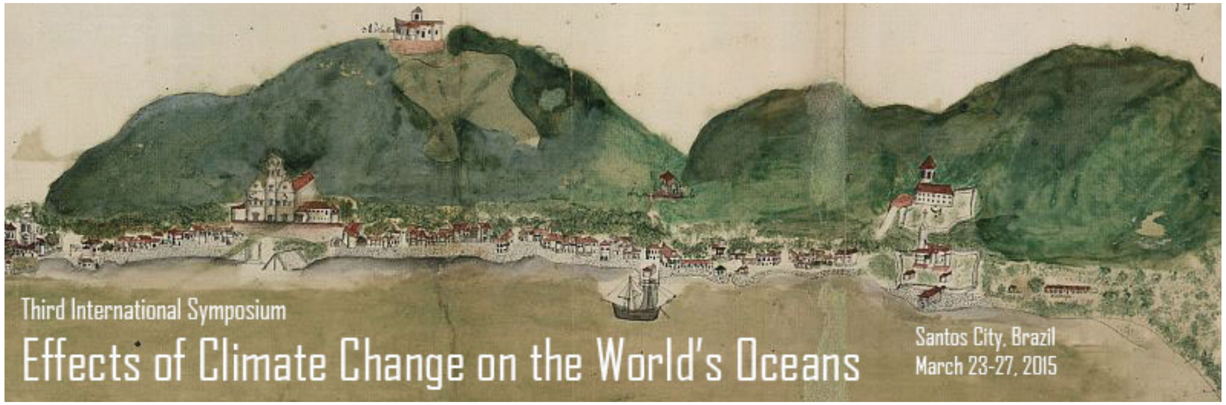

Session S6

Climate change in the seasonal domain : impacts on the phenology of marine ecosystems and their consequences

Control of plankton phenology by climate variation in a Mediterranean coastal area : results from a long-term study (1979-2011)

Anne GOFFART, Amandine COLLIGNON and Jean-Henri HECQ

University of Liège, Belgium
A.Goffart@ulg.ac.be

March 15

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Objectives

- **To understand how physical forcing affects the timing, duration and magnitude of the winter-spring phyto- and zooplankton blooms in a well-preserved Mediterranean coastal area;**

- **To provide new insights on the regulation of the phyto- and zooplankton phenology by environmental factors.**

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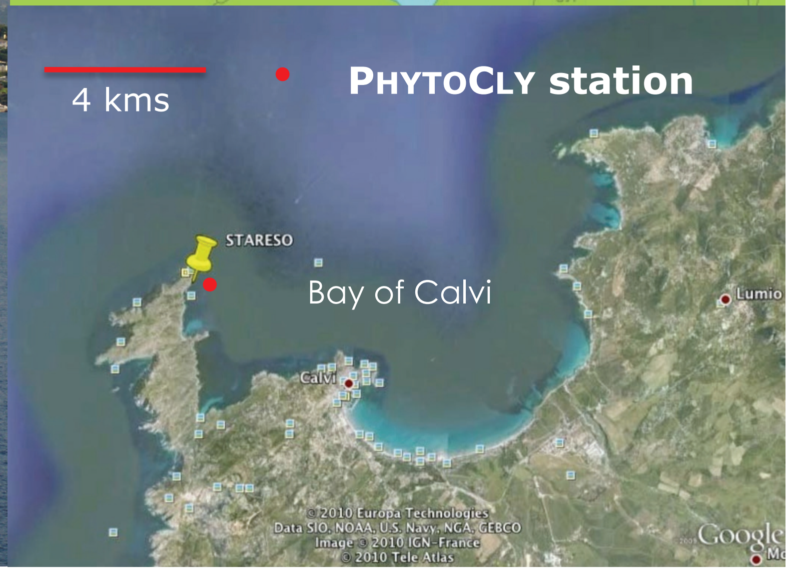
The studied area : the Bay of Calvi, Corsica, Western Mediterranean

- **Open bay and narrow shelf**
- **Presence of a deep canyon in front of the city of Calvi**
- **Few anthropogenic pressures**
- **Low-runoff system**
- **Reference for the WFD**



Long-term time series (subsurface data)

From 1979 :

- **water temperature and wind (continuous data)**
- **phytoplankton (18 years, continuous data from 2006)**
- **zooplankton (15 years, continuous data from 2003)**

From 1988 :

- **nutrients (16 years, continuous data from 2006).**

High sampling frequency during the winter-spring period :

- **Phytoplankton and nutrients : daily to biweekly**
- **Zooplankton : weekly.**

