Project information

Project title

Synergic effects of ocean acidification, increasing temperature and decreasing salinity on Arctic calcifying organisms: Mesoplankton vs. holoplankton

Year

2011/2012

Project leader

Clara Manno, UiT

Participants

- Clara Manno, Postdoc, Department of Arctic and marine Biology, University of Tromsø
- Nathalie Morata, Post doc, LEMAR, Brest University

Flagship

Ocean acidification, Theme: Effect of ocean acidification on species and ecosystems

Summary of Results

1- Ocean acidification is inversely correlated to the “shell fitness” (dissolution and growth) of pteropods Limacina retroversa and foraminifera N. pachyderma 2- Limacina retroversa should be able counteract the dissolution and freshening when stress factor are not combined, whereas the synergic effect of ocean acidification and freshening highlights that the vulnerability of the organisms could be higher when an environmental stress is added.
3-Shells of dead Limacina retroversa dissolve faster that shell of living one highlights that the key role of the physiological activity to counteract changes in sea water chemistry.
4- The combined effects of increased temperature and decreased pH seem to act as a moderator on N. pachyderma (s) calcification rates compared to the rates' decrease in reduced pH alone highlights that global warming could “moderate” ocean acidification effects on those organisms.
Anthropogenic carbon dioxide emissions induce ocean acidification, thereby reducing carbonate ion concentration that may affect the ability of calcifying organisms to build shells. Pteropods and foraminifera, which are the main planktonic producers of aragonite and calcite respectively in the worlds’ oceans, may be particularly vulnerable to changes in sea water chemistry. The negative effects are considered to be especially increased in high-latitudes, where naturally carbonate ion concentrations are low.
The big part of the project was dedicated to investigate the combined effects of increasing in ocean acidification and freshening on Limacina retroversa (the dominant pteropod in the sub polar area). Living Limacina retroversa were collected in Northern Norwegian Sea. The perturbation experiments were performed manipulating sea water at four different pH. Values of pH ranged from the pre-industrial level to the forecasted ocean acidification scenario (end of century). Since over the past half-century Norwegian Sea experienced a progressive amplification of the freshening with time, each pH level was combined with different concentration of diluted sea water. In addition to investigate the shell degradation without any physiologic influence one perturbation experiments using only shells of dead pteropods was performed.
Results showed that there is an inverse relationship between increase in ocean acidification and decrease in shell growth whereas shell dissolution increase as well as pCO2 increase. Interestingly, shell of dead organisms presented higher degree of dissolution than shells of living individuals. Mortality of Limacina retroversa was strongly affected only when both, pH and salinity, dropped simultaneously. The combined effects of lower salinity and lower pH also affect negatively the ability of pteropods to swim upward. Results suggest that, the extra energy cost due to maintaining of body fluids and to avoid sinking (in low salinity scenario) combined with the extra energy cost necessary to counteract the dissolution (in high pCO2 scenario), exceeds the available energy budget of this organism and then pteropods change in swimming behavior and begin to collapse. Since Limacina retroversa play an important role in the transport of carbonates to the deep oceans these findings have significant implications for the mechanisms influencing the inorganic carbon cycle in the sub-polar area.
A small part of the project was dedicated to the response of Arctic foraminifera to the synergic effect of Ocean acidification and Global warming. N. pachyderma (s) is a non spinose species prefer feeding on phytoplankton whereas T. quinqueloba is carnivore spinose specie. While for T. quinqueloba generation time is related to the lunar cycle and N. pachyderma (s) have longer reproductive cycles. The ecological differences between those two dominant polar foraminifera could reflect different reaction/adaptation to the forecasting climate change. Under low pH, N. Pachyderma (s) shell net calcification rates decreased. However, this decrease of net calcification was moderated when both, pH decreased and temperature increased simultaneously. Since foraminifera shells play an important role in the transport of organic carbon to the deep ocean, the decrease of calcite production will lead to a reduction of the carbonate ballast effect and then a reduction of biologic pump efficiency.
The last part of the project was dedicated to improve the link between science and education by the dissemination of results to the high schools (i.e. meeting with teachers, presentation of the project as small seminary during the lessons, laboratory activity into the classrooms
reproducing the perturbation experiments).

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pteropods Limacina retroversa and foraminifera N. pachyderma 2- Limacina retroversa should be able counteract the dissolution and freshening when stress factor are not combined, whereas the synergic effect of ocean acidification and freshening highlights that the vulnerability of the organisms could be higher when an environmental stress is added.
3-Shells of dead Limacina retroversa dissolve faster that shell of living one highlights that the key role of the physiological activity to counteract changes in sea water chemistry.
4- The combined effects of increased temperature and decreased pH seem to act as a moderator on N. pachyderma (s) calcification rates compared to the rates' decrease in reduced pH alone highlights that global warming could “moderate” ocean acidification effects on those organisms.
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Published Results/Planned Publications

Manno C, Morata N, Primicerio R Limacina retroversa's response to combined effects of ocean acidification and seawater freshening ECSS, under review

Manno C., Pavlov A. Planktonic foraminifera distribution along the Fraim Strait: NP(s) vs. TQ abundance shift? (submission in December) JPR

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Communicated Results

-Manno C. Synergic Effect of OA and GW on Arctic Calcifying Zooplankton: Carbon Pump Implication, (Poster), ASLO meeting, Puerto Rico (Poster) 2011

-Morata N, Manno C. Impact of ocean acidification on the metabolism of calcifying planktonic organisms. ASLO meeting, Puerto Rico (Poster) 2011

-Manno C., Pecchiar I. Italian School following in the footsteps of the Arctic, ASLO meeting, Puerto Rico (poster) 2011

Interdisciplinary Cooperation

The project presents a strong interdisciplinary component. Consequently the cooperation is an essential aspect to reach the goal of this study. Positive aspect: Was useful to improve the project by the discussion with people with different competences and background. Negative aspect : Was hard to find a common language inside so many disciplines

Disciplines:

- Biogeochemistry
- Marine biodiversity
- Biology
- Chemistry
- Geology
- Oceanography
- Clima
- Ice

Budget in accordance to results

The funding from the Fram Centre were crucial to support the critical stage of the experiments design through:

-the acquisition of new instrumentation for the performance of CO2 perturbation experiments

-the participation to the international meeting to increase the knowledge need for the project development

-the participation of students (master thesis and stage)

-the dissemination of results into the schools by a strong collaboration with high school teachers

Since this was a pilot study project, the Fram Centre funding was sufficient for completing the project. Anyway, the time to use the funding was short from the logistic point of view

Could results from the project be subject for any commercial utilization

No

Conclusions

a) Future research and perspective will include :

-the investigation of the effect of ocean acidification including more synergic stressor as depletion in Oxygen and pollution (trace metal assimilation)

-the integration of the results from this project with investigation of zooplankton calcifying organisms collected from sediment traps and sediment core to investigate the dissolution processes at different time scale

-the use of additional pH target values reflecting the natural variability of pH during the year to identify the potential adaptability of calcifying zooplankton to natural ocean acidification

b) During the project were improved/adapted/modified the techniques concerning the investigation of change in behavior of the calcifying organisms (related to the increase in OA and other synergic factor) by visual analysis (digital camera plus infrared diode to define the change in trajectory)

Dissolution investigation used from other authors for Atlantic zooplankton species were adapted to Arctic calcifying organisms