COUPLING DINOFLAGELLATE CYSTS AND GEOCHEMISTRY IN THE NORTH ADRIATIC SEDIMENTS: CLUES TO POLLUTION AND EUTROPHICATION

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Abstract

In this preliminary work we tried to investigate the relationships between geochemistry and organic-walled dinoflagellate cyst assemblages in sediments from the North Adriatic Sea. The area is strongly influenced by the Po river that transports large amount of heavy metals (Cu, Zn and Pb) and nutrients to the open sea. Direct relations between heavy metals and dinocysts were observed only for Zn in the core close to the Po delta front.

Keywords : Adriatic Sea, Dinoflagellate cysts, Geochemistry, Sediments

Dinoflagellates are one of the important phytoplankton groups and the motile stage has been correlated to the fossilizable benthic cysts about 30 years ago (1). Dinoflagellate assemblages consist of autotrophic and heterotrophic species: gonyaulacoids and gymnodinioids (except for *Polykrikos*) are autotroph, whereas protoperidinioids are heterotroph. Since heterotrophs can predate both solitary and colonial diatoms (2) they are considered a proxy for eutrophication in coastal waters. Cysts can be used as potential indicators of anthropic impact, both reflecting eutrophication and industrial pollution, but results concerning links between dinocysts and pollution and between dinocysts and eutrophication are still unclear (3). The studied area is strongly influenced by the Po river that supplies large amounts of nutrients and dissolved and particulate heavy metals (4, 5, 6, 7).

Material and methods

Surface sediments from the coastal area of the Po River delta (five stations) and from offshore Ancona (two stations) and 2 shallow cores (one for each area) were collected by means of a box-corer. The Po sampling sites are located one north and one south of the delta and three along a transect seaward from the mouth. The Ancona stations are also located along a transect. A total of 19 sediment samples were treated with standard marine palynological methods for quantitative preparation (8) and analysed for dinocysts. Geochemical analyses were performed by X-ray Fluorescence spectrometry.

Results and discussion

A total of 38 dinoflagellate cyst species were identified. The most representative groups or species in all the assemblages are Protoperidinioids, *Spiniferites* spp. (cysts of *Gonyaulax scrippsae* group and *G. spinifera* complex), *Operculodinium centrocarpum* (cyst of *Protoceratium reticulatum*), *Lingulodinium machaerophorum* (cyst of *Lingulodinium polyedrum*). In surface sediments, cysts of the heterotrophic group dominate the samples in the Po area, while in Ancona area *Spiniferites* spp. and *O. centrocarpum* are more abundant. Total cyst concentrations in the Po area range from about 1500 cysts/g sediment north of Po delta to about 12000 cysts/g sediment closer to Po River mouth where the influence of the nutrient enriched water outflow is much higher. Offshore Ancona, cyst concentration ranges from about 3500 to about 6000 cysts/g and decreases with increasing distance from the coast. Concerning the two shallow cores, the highest total cyst concentration offshore Ancona is found in the upper section, while in the Po core the maximum value (about 16000 cysts/gram) is found in a deeper section. Distribution of selected heavy metals (Cr, Cu, Zn, Pb) gradually decrease from the delta seawards and southwards. Zinc and Pb reach values of 200 ppm and 55 ppm respectively close to the Po delta, being fairly constant downcore. Zinc shows a positive correlation with Corg and an unexpected low correlation with Al_2O_3. In the Ancona core Zn and Pb display lower concentrations (100 ppm Zn, 20 ppm Pb) both showing peaks at the top. In this core Pb is slightly correlated with Corg whereas the other elements result uncorrelated.

We divided dinocysts in three groups (autotroph, heterotroph, total cysts) and chose some species considered as possible indicators of pollution and eutrophication (3). These groups were hence statistically compared with some important geochemical parameters in order to identify possible eutrophication and pollution signals. The most significant results are shown in Fig. 1. In the Po core a good correlation between concentration of heterotrophic species (particularly *Selenopemphix quanta*) and both Corg and Zn content is observed while autotrophic species show poorer correlation. Since Zn values are very high in this area, we can conclude that heterotrophic species and mainly *Selenopemphix quanta* (cyst of *Protoperidinium conicum*) might be used as indicators of pollution more than eutrophication. Cr, Pb and Cu are not correlated with any dinocyst groups but are better correlated with lithological parameters.

