STARESO
Station de Recherches Sous-Marines et Océanographiques

INTERNATIONAL SYMPOSIUM ON IMPACTS,VALUNERABILITY AND ADAPTATION TO CLIMATE CHANGE IN SMALL ISLAND DEVELOPING STATES

"Implications to Poverty Reduction"

December 12-14, Zanzibar Tanzania, Venue: Zanzibar Ocean View Hotel

Université de Liège

Control of plankton dynamics and fish recruitment by climate variation : example of Corsica, a Mediterranean island

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agence de l'eau rhône méditerranée & corse
établissement public du ministère chargé du développement durable

Ifremer

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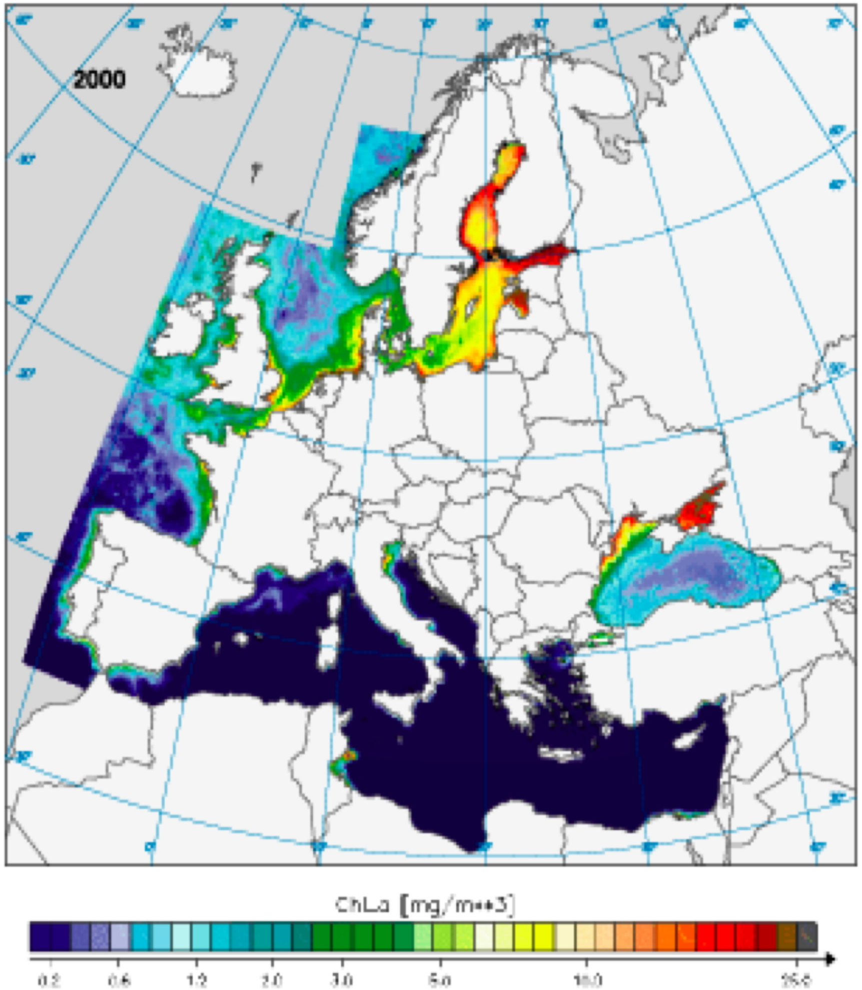
Objectives

- To detect trends in changes in plankton communities of the coastal zone of a Mediterranean Island (Corsica, France) between 1979 and 2010
- To show how climate variations affect the plankton food chain and the human resources of the Island

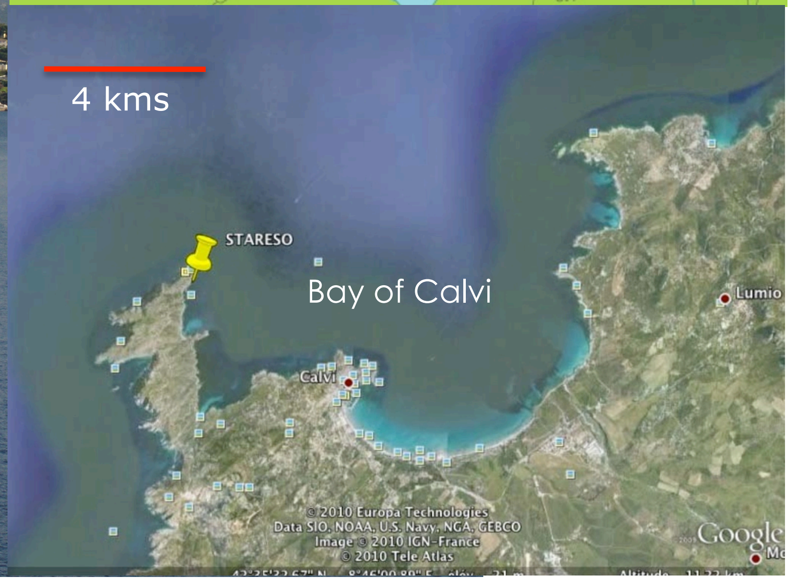
Zoom on the winter - spring bloom

The Mediterranean Sea concerns Africa and Europe : oscillations between temperate and tropical climate



The Corsica Island and the Bay of CalvI: our studied area

- Open bay and narrow shelf
- Oligotrophic characteristics
- Few anthropogenic pressures
- Sensitive to the impact of climate variation
- Important for tourism



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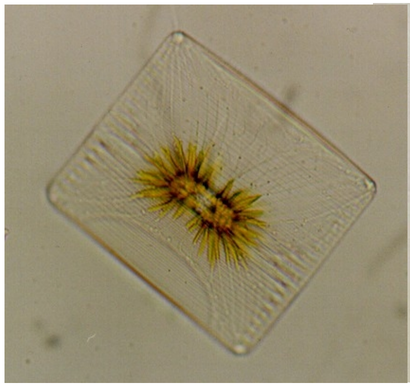
Time-series

Phyto- and zooplankton time-series from 1979

High sampling frequency during phyto- and zooplankton blooms (1-7 times per week)