A.Goffart@ulg.ac.be

JH.Hecq@ulg.ac.be
Amandine.Collignon@ulg.ac.be

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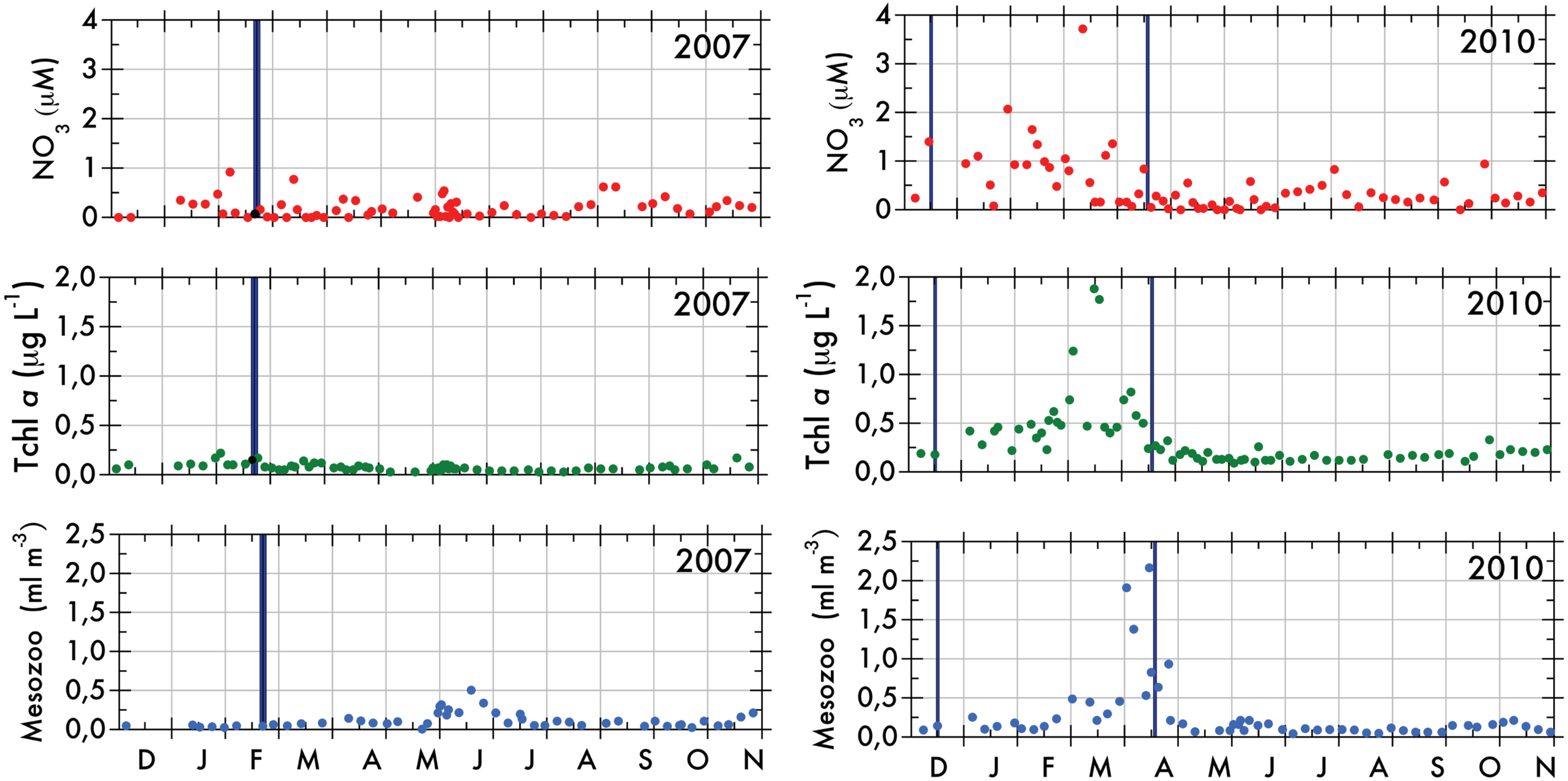
High interannual variability



The vertical dark bars identify the limits of the cold-water periods (≤13.5°C)

High interannual variability

PHYTOPLANKTON BIOMASS

Marked differences in the onset, date of maximum concentration, duration and intensity of the surface phytoplankton bloom

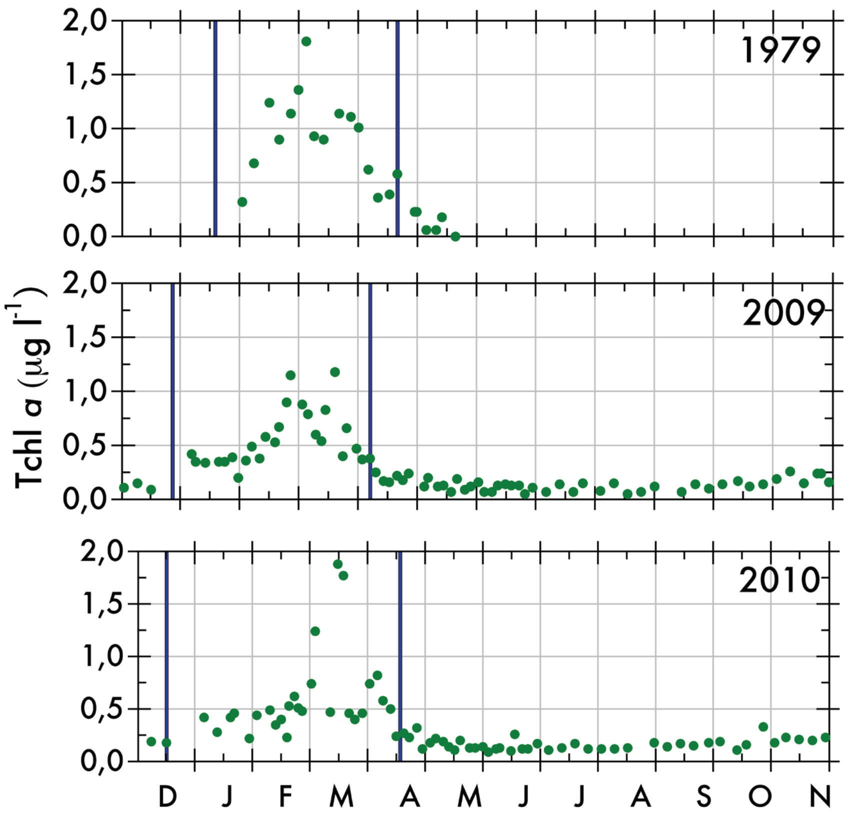
BUT

all blooming years share one key characteristic, *i.e.* Tchl *a* always increases and peaks during the cold-water period, when subsurface water is ≤13.5°C.

