Project information

Keywords
Biosensor, remote sensing

Project title
The Arctic scallop Chlamys islandica as a biosensor for detection of effects of climate upon ecosystem functioning and anthropogenic impact in Svalbard –CONTINUATION 2017-

Year
2017

Project leader
Lionel Camus

Geographical localization of the research project in decimal degrees (max 5 per project, ex. 70,662°N and 23,707°E)
Ny-Ålesund. Lat: 78.930197 Long: 11.919607

Participants

Damien Tran, Mickael Perrigault, Pierre Ciret, Jean-Charles Massabuau /University of Bordeaux-CNRS-; Jørgen Berge, Peter Leopold/University of Tromsø; Lionel Camus, Hector Andrade, Carl Ballantine/APN

Flagship
Fjord and Coast

Funding Source

Flagship Fjord and Coast, Agence National pour la Recherche

Summary of Results

Our objectives for this project were:

- To record the effects of different environmental drivers on the gaping behaviour and growth of *Chlamys islandica* and *Mytilus edulis* in Ny Ålesund, Svalbard over a 2-year period.

- To study the phenological traits and circannual/circadian molecular clock system of the scallop *C. islandica* in Ny Ålesund, Svalbard

Several activities have been carried out to achieve these goals:

First, this project reached a very high scientific profile since it has been cited in the News section of the Science journal in November 2016. https://www.sciencenews.org/blog/wild-things/life-polar-ocean-surprisingly-active-dark-winter

1. Scallops needed for the experiment and biosensor deployment were collected around Svalbard during two cruises (APN-UiT-UNIS) and deposited in cages in Ny-Ålesund. Collection of blue mussels was performed by UiT. About 700 scallops were collected in total.

2. Fieldtrips were carried out to Ny-Ålensund on the 25th of April to May 2nd, 2016; the 23rd-30th of January 2017, and 18th -28th of September 2017. During the first fieldtrip, we built and installed 2 biosensors comprised of 16 *C. islandica* and 16 *Mytilus edulis.* During the polar night (23.01-30.01.17), samples were taken from gills, mantel and muscle in scallops deployed near the valvometer unit, to investigate transcriptional variations of genes controlling the internal biological clock and the light perception. A new fieldwork period was carried out in September (18-28), again to sample scallops for genetics purposes but during the autumn equinox. In total, 130 scallops were sampled during the winter and equinox campaigns.

3. Biosensor deployment: We carried out fieldwork in Ny-Ålesund from the April 25th to the 2nd May 2016, to deploy 2 HFNI valvometers, one with Icelandic scallops and one with blue mussels. This second unit was made possible thanks to the in-kind contribution of CNRS and a collaboration with the University of Tromsø. By making this deployment, we have now expanded our scallop gaping recordings for two more years. At the present date (November 2017), we keep recording behavior and growth in both scallops and mussels, to study among others, the effect of climate change upon the species behavior and growth.

4. Molecular approach: 7 out of 8 genes involved in the molecular clockwork of *C. islandica* have been characterized (Period, Cryptochrome1-insect, Cryptochrome2-vertebrate, cycle/Bmal, ROR, Rev-erb, Timeless. Sequence fragments of the molecular clockwork already allowed the design of specific primers for their application in qPCR in order to assess transcriptional variations of these genes in different tissues (gills, mantle, muscle) as well as phylogenetic analyses. Full-length sequences of candidates should be completed soon by Rapid amplification, cDNA ends (RACE), and qPCR analyses (delay due to replacement of malfunctioning equipment, operating instrument was ordered by the molecular platform of the research team EPOC, UMR 5805, Arcachon, France on December 2017).

5. Publications: Two peer-reviewed articles have been published:

- Andrade H, Massabuau J-C, Cochrane S, Ciret P, Tran D, Sow M, Camus L (2016) High Frequency Non- invasive (HFNI) Bio-Sensors As a Potential Tool for Marine Monitoring and Assessments. Frontiers in Marine Science 3
- Tran, D., Sow, M., Camus, L., Ciret, P., Berge, J., and Massabuau, J.-C. (2016). In the darkness of the polar night, scallops keep on a steady rhythm. Sci. Rep. 6:32435. doi: 10.1038/srep32435

6. New proposal: We have submitted a new proposal to the Fram Centre flagship "Effects of climate change on sea and coastal ecology in the north" to carry out an experiment to text whether the *C. islandica* biosensor might effectively detect harmful algae under experimental conditions.

