Plankton ecosystem response to the decadal variation of winter intensity in the Mediterranean Sea : a long-term study (1979-2014)

Anne GOFFART [1]*, Amandine COLLIGNON [1,2], Jean-Henri HECQ [1], Marc BINARD[1], Pierre LEJEUNE [2]

[1] University of Liège, Belgium [2] Station Stareso, Calvi, France *A.Goffart@ulg.ac.be

1. Context

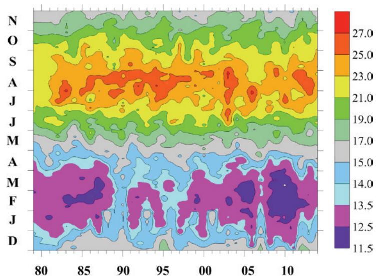
In the Mediterranean Sea, several studies with distinct data sets indicate that the pelagic ecosystem underwent periods of change in the late 1980s and in the early 2000s (e.g. Molinero et al., 2008; Conversi et al., 2010; Vandromme et al., 2011). However, evaluating the ecological implications of lasting ecosystem changes for resource management is largely unknown.

Fig 1 : the Bay of Calvi

2. Objectives

- To explore the synchrony between changes in environmental conditions from the end of the 1970s and phyto- and zooplankton dynamics in the well-preserved Bay of Calvi (Corsica island, Ligurian Sea, NW Mediterranean, Fig 1);
- To answer the question whether regime shifts occurred and to explore some of the potential impact on the pelagic food-web dynamics.

Fig 2 : Temporal changes in subsurface water temperature in the Bay of Calvi (1979 - 2014)



3. Pelagic ecosystem characteristics

Long-term time series (subsurface data, PHYTOCLY station) reveal high interannual variability in subsurface temperature (Fig 2), nutrient, phyto- and zooplankton.

4. A new winter index intensity : WII

$$WII = (CW \times WE) / 1000,$$

where CW is the duration (number of days) of the cold-water period (subsurface water ≤13.5°C), and WE is the number of wind events (mean daily wind speed > 5 m s^{-1}) during the cold-water period (Goffart et al., 2015).

5. Decadal changes in WII

WII highlights decadal changes in winter intensity (Fig 3).
It is used to track regime shifts in the Bay of Calvi.

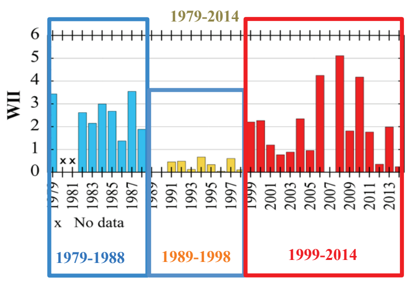


Fig 3 : Changes in the winter intensity index WII during the 1979-2014 period

6. Control of phytoplankton dynamics by WII

Winter intensity is a key driver of phytoplankton biomass and composition over the year (Fig 4).

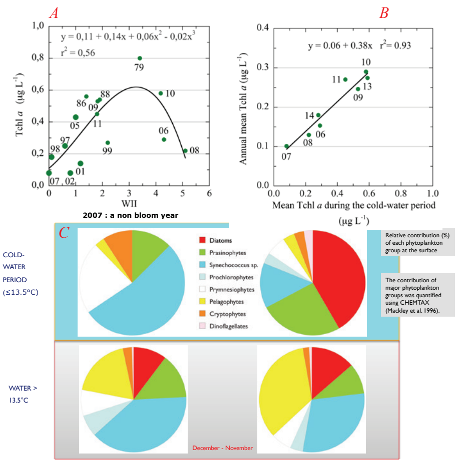


Fig 4. A. Scatter diagrams of mean subsurface Tchl a during the cold-water periods as a function of the Winter Intensity Index (WII). Numbers near the dots refer to years. From Goffart et al., 2015. B. Relationships between mean subsurface Tchl a during the cold-water periods and during the entire years. Numbers near the dots refer to years. C. Relative contribution of each phytoplankton group at the surface during a non bloom year (2007) and a bloom year (2010).

7. Control of zooplankton dynamics by WII

Winter intensity is a key driver of herbivorous zooplankton biomass over the year (Fig 5). It is likely to affect abundance of some groups (*e.g.* meroplanktonic Crustaceans) through food (detritus) availability. Abundance of fish larvae is NOT directly affected by winter intensity, but effective recruitment could be limited by food availability (mismatch between food recruitment and food availability).

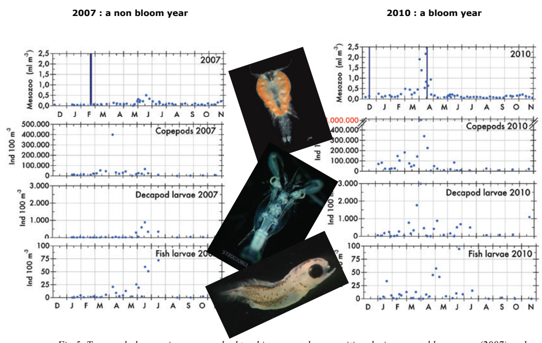


Fig 5. Temporal changes in mesozooplankton biomass and composition during a non bloom year (2007) and a bloom year (2010).

8. Conclusions

- The Bay of Calvi has undergone regime shifts in the late 1980s and in the late 1990s.
- Winter intensity is a key driver for phytoplankton biomass and composition. It affects herbivorous zooplankton biomass by direct control and is likely to influence higher trophic levels, including marine resources, via food limitation.
- WII can be used to characterize/forecast ranges of plankton abundance and composition. This could help to characterize food resources available for consumers, and to improve our knowledge of recruitment variability.