NUTRIENTS

Nutrient enrichment of surface waters, although variable interannually in intensity, is driven every year by wind forcing during the cold-water period.

(Goffart, Hecq, Legendre, in revision for Progress in Oceanography)



The vertical dark bars identify the limits of the cold-water periods (≤13.5°C)

Winter intensity index

WII : A WINTER INTENSITY INDEX

This led us to define a Winter Intensity Index

WII = (CW x WE) / 1000,

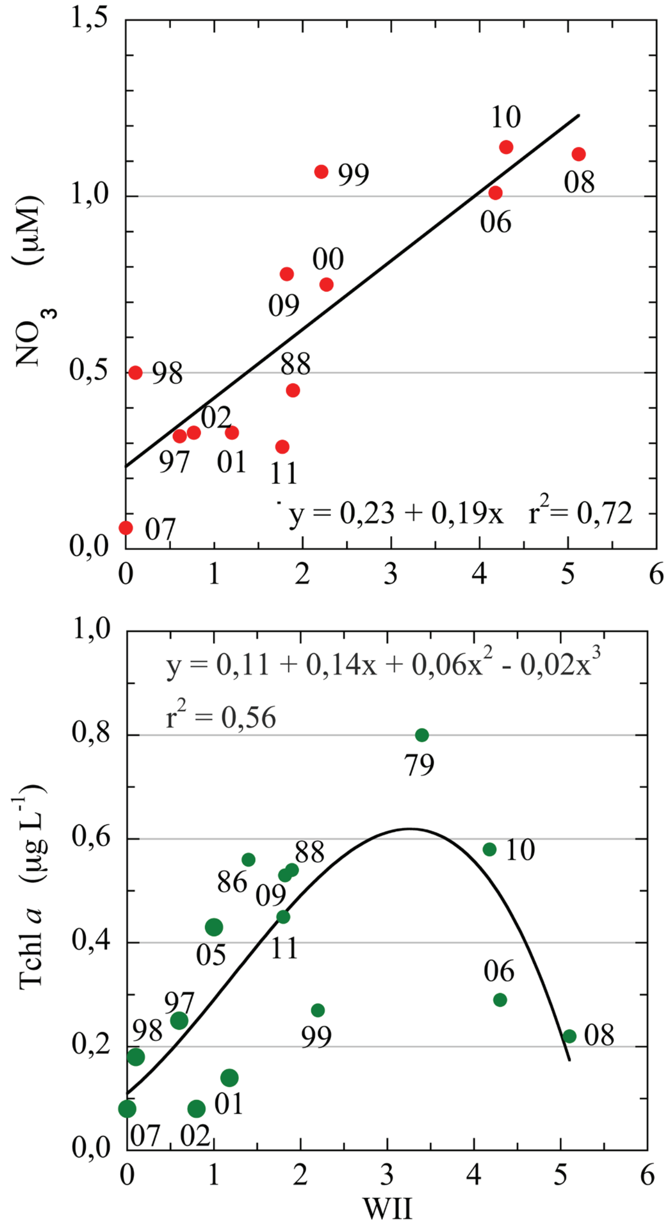
where CW is the duration (number of days) of the cold-water period, and WE is the number of wind events during the cold-water period.

NUTRIENTS VS WII

The plot of nitrate averaged over the cold-water periods as function of WII shows highly significant linear relationship.

TCHL *a* VS WII

The plot of average Tchl *a* during the cold-water period as a function of WII is strongly related to WII, but not linearly.



(Goffart, Hecq, Legendre, in revision for Progress in Oceanography)

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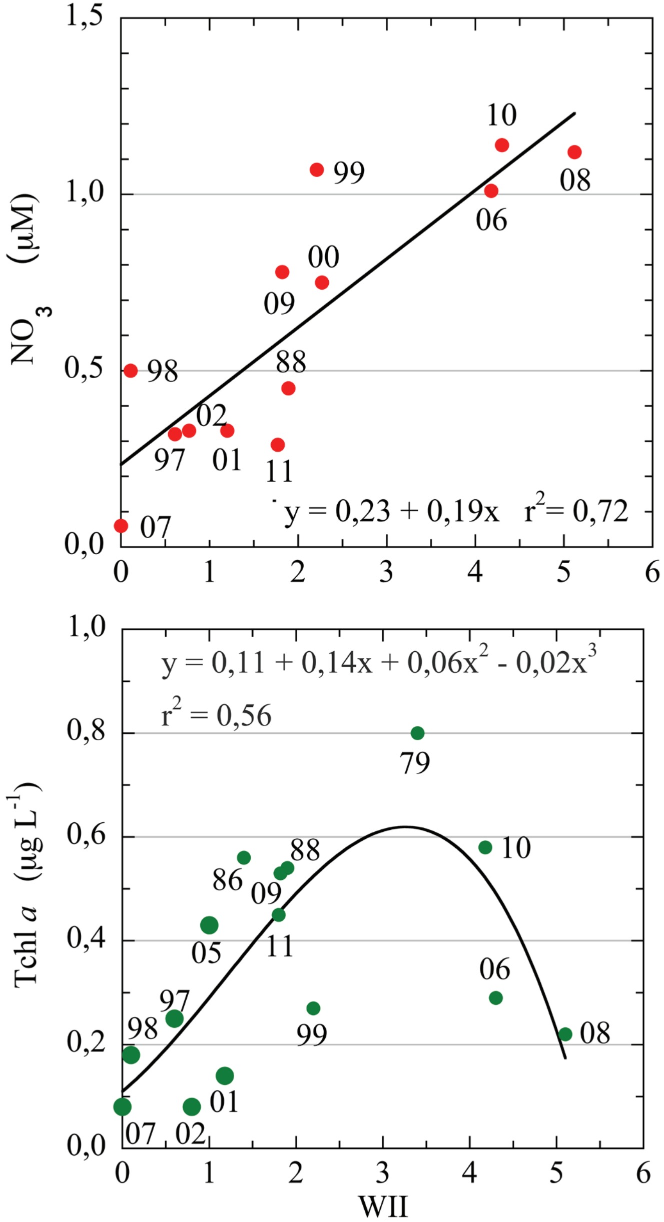
Winter intensity index

