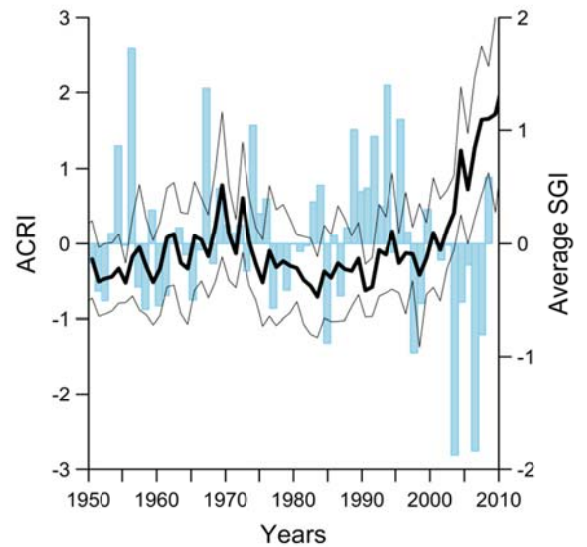
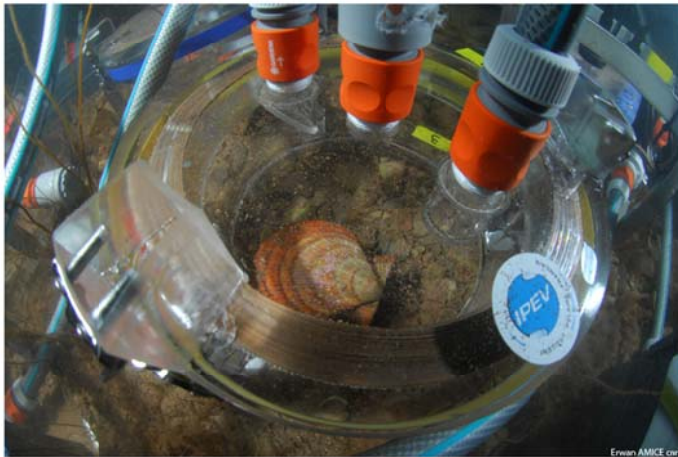
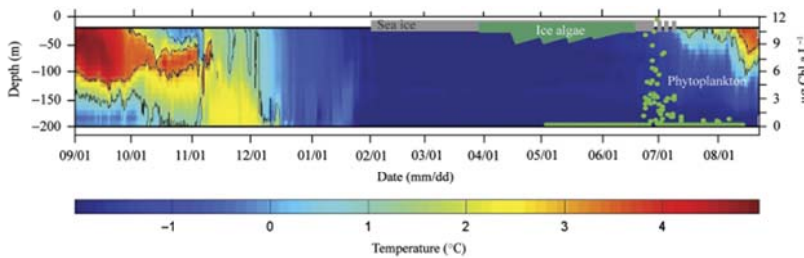


PAN-ARCTIC BIVALVES AS POLAR BIOARCHIVES

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PROJECT IDENTIFICATION

Project acronym: B.B.Polar

Project title: Bivalves pan-arctique comme bio-archives polaires

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Date of commencement of project: March 1, 2013

End date of the project: March 1, 2016

Project website:

French version: <http://www-ium.univ-brest.fr/observatoire/observation-outre-mer/spitzberg/observation-outre-mer/spitzberg/b-b-polar>

English version: <http://www-ium.univ-brest.fr/observatoire/observation-outre-mer/spitzberg/observation-outre-mer/spitzberg/b-b-polar-en>

Date of preparation of the present report: 14 April 2014

Period covered by the present report: the first year of the project from March 1, 2013 to March 1, 2014.

PROJECT PROGRESS

Description of project progress – Scientific Part

In B.B. Polar project, we propose to use marine bivalves as biological archives of environmental changes in Arctic Ocean. These biological tools will be implemented to monitor the parameters of the Arctic environment at different time scales (daily to decadal) and space (from the single fjord to pan-Arctic view) by using two bivalve species, *Chlamys islandica* and *Astarte spp.*

B.B. polar proposes to apply the methods of describing the recent past environment in order to obtain:

1. A calibration and validation of the environmental descriptors of the sites already instrumented (Kongsfjorden and Rijpfjorden in Svalbard)
2. A description of the environmental variations during the last decades coupling data on *Chlamys islandica* and the long-lived species *Astarte spp.*
3. A description of the environmental variations at the Pan-Arctic scale by enhancing the geographical area to non-instrumented sites in the Greenland and Canadian Arctic.

To address these objectives, the first year of the project was dedicated to instrumentation and sampling during four scientific missions:

- April 30 to May 17: 1st mission in Kongsfjorden (Svalbard)
- 9 to 23 May: 1st Mission in Nuuk (Greenland)
- 24 August to 5 September: 2nd mission in Nuuk (Greenland)
- 23 September to 7 October: 2nd mission in Kongsfjorden (Svalbard)

Sampling and instrumentation of sites in Svalbard (Figure 1) were carried out in collaboration with the ANR project - ECOTAB (N. Morata) also working on *Chlamys islandica*.