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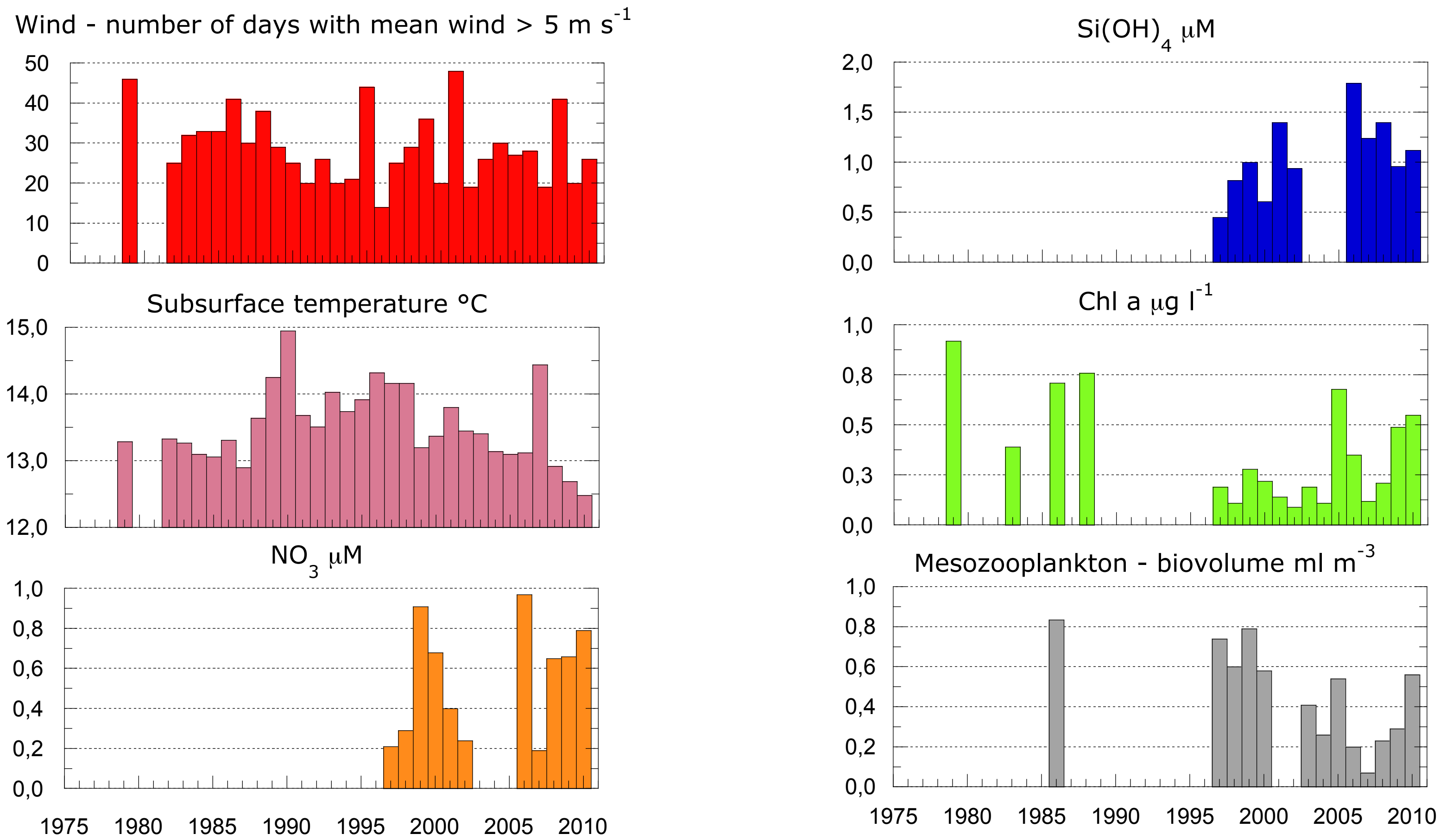
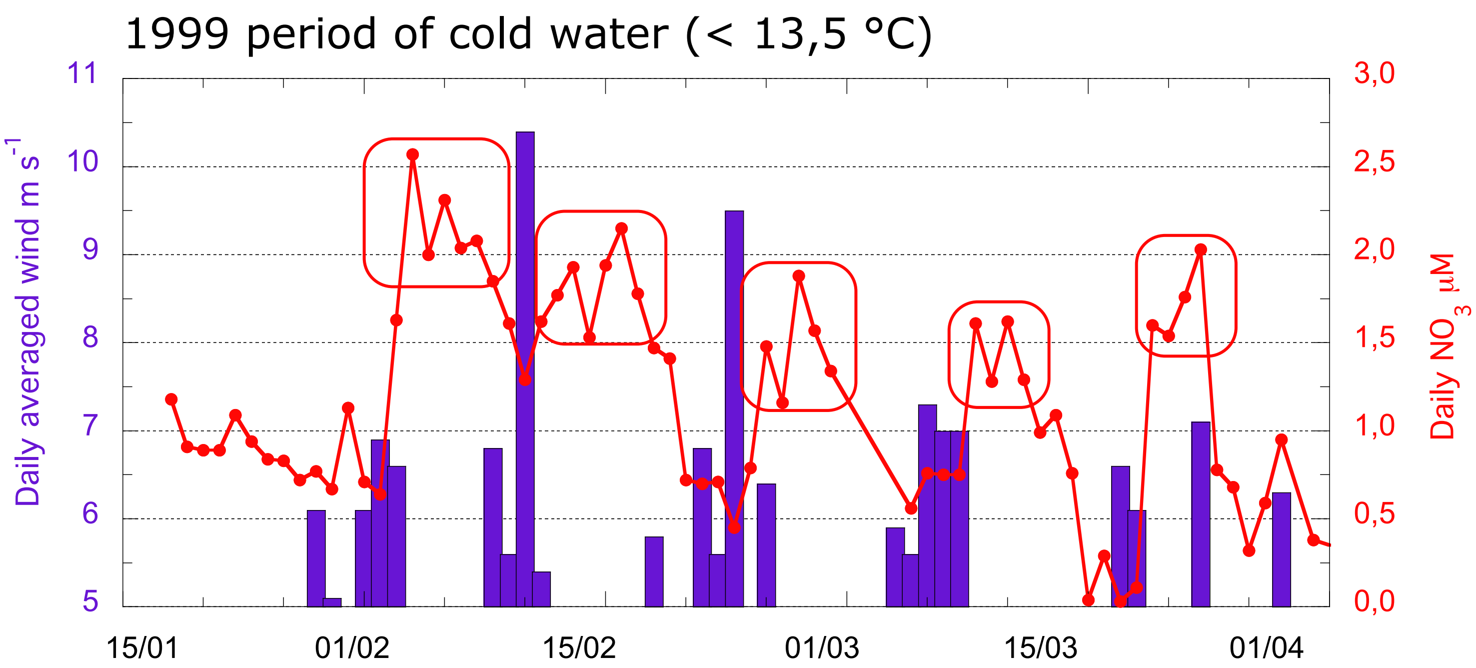
Trends in environmental and plankton parameters