According to winter intensity, the trophic character of the Bay of Calvi varies from very oligotrophic (subtropical regime, low seasonal variability) to mesotrophic (temperate regime, well-marked increase in nutrient concentrations and chl *a* during the winter-spring period) during mild and moderate winters, respectively.

A third regime occurs during severe winters characterized by specific wind conditions (*i.e.* high frequency of northeasterly winds), when Mediterranean "high nutrient - low chlorophyll" conditions occurred.

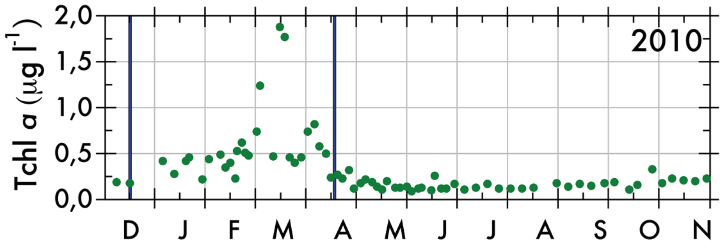
(Goffart, Hecq, Legendre, in revision for Progress in Oceanography)



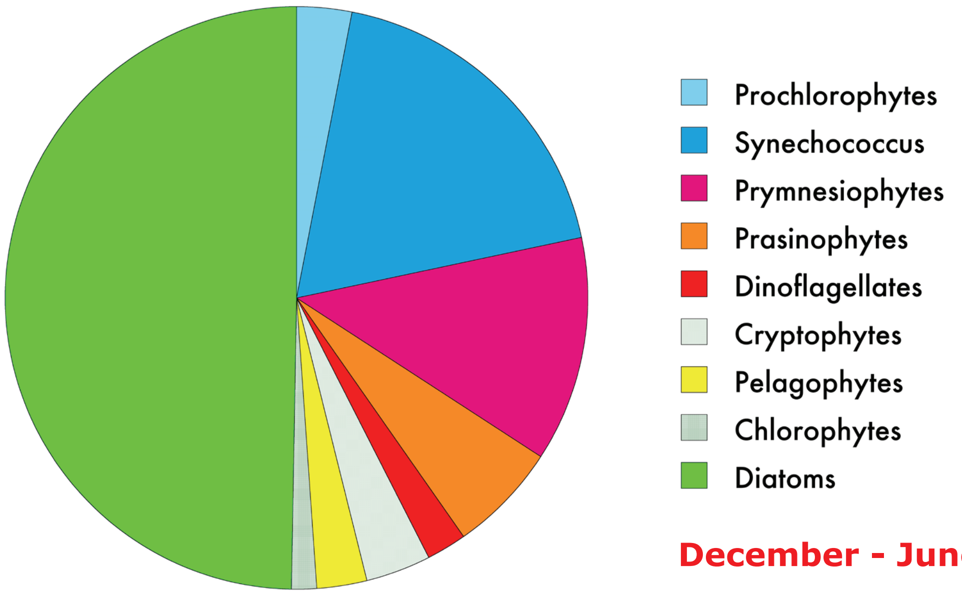
Control of phytoplankton composition and phenology by winter intensity

2010 : a blooming year

The contribution of major phytoplankton groups was quantified using CHEMTAX (Mackley et al. 1996).

