An integrated approach for the assessment of HAB dynamics in two NW Mediterranean bays from a GEOHAB perspective

Julia A. Busch[1], Allan D. Cembella[2], Margarita Fernández-Tejedor[3], Jorge Diogène[4] & Oliver Zielinski[5]

[1] Institute for Marine Resources, Bussestrasse 27, 27570 Bremerhaven, Germany. E-mail: Julia.Busch@imare.de, [2] Alfred Wegener Institute for Polar and Marine Research, Am Handelshafen 12, 27570 Bremerhaven, Germany. E-mail: Allan.Cembella@awi.de, [3] Institut de Recerca i Tecnologia Agroalimentaries, Ctra. Poble Nou Km 5,5, 43540 Sant Carles de la Rápita,Tarragona, Spain. E-mail: margarita.fernandez@irta.cat, [4] Institut de Recerca i Tecnologia Agroalimentaries, Ctra. Poble Nou Km 5,5, 43540 Sant Carles de la Rápita,Tarragona, Spain. E-mail: jorge.diogene@irta.cat, [5] Institute for Marine Resources, Bussestrasse 27, 27570 Bremerhaven, Germany. E-mail: Oliver.Zielinski@imare.de

Abstract

Alfacs and Fangar Bay in the Ebro Delta, NW Mediterranean are the major sites in Catalonia for shellfish cultivation. These bays are subject to occasional closures in shellfish harvesting due to the presence of phycotoxins. Fish kills have also been associated with harmful algal blooms. The comparison of phytoplankton dynamics in both bays offers the opportunity to reveal differences in bloom patterns of species known to be harmful for the ecosystem and aquaculture activities. Field research is underway under the GEOHAB framework within the Core Research Project on HABs in Fjords and Coastal Embayments. The overall objective of this study is to improve our understanding of HAB biogeographical patterns, and key elements driving bloom dynamics in time and space within these semi-constrained embayments. Via the comparative approach we aim to improve the prediction for monitoring purposes, with a focus on *Karlodinium* spp. associated with massive kills of aquaculture species. This objective is addressed by incorporating long-term time series of phytoplankton identification and enumeration with the first results of recent field work in both bays. The latter includes the application of optical sensors, to yield a complementary view with enhanced spatial and temporal resolution of bloom phenomena.

Introduction

The two semi-enclosed embayments Alfacs and Fangar Bay in the Ebro Delta system, NW Mediterranean, are the major aquaculture sites in Catalonia. Due to the presence of phycotoxins, both bays are subject to occasional harvesting closures. The ichthyotoxic species *Karlodinium veneficum* and *K. armiger* (in this area previously referred to as *Gyrodinium corsicum* (Garcés *et al*. 2006)) have been found in Alfacs Bay since 1994. In 2010 the species were also detected in Fangar Bay. In spite of their proximity and similar climatic conditions, Alfacs and Fangar Bay profoundly differ in HAB dynamics. Circulation patterns and retention time of water in both bays are differently affected by winds, coastal currents, and freshwater inflow from

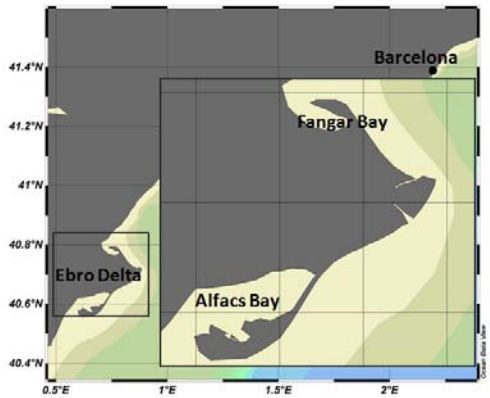

Fig.1 Study area in the Ebro Delta, Spain, NW Mediterranean.

agriculture. The comparison of environmental forcing functions and bloom characteristics in both bays therefore provides the opportunity to improve our understanding of the key elements that drive bloom dynamics in time and space.

Via the comparative approach we aim to improve the prediction for monitoring

purposes, with a focus on *Karlodinium* spp. associated with massive kills of aquaculture species (Delgado *et al.* 1995). This objective is addressed by incorporating long-term time series of phytoplankton identification and enumeration with the first results of recent field work in both bays. The latter includes the application of oceanographic and optical sensors, to yield a complementary view with enhanced spatial and temporal resolution of bloom phenomena. The objective of the presented work is the comparison of high *Karlodinium* spp. abundances in both bays.

Material and Methods

Cell numbers for abundance class generation of *Karlodinium* spp., temperature, salinity, and oxygen values were taken within the regular monitoring project in five stations in each of both bays for the time between January and August 2010. Complementary, an intensive depth resolved comparative field study was conducted between May and July, here only CTD casts along a transect of regular monitoring stations in both bays are taken into account.

Results and Discussion

Variation in time and space of t he environmental conditions in both bays (temperature, salinity, and oxygen saturation) as well as maximum abundances of *Karlodinium* spp. are reported. The highest abundances and maximum cell concentrations were reached in Alfacs Bay. At the time of maximum abundance of *Karlodinium* spp. in Alfacs Bay and first detection in Fangar Bay, we identify differences in environmental characteristics between bays (Fig. 2a). At the stations of high algal abundance in each bay (first station in the transects, at 0km section distance), we report a difference of >1 °C in temperature and >1 in salinity from surface to bottom, indicating a certain degree of stratification (Fig. 2a). A trend of *Karlodinium* spp. blooms in stratified waters was recognized in a 20 years´ time series of monitoring in the Ebro Delta Bays (Fernandéz-Tejedor 2010). During the summer months, dams are open for rice field irrigation in the Delta area. Consequently flow of freshwater increases from the rice fields to the bays and stratification predominates in both bays. This is due to a lateral fresh water inflow through a series of channels of the main land, and sea water inflow from the Mediterranean as a salt wedge along the bottom (Camp and Delgado 1987).