January - April



Control of nutrient availability by wind stress

In unstratified water column (surface temperature < 13,5 °C), surface nutrient enrichment is strongly controlled by wind stress - annual example -



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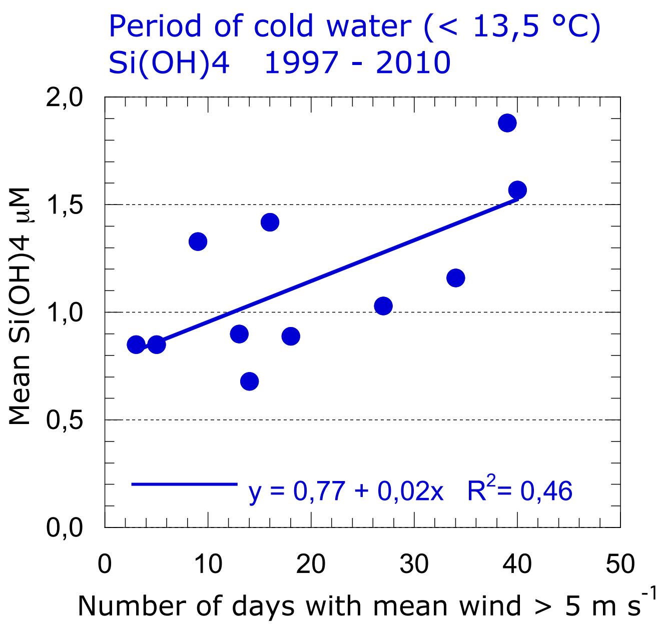
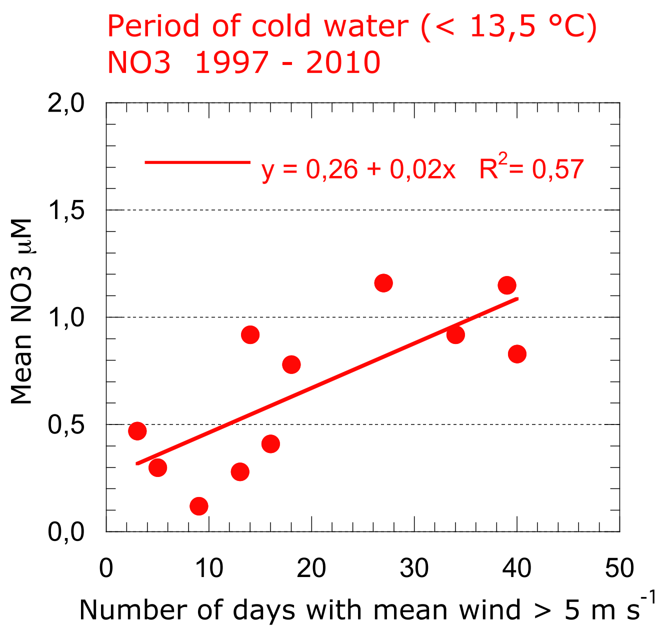
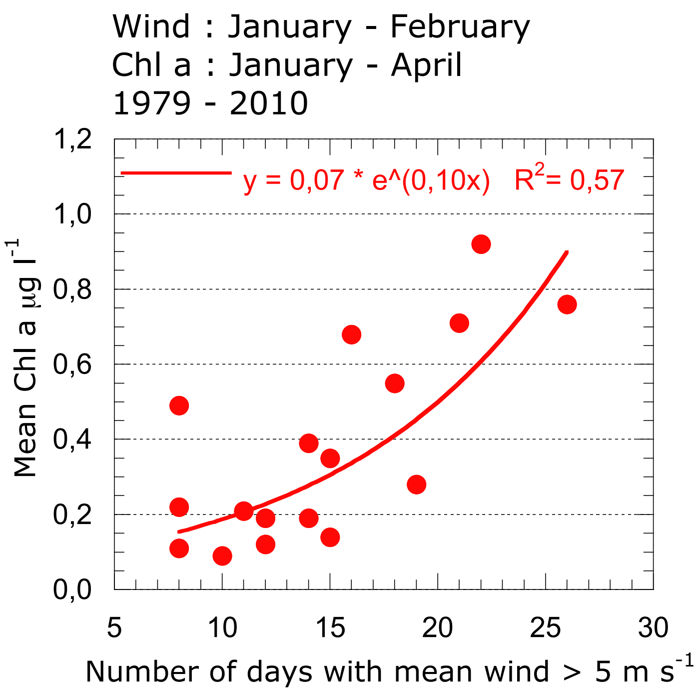




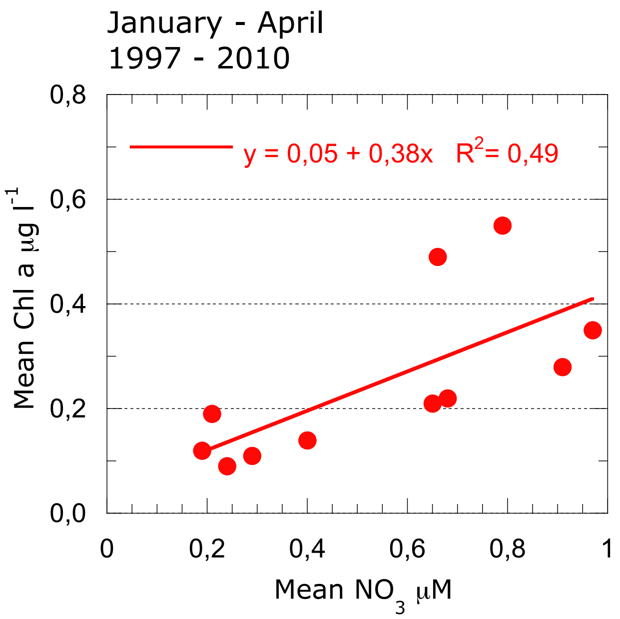
Control of phytoplankton by wind stress

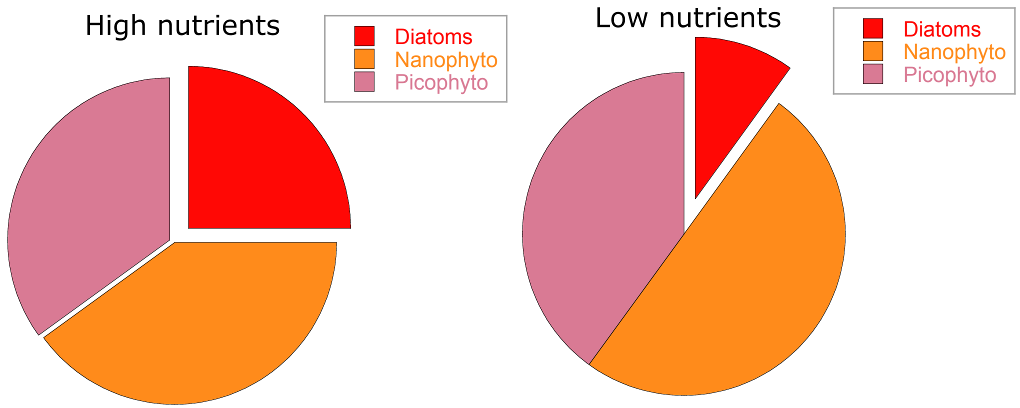
Phytoplankton biomass is controlled by wind forcing