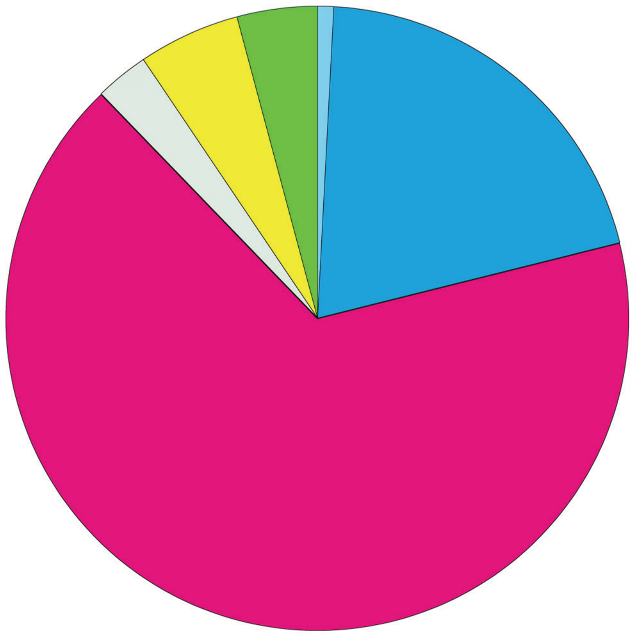


2010
% groups during the cold-water period



December - June

2010
% groups when water >13,5 °C



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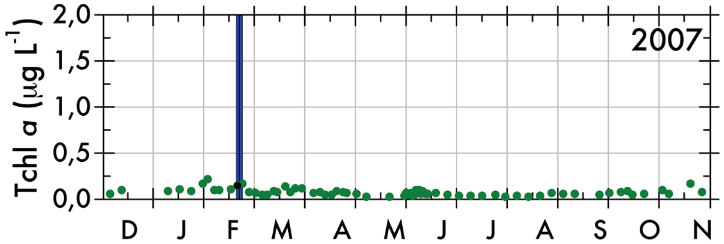
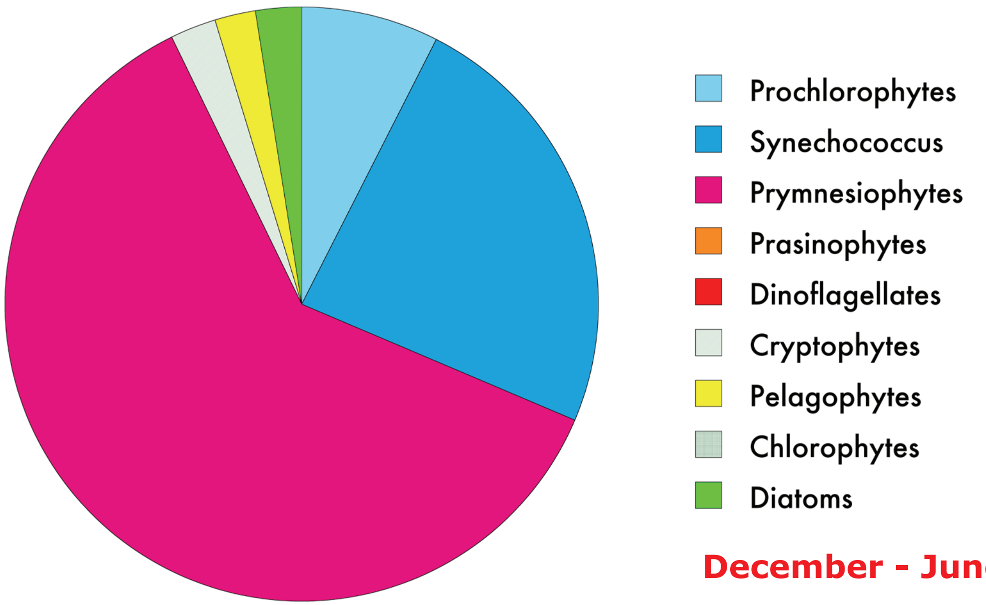
Control of phytoplankton composition and phenology by winter intensity