Master and PhD-students involved in the project

The project receives the contribution of a 100% Post Doc position financed by the French Research Council. A student from the University of Bordeaux will be enrolled in the project to analyze the valve behavior of *Mytilus edulis* and *Chlamys islandica* as part of its Master Degree thesis (January to June

2018).

For the Management

Although the prevailing paradigm has held that the polar night is a period of biological quiescence, results with the scallops have shown that the species is active during the polar night, and that they continue to grow. These results thus challenge such paradigm. The daily growth data obtained since the first deployment (2012) is still been expanded until today (2017). These data can be correlated to water temperature to study the effects of temperature and growth. Results can be employed to make comparisons with scallops collected prior to the warming period using sclerochronology techniques. In addition, the growth rates derived here can provide an indirect measurement of biological productivity during the study period. This is a unique biosensor that monitors in real time, remotely and online the health of an Arctic marine organism, and as such can be used as a sentinel animal for detecting any anomalies in the water column.

Also, from 2018 a PhD student with a degree in mathematics will study the data that we have collected since 2012 (growth and behavior) to develop statistical tools and algorithm to detect trends and/or pattern of interest with a particular focus on environmental drivers and climate change.

Published Results/Planned Publications

Andrade H, Massabuau J-C, Cochrane S, Ciret P, Tran D, Sow M, Camus L (2016) High Frequency Non-invasive (HFNI) Bio-Sensors As a Potential Tool for Marine Monitoring and Assessments. Frontiers in Marine Science 3

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Results from this project were highlighted in the prestigious Science magazine in the News section: https://www.sciencenews.org/blog/wild-things/life-polar-ocean-surprisingly-active-dark-winter

Planed publications:

Long-term analysis of *Chlamys islandica* rhythms in polar environment in a context of global change.

Phylogenetic and molecular characterization of *Chlamys islandica* clockwork: analysis of molecular origin of their rhythms in polar environments

Behavioral response of valve activity of the invasive blue mussel *Mytilus edulis* in polar night conditions.

Communicated Results

The Facebook page "Talking clams" (https://www.facebook.com/TalkingClams/) has been actively updated with information regarding the polar night and equinox fieldwork missions.

Presentation at the 2017 AWIPEV – 20-21/02. *Study of the circadian clock of the Arctic scallop Chlamys islandica during the polar night.* Science Introduction Seminar. Brest, France.

Interdisciplinary Cooperation

The biosensor development and deployment is an interdisciplinary collaborative project between marine biology, electronics and applied mathematics, molecular biology (gene/clock) and ecological behaviour (opening and closing).

Budget in accordance to results

Yes

Could results from the project be subject for any commercial utilization

No

Conclusions

This project has been successful in integrating multidisciplinary fields of expertise (ecologist, chronobiologist, electricians, mathematicians, statisticians). All the different expertise helped to demonstrate the usefulness of the biosensor for both basic and applied research. We believe that the biosensor can have direct applications to monitor the oil and gas industrial installations (offshore and onshore) and other industrial activities (aquaculture, mining etc.) and will continue to look for funding opportunities. Moreover, molecular approaches are still in progress but already led to the identification of the central components of the molecular clockwork of *C. islandica*, providing bases to investigations and quantifications of phenological alterations associated to climate change in *C. islandica*. Analyses of identified clock sequences also provided information regarding light synchronization in scallop, especially during polar night. For instance, phylogenetic analyses of molecular clock components revealed that sequences clustered well with previously characterized genes in the oyster *Crassostrea gigas* (Perrigault and Tran, 2017). These results suggest some specialization of these molecules to the specific conditions (light intensity and wavelength) of polar environments. Results reached a high scientific profile since it has been highlighted in the prestigious Science News: https://www.sciencenews.org/blog/wild-things/life-polar-ocean-surprisingly-active-dark-winter

Finally, the project is not stopping in 2017, a PhD student with degree in mathematics will start in 2018 to study the data that we have collected since 2012 (growth and behavior) to develop statistical tools and algorithm to detect trends and/or pattern of interest with a particular focus on environmental drivers and climate change.