Control of phytoplankton by wind stress

Phytoplankton biomass and composition are controlled by wind forcing and subsequent nutrient enrichment





Bottom-up control of phytoplankton production

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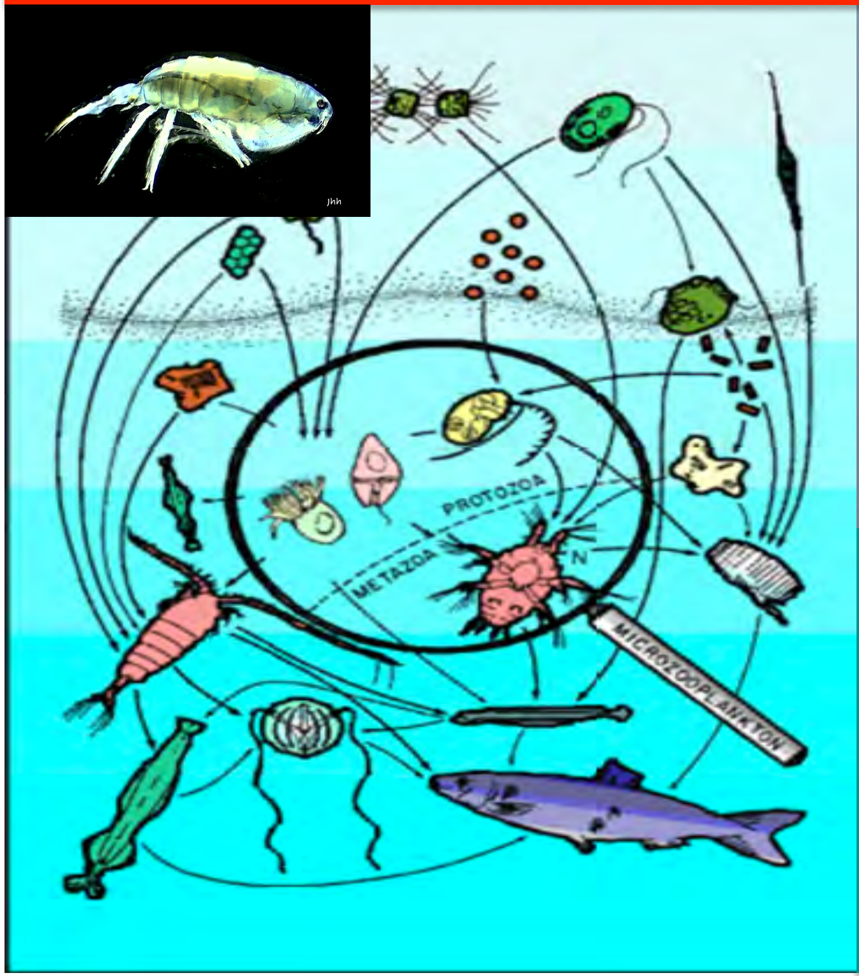
Trends for phytoplankton

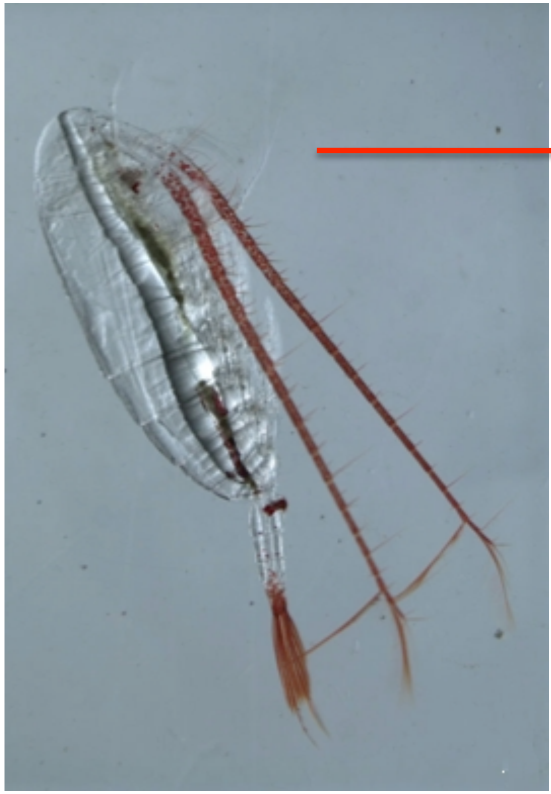
- No continous trends in changes in phytoplankton communities of the Bay of Calvi between 1979 and 2010 but an exceptional response of the system to climate variations (wind intensity) during the winter - spring period

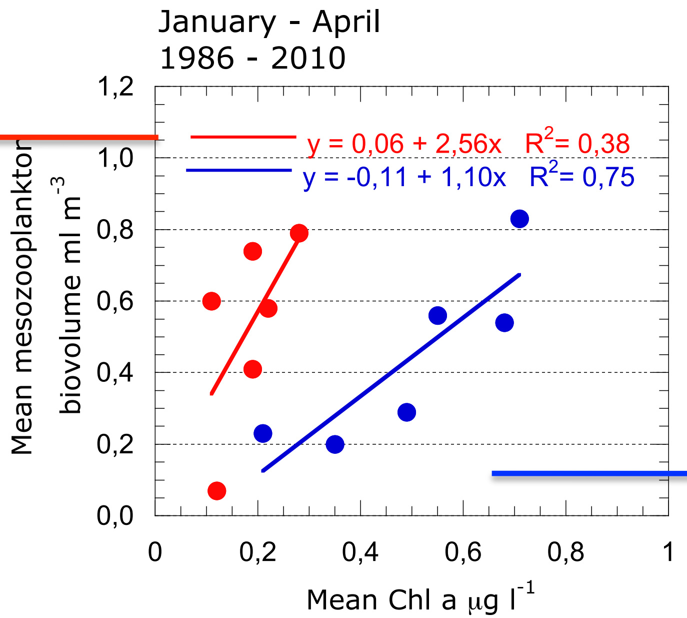
In coastal systems, climate change impacts subsequently zooplankton, fishes and the entire pelagic food web



