be used for tracing Levantine Intermediate Water in the Adriatic.

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