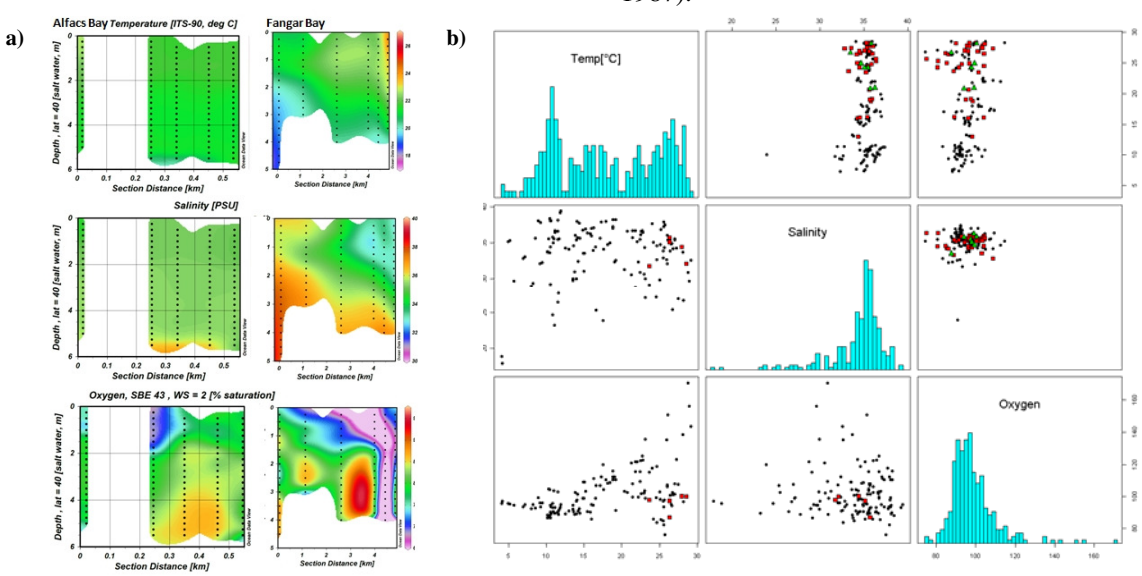

Fig.2 a) CTD casts on a transect of sampling stations (vertical dotted lines) in Alfacs (left) and Fangar (right) Bay. The first station is at section distance 0km). b) Pair plot of *Karlodinium* spp. detection in three abundance classes (<1000cells L-1=black dots; <10,000 cells L-1 =red squares; >10,000 cells L-1=green triangles) from 4 Jan – 30 Aug 2010 in Alfacs (upper three scatter plots) and Fangar (lower three scatter plots) with respect to temperature, salinity and oxygen saturation. The distribution of total *Karlodinium* spp. abundances in environmental ranges of both bays is given in the bar charts.

As Fangar Bay is smaller than Alfacs Bay, the influences of freshwater inflow, as well as from the southwesterly coastal currents, have a stronger effect on this bay. In 2010, *Karlodinium* spp. have been detected throughout a wide range of environmental conditions (Fig. 2b). Higher abundances, however, occur in the range of salinity of 32-35, and temperature of 20-27°C in both bays. The combination of these small ranges in salinity and temperature may not be the key elements that trigger high *Karlodinium* spp. abundances, but provide an environmental setting of this year´s bloom patterns. This can be an indication of the presence of proxies for algal proliferations that can be used for the early detection of blooms, e.g. by means of optical sensors.

Outlook on coupling of environmental- and HAB patterns:

- Inclusion of additional environmental parameters such as nutrients and turbidity
- Analysis of high depth resolution of biological and physical parameters from May to July
- Application of an optical sensor system and derivation of physical-optical bloom proxies
- Incorporation of bio-optical datasets into oceanographic models
- Setup of a long-term environmental observatory

Acknowledgements

The authors thank staff of IRTA, IMARE, and Bremerhaven University of Applied Sciences for their assistance in fieldwork. The support of Jan Schulz (IMARE) in statistical analysis is gratefully acknowledged. Part of the work was financially supported by the Helmholtz POLMAR Graduate School. The IRTA monitoring is conducted within the project "Monitoring of water quality in shellfish growing areas of the Catalan coast (DGPM-Generalitat de Catalunya).The IMARE GmbH is subsidized by ERDF (European Regional Development Fund).

References

Delgado, M., Fernández-Tejedor, M., Garcés, E., Matamaros, E. & Camp, J. (1995). In: Actas del V Congreso Nacional de Acuicultura, Cartelló, F. & Calderer, A., (eds), Universidad de Barcelona, pp. 700-704.
Camp, M. & Delgado, M. (1987) Inv. Pesq. 51:351-369.
Fernández-Tejedor, M. (2010). In: CIESM Workshop Monographs, Briand, F. (ed), Monaco, p 120.
Garcés, E., Fernández-Tejedor, M., Penna, A., Van Lenning, K., Gutierrez, A., Camp, J. & Zapata, M. (2006) J. Phycol. 42:1096-1112.

Software:

Schlitzer, R., Ocean Data View
http://odv.awi.de, 2010
http://R-project.org