Climate shifts will change not only the abundance and growth rates of species in coastal environments, but likely result in a shift in the type of species present, with poorly known consequences to the food web

Control of mesozooplankton by phytoplankton availability AND interactions with higher trophic levels (e.g. jellyfishes)





Bottom-up & top-down control

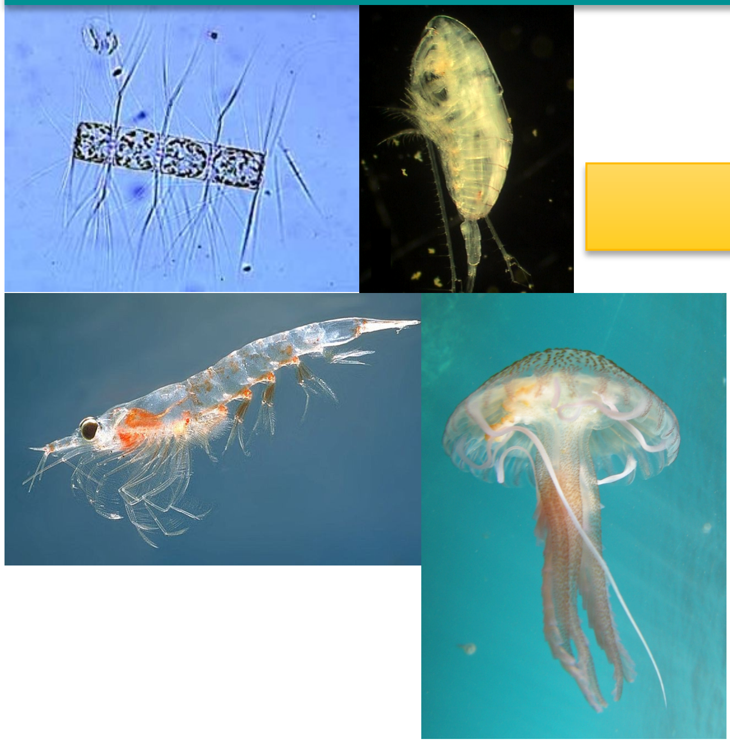
Shifts in plankton diversity

Strong wind regime

High nutrients
Diatoms
Mesozooplankton (Copepods)
Herbivorous food web
High production
Large fish recruitment

Low wind regime

Low nutrients
Small flagellates
Microzooplankton (Protists)
Microbial food web
Low production
Small fish recruitment



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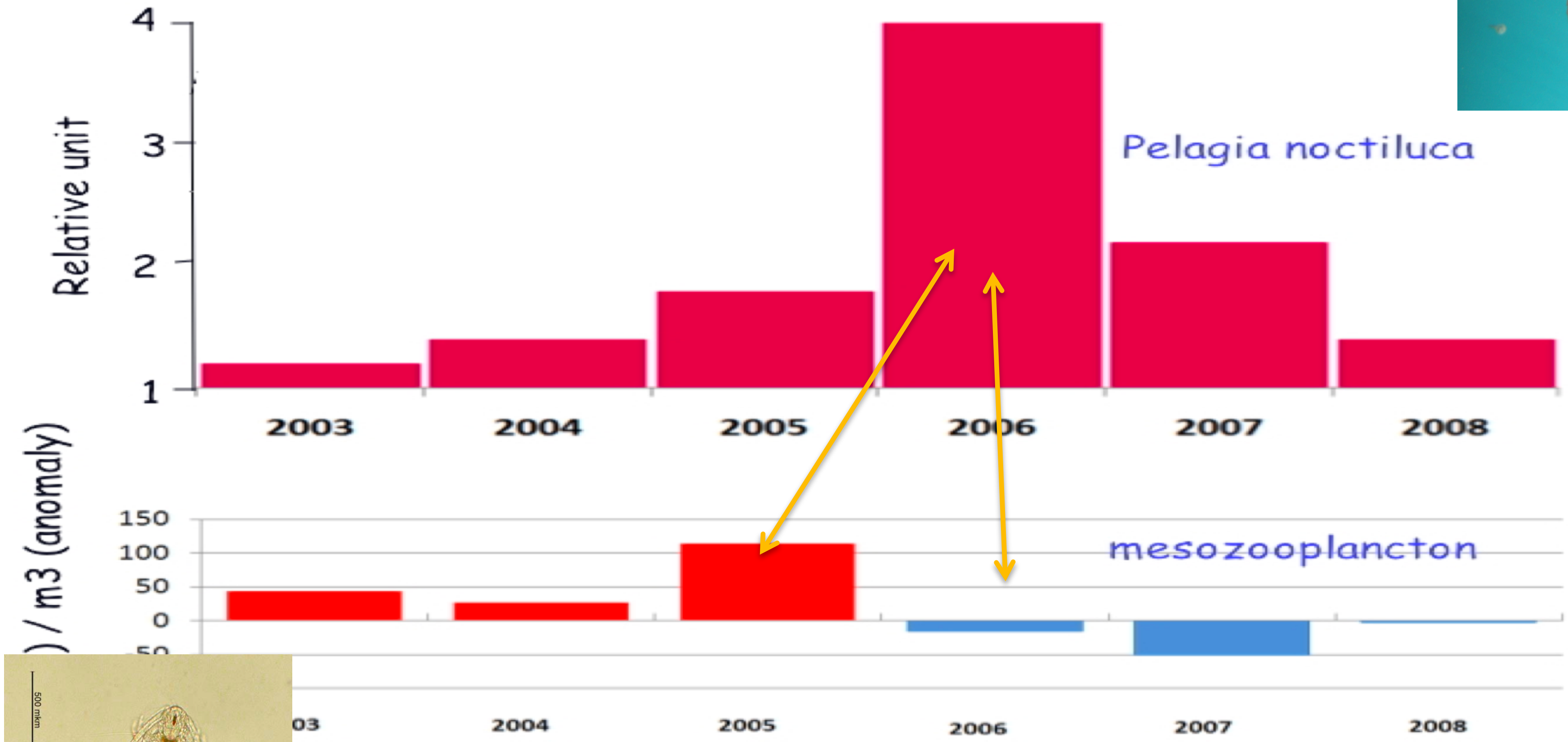
An example of climate induced shift in food web is the large increase in jellyfish populations observed worldwide in coastal ecosystems