In the Ancona core no correlation between dinocysts and geochemical parameters was obtained. In surface samples a good matching between autotrophic dinocysts and both lithological parameters (Al_2O_3, indicating fine sediment) and Ni or Cr (marking Po river plume) occurs. This group thus benefits from high nutrient levels.

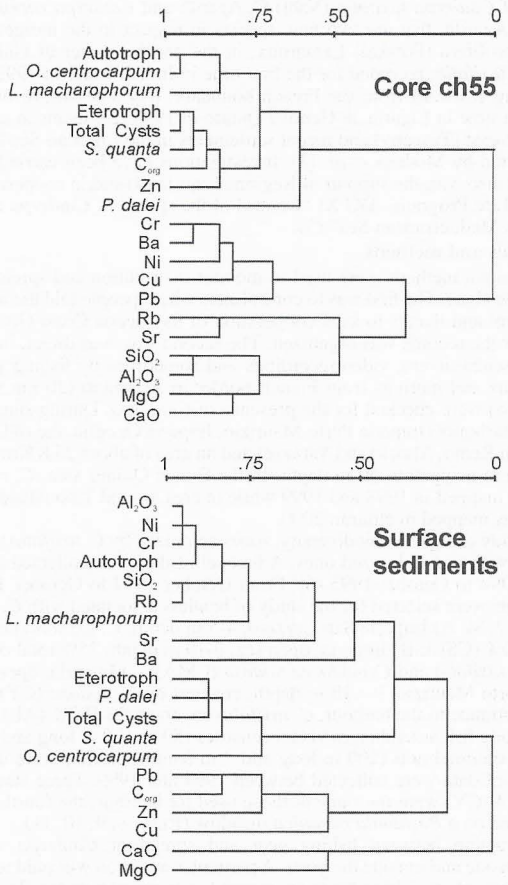

Fig. 1 – Dendrograms relative to the Po area core and surface samples. Correlations are statistically significant for r > 0.87 in both cases.

Conclusions

Our results indicate the existence of some good correlations between degree of pollution and species distribution which is more evident in the stations close to the Po river delta. The species Selenopemphix quanta is abundant in highly polluted sediments and could be an indicator of heavy metal contamination. Autotrophic species distributions in surface sediments are associated to a geochemical signal indicative of Po-derived sediments, which reflects nutrient dispersion patterns.

References

1. Wall D. and Dale B., 1968. Modern dinoflagellate cyst and evolution of the Peridiniales. *Micropaleontology*, 14: 265 – 304.
2. Jacobson D.M. and Anderson D.M., 1986. Thecate heterotrophic dinoflagellates: feeding behaviour and mechanics. *J. Phycol.*, 22: 249 – 258.
3. Dale B., 2001. Marine dinoflagellate cysts as indicators of eutrophication and pollution: a discussion. *Sci. Total Environ.*, 264: 235 – 240.
4. Bortoluzzi G., Frascari F., Frignani M., Giordani P., Guerzoni S., Rovatti G., and Turci C., 1984. Influenza del Po e dei fiumi minori sul contenuto di sostanza organica e nutrienti nei sedimenti marini dell'Emilia Romagna. *Mem. Soc. Geol.* It., 27: 483-497.
5. Frascari F., Frignani M., Guerzoni S., and Ravaioli M., 1988. Sediments and pollution in the Northern Adriatic Sea. *Annals New York Ac. Sci.*, 534: 1000-1020.
6. Pettine M., Camusso M., Martinotti W., Marchetti R., Passino R., and Queirazza G., 1994. Soluble and particulate metals in the Po River: factors affecting concentrations and partitioning. *Sci. Total Environ.*, 145: 243-265.
7. Dinelli E. and Lucchini F., 1999. Sediment supply to the Adriatic sea basin from the Italian rivers; geochemical features and environmental constraints. *Gior. Geol.* 61, 121-132.
8. Dale B., 1976. Cyst formation, sedimentation, and preservation: factors affecting dinoflagellate assemblages in Recent sediments from Trondheimsfjord, Norway. *Rev. Palaeobot. Palynol.*, 22: 39 – 60.