2007 : a non-blooming year



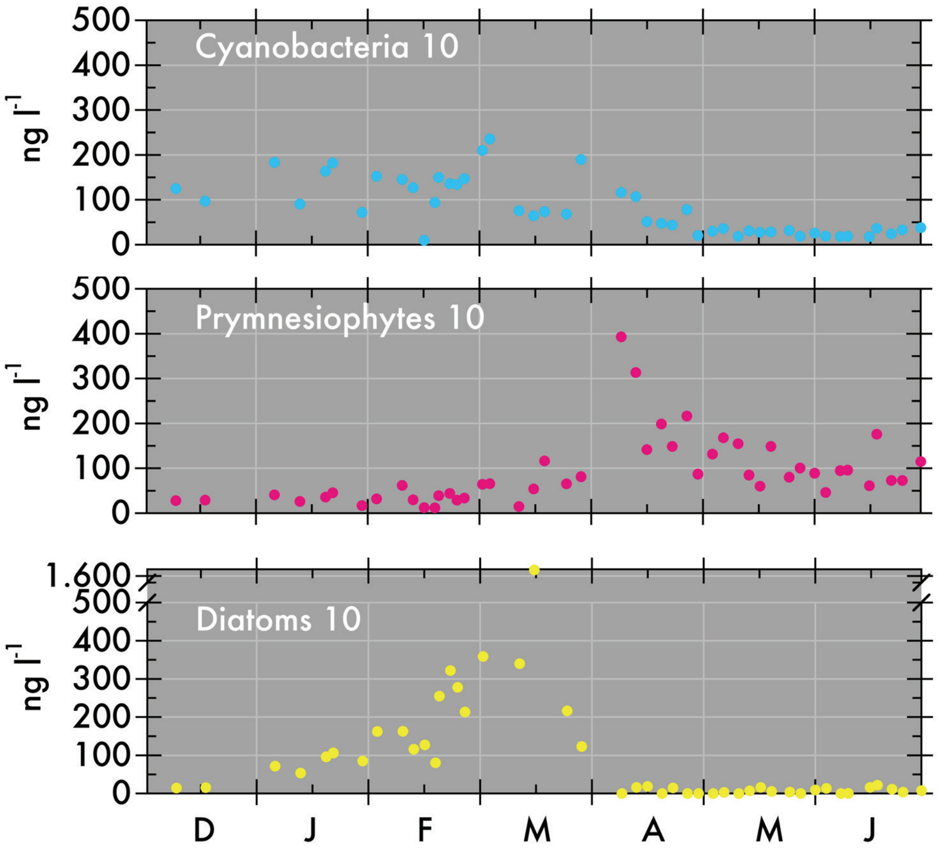
2007
% groups when water > 13,5°C



December - June

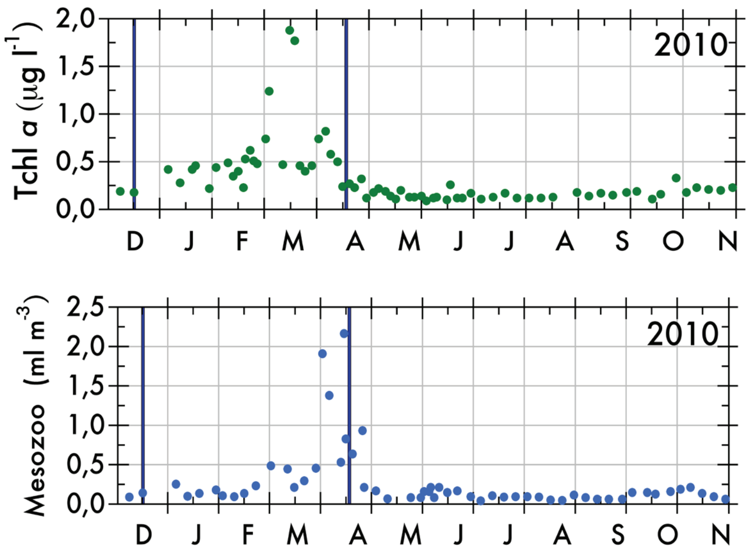
Control of phytoplankton composition and phenology by winter intensity

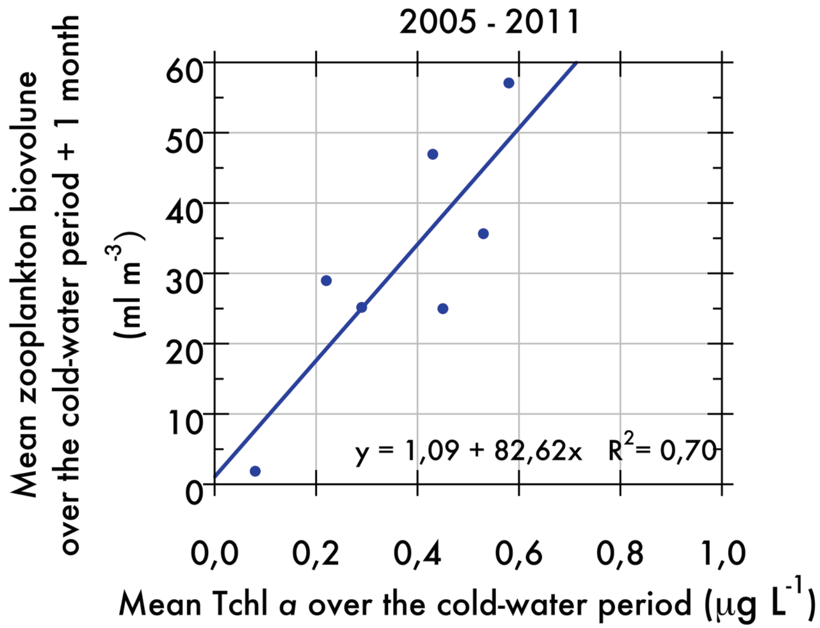
Our study is consistent with the report that, when occurring, diatoms peaks were added to the initial phytoplankton groups instead of replacing them (Barber & Hiscock 2006).



Control of zooplankton composition and phenology by winter intensity

2010 : a blooming year





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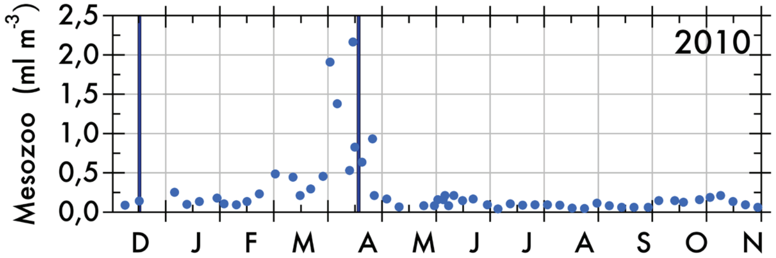
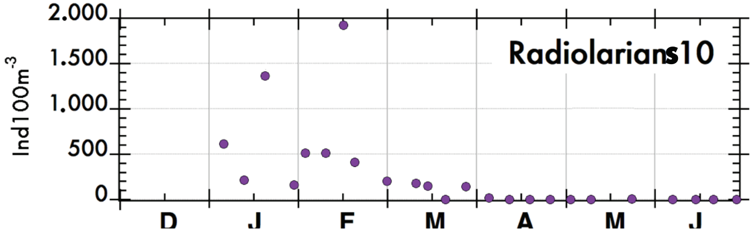
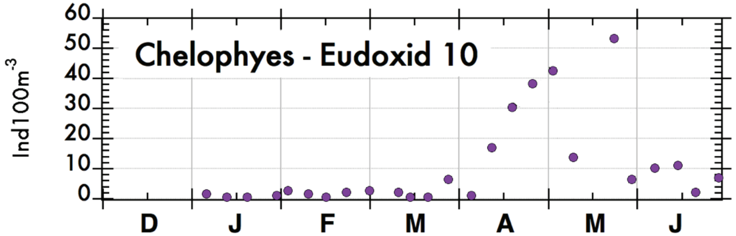
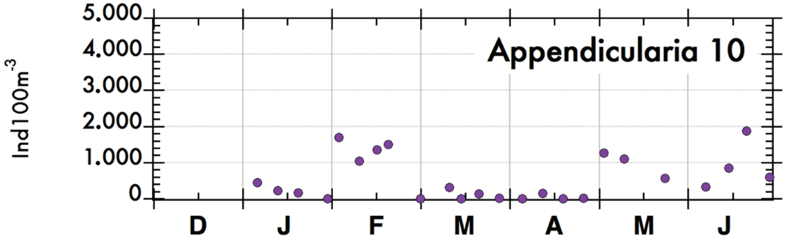
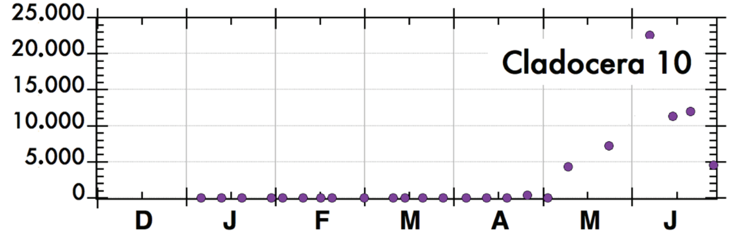
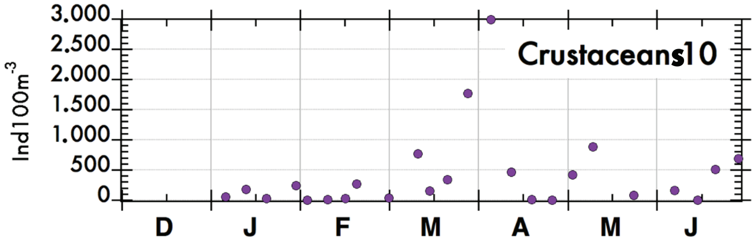