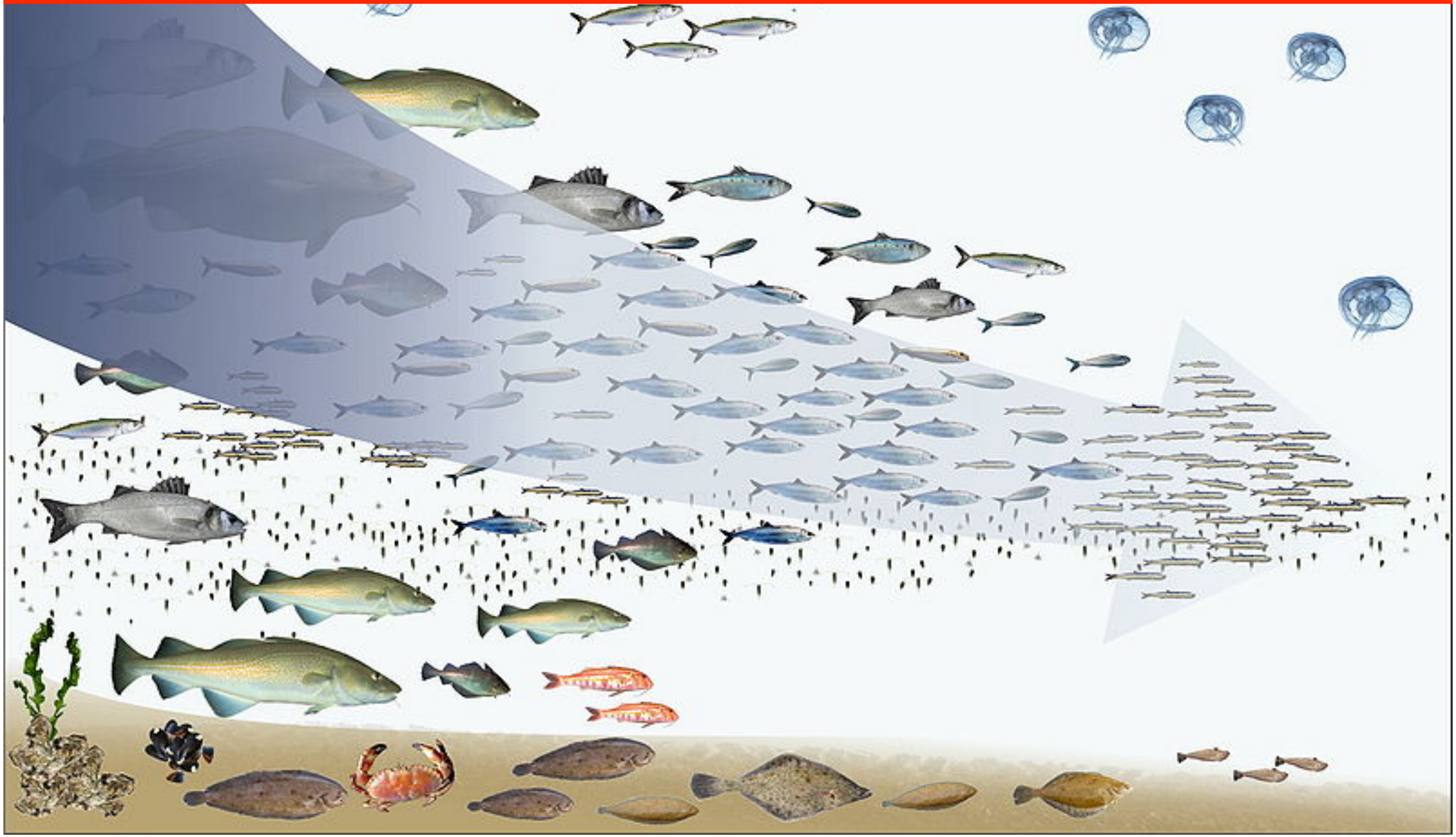
Increase in nutrients stimulates phytoplankton, which in turn stimulate other zooplankton such as copepods (the major food source of jellyfish)

Causality of *Pelagia* outbreaks in Calvi : food ressources ?

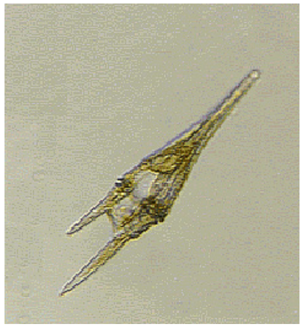


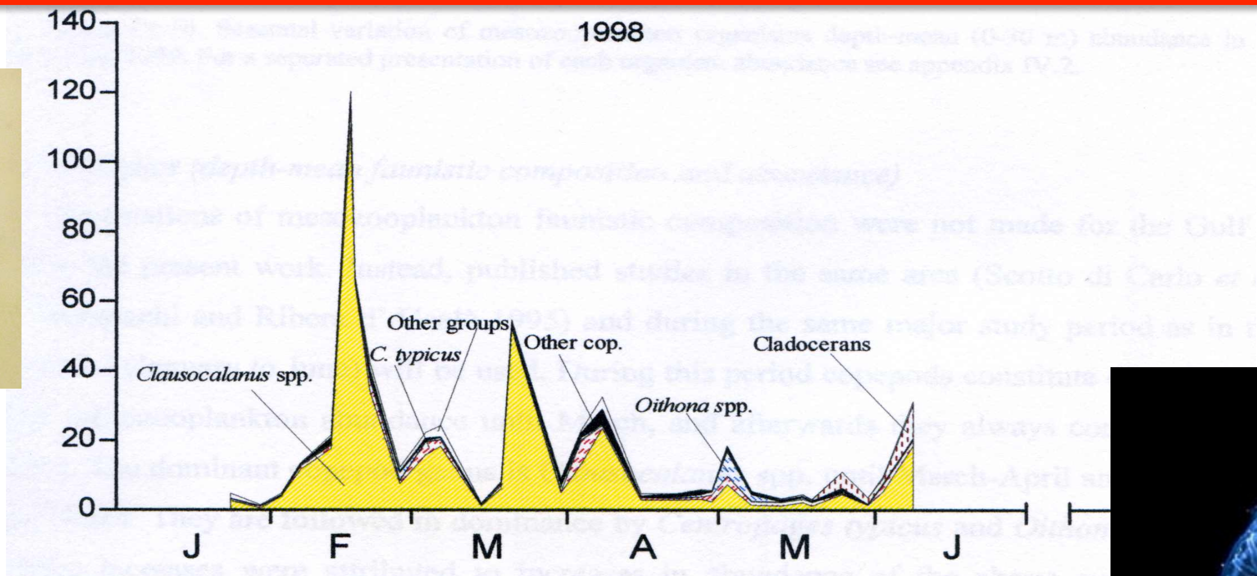
Abondance of *Pelagia noctiluca* (relative units, 1 : absence, 4 : outbreaks) and of mesozooplankton (biomass anomaly, mg FW m^{-3}) from 2003 to 2008 in the Bay of Calvi