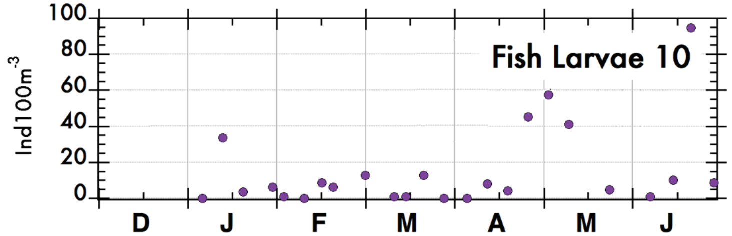


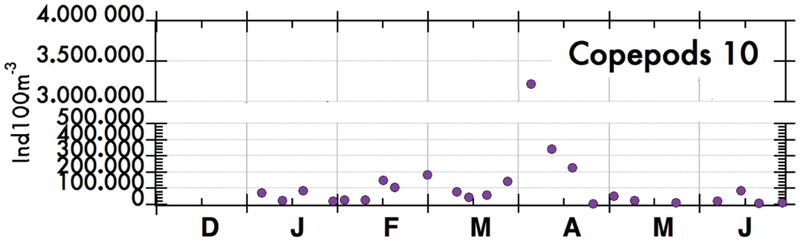


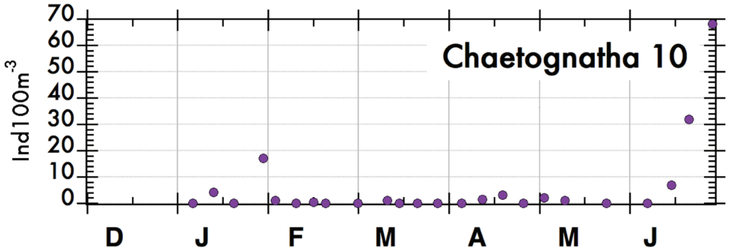








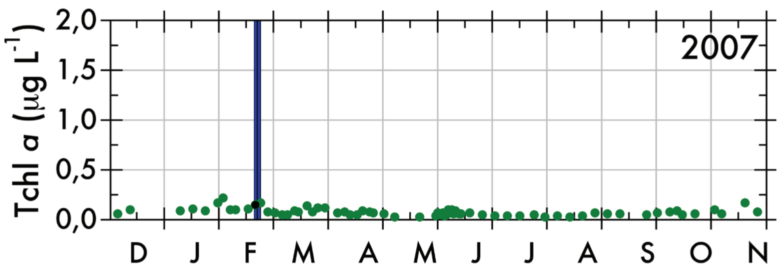


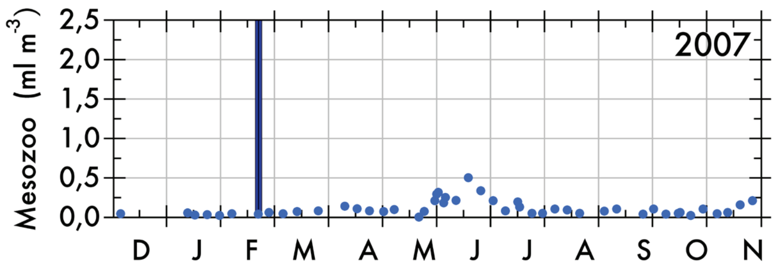


December - June

Control of zooplankton composition and phenology by winter intensity

2007 : a non-blooming year





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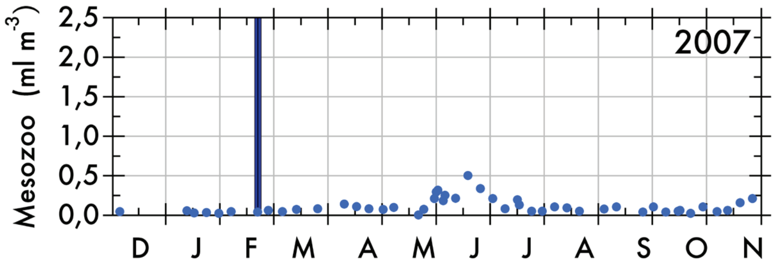

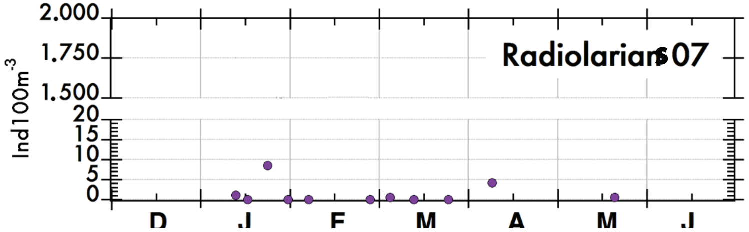

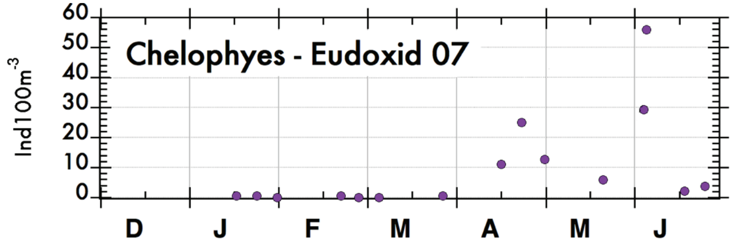

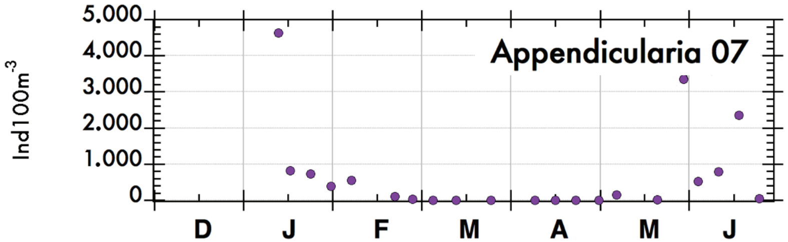

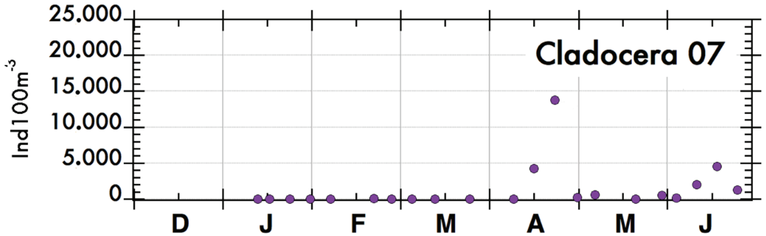

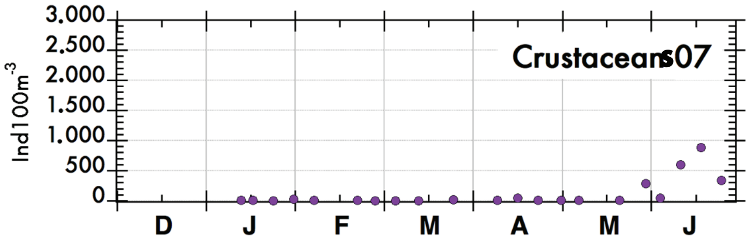

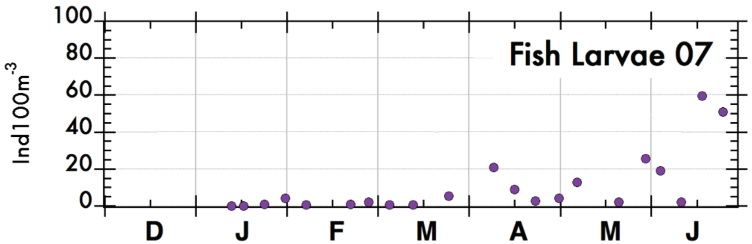

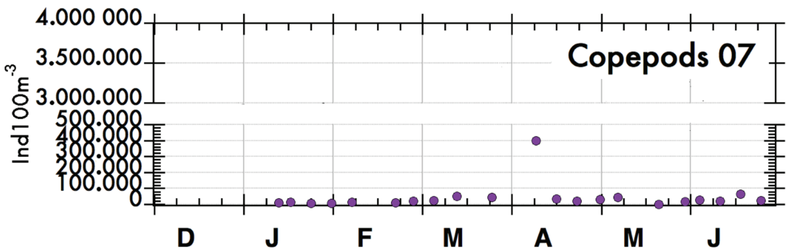

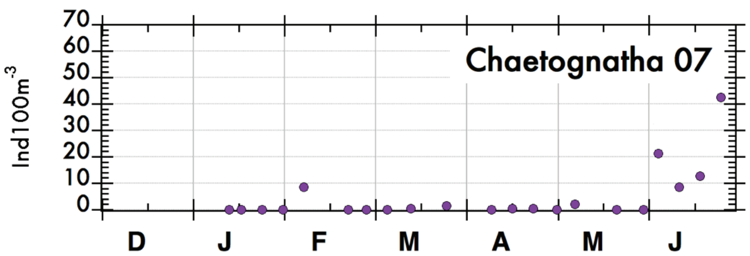

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Control of zooplankton composition and phenology by winter intensity

In contrast to phytoplankton, zooplankton phenology follows a replacement sequence of the main groups.

Conclusions

Based on the results provided by our long-term time series,

- **we described a mechanism that links winter physics, nutrient replenishment of the surface layer and plankton dynamics under the different combinations of meteorological conditions that occur in the Bay of Calvi (PHYTOCLY station),**
- **we showed that plankton phenology is highly controlled by winter intensity and climate variation.**

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Thank you for your attention !