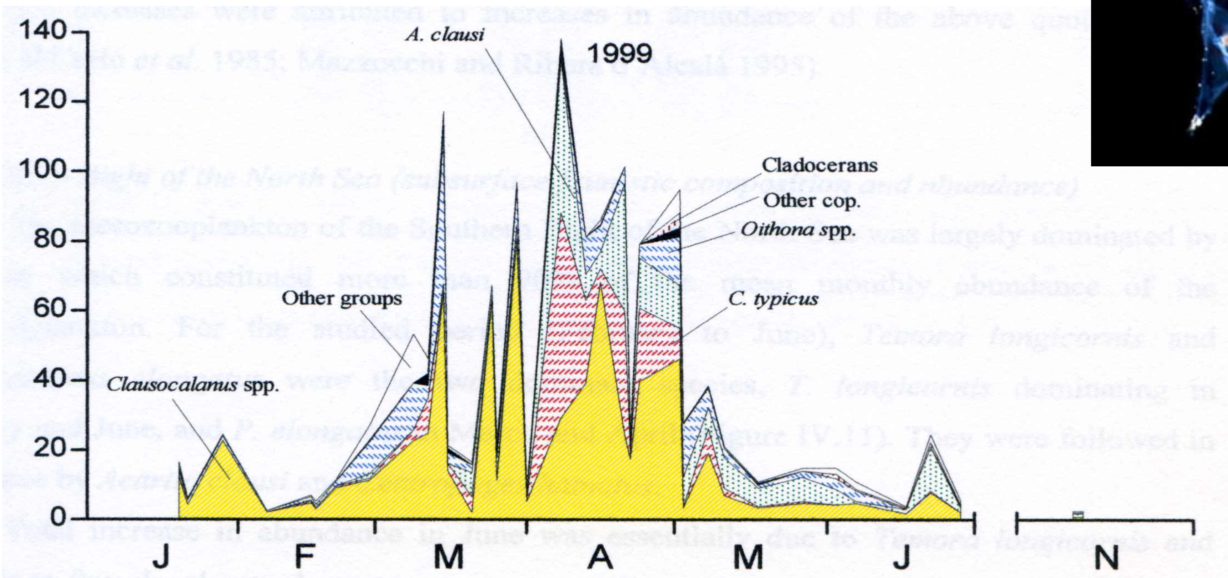
Climate change, overfishing and catches of the largest fish are responsible of the decrease of the size of the components of the marine food web with benefit for jellyfish ''Pauly''

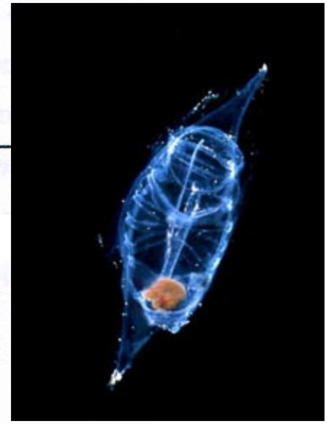


Climate change alters the timing of natural cycles

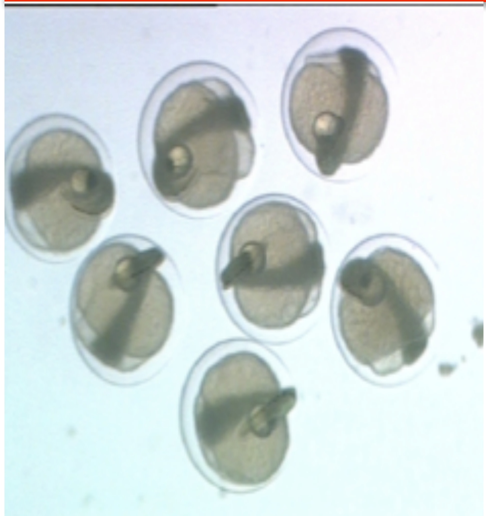


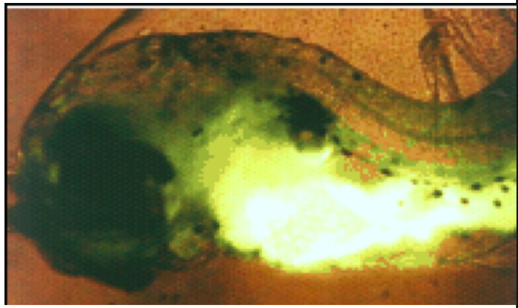


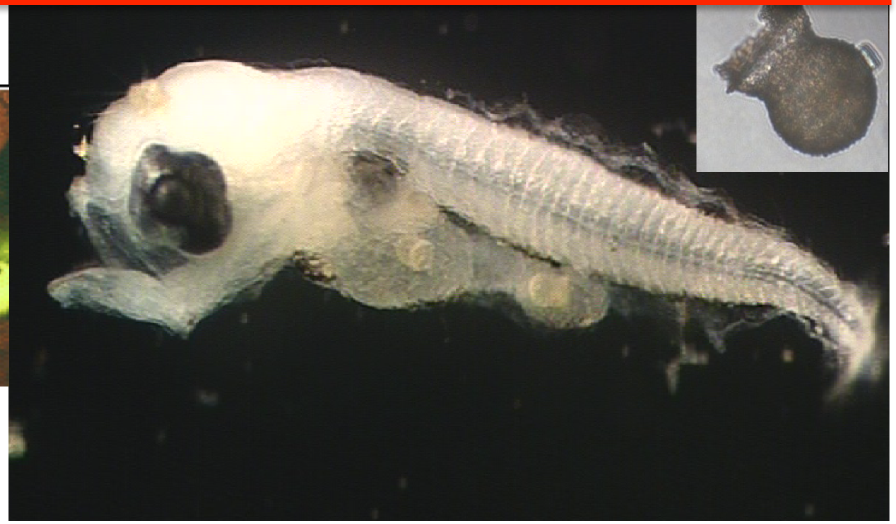


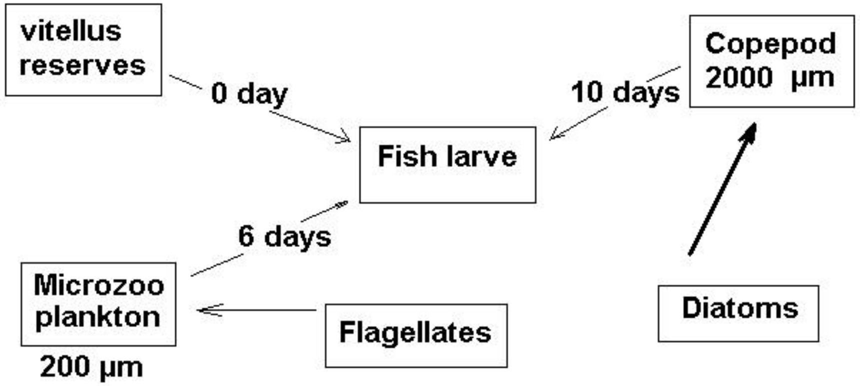


Recruitment of juvenile fish depends on the temperature and overall on the occurence of specific plankton food







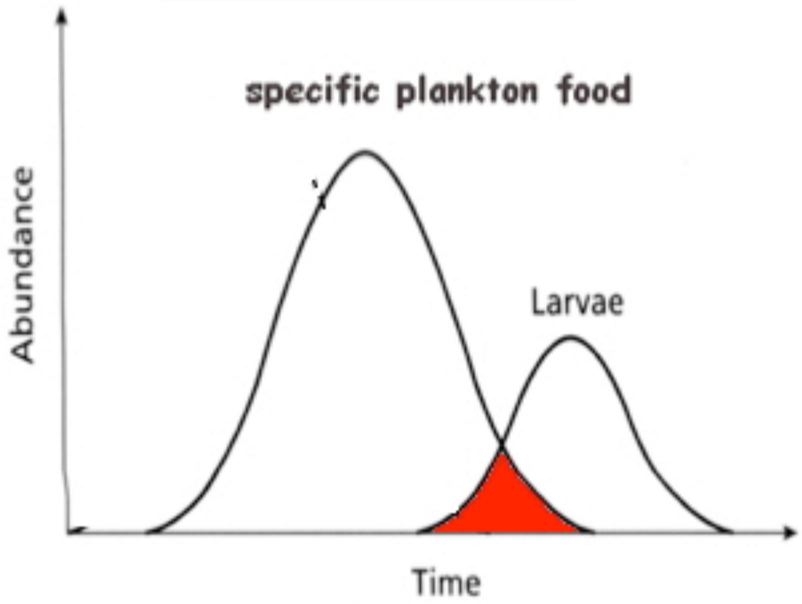


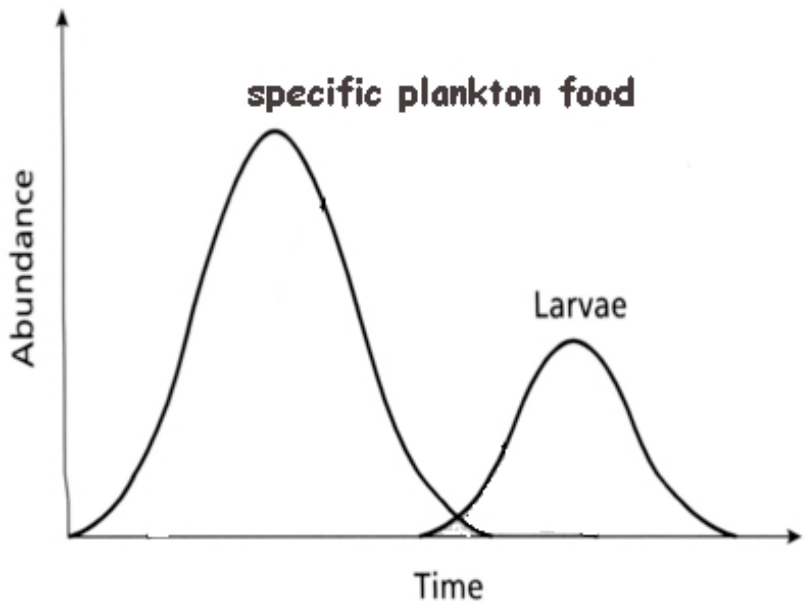
During the first days of the life, the food change quickly

Recruitment of juvenile fish depends on the temperature and overall on the occurence of specific plankton food

Match

Mismatch





Changes of plankton natural cycles result in a mismatch between specific plankton prey and fish larvae with dramatic consequences for larval survival and adult recruitment

Long-term changes in catches of pelagic fishes in the Mediterranean is correlated with the climate oscillations over the Northern hemisphere

Decrease in abundance of cold-water species (e.g. *Sardinia pilchardus*) in the coldest areas

Increase in abundance of warm-water species in Corsican coastal area

Thysanoteuthis rhombus

Thalassoma pavo

Nutrient enrichment can generate harmful algal bloom (HAB) with toxic consequences for fisheries and aquaculture

Many phytoplankton species can grow and reach high cell concentrations when nutrients (nitrogen and phosphorus) are added or when specific environmental conditions are observed.

HABs often have high concentrations of toxic compounds that can accumulate in or kill filter feeding organisms.

Strong wind carries sand from Sahara with an enrichment of surface water

Summary of climate impacts on coastal plankton

In the near future, changes in environmental variables such as wind intensity, nutrients, temperature, salinity and CO_2 concentrations can be expected to :

- change not only the abundance and growth rates of plankton species in coastal environments, but likely result in a shift in the type of species present, with unestimated consequences to the food web;
- produce interactive effects resulting in perturbations that far exceed changes in one variable;
- increase the growth and accumulation of noxious species (such as harmful algae and jellyfish), with severe attendant socioeconomic and human health impacts;
- alter the timing of natural events, with significant impacts on coastal food webs;
- economically important species will be influenced directly by climate-induced changes in plankton.

Likely social and economic consequences

- Temperature and environmental (nutrient, salinity, CO_2) changes will result in an altered plankton community, and that this change will likely degrade the socioeconomic “return” from the coastal area by decreasing yield of harvestable species and altering the human life styles dependent on those.

- It is also probable that HABs and jellyfish will increase in magnitude, duration and distribution, and that there will be a substantial, negative impact on the populations economy and tourism on coastal area.

Needs

- Continuous monitoring of selected physical, chemical and biological parameters in areas non affected by local anthropogenic pressure (reference areas)
- Interdisciplinary approach


Thank you
for attention
Jhh