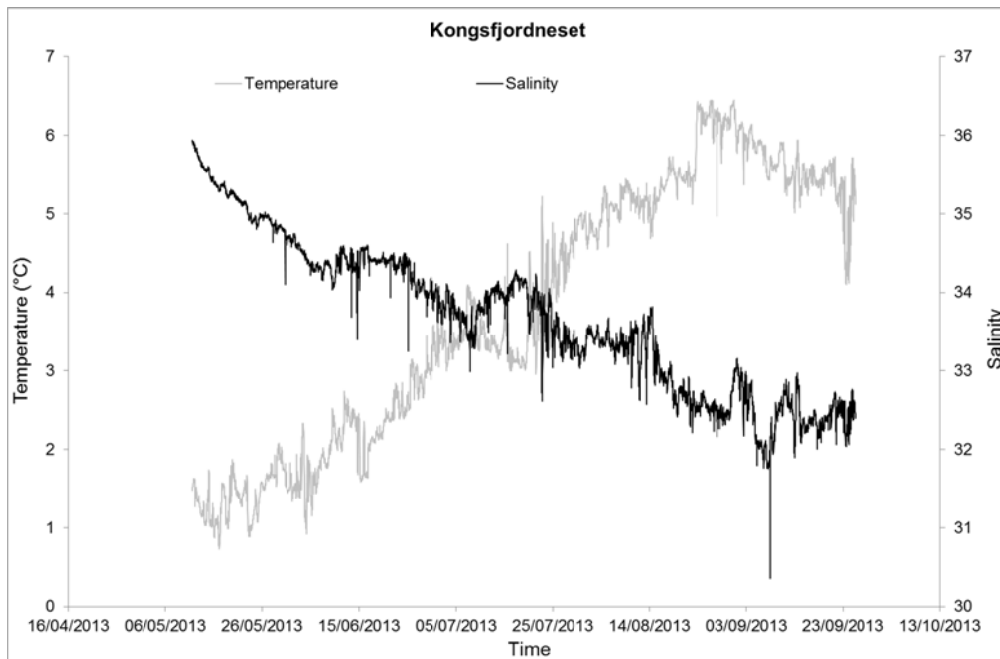


Figure 1: Monitoring of environmental parameters (temperature and salinity) between May and September 2013 in Svalbard

Analysis of *Chlamys islandica* and *Astarte spp* samples was made simultaneously by teams LEMAR Brest and MNHN in Paris and Rimouski (Quebec), respectively.

Works realized by LEMAR team

Works carried out in 2013 on *Chlamys islandica* aim to: 1) define the growth pattern of this species; 2) study the behavior of this species under environmental variations through the use of accelerometers and measures of respiration in benthic chambers.

To study the growth of *Chlamys islandica* shells, a tagging experiment with calcein was performed on 20 individuals during the mission to Svalbard in May 2013 (Figure 2). Individuals were then returned to their natural environment and were captured during the mission in September 2013 (four months later). Calcein is fluorescent marker that is incorporated into the shell structure and which is visible under UV lamp (Figure 3) allowing measuring the shell growth between the tagging date and the capture date (the edge of the shell).



Figure 2: Tagging of Chlamys islandica shells by using calcein during the mission in Svalbard in May 2013

Simultaneously, a sample of individuals covering a wide range of size was made during BB Polar missions and during ECOTAB project missions. The study of tagged and non-tagged shells was performed by Master I student, Thomas Andro, supervised by Richard Joëlle and Aurélie Jolivet, between January and February 2014. 37 shells from Kongsfjord (16 tagged and 11 non-tagged) and 11 shells from Ripfjord have been cleaned, photographed and thin prepared sections to study the deposition rate of visible growth marks on the outer surface (Figure 3) and on the cutting shell. Growth patterns of Kongsfjord and Ripfjord populations and will be described and compared to environmental parameters for each site. These data are in progress and report will be delivered on 15 May 2014.

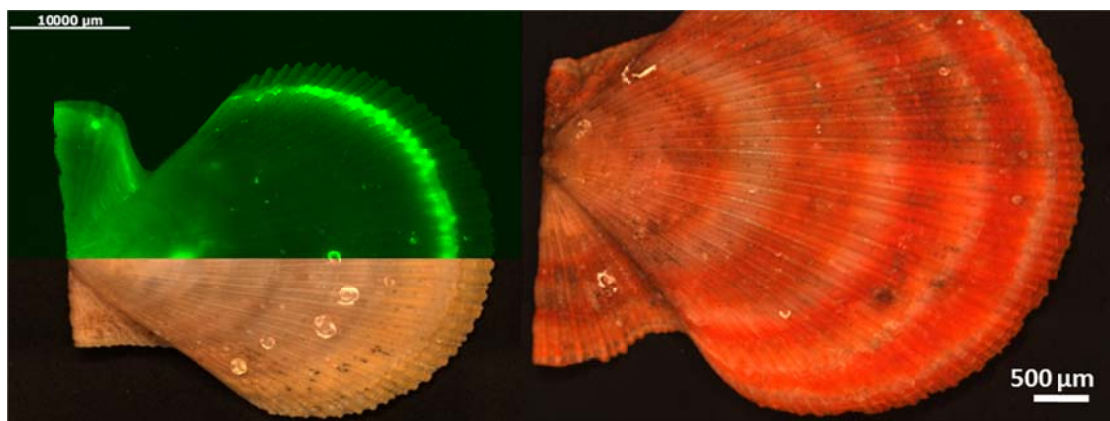


Figure 3: Analysis of deposition rate of growth marks on Chlamys islandica shells. Left: Photograph of valve under reflected light and UV light allowing visualization of calcein tagging. Right: Alternation of pigmented and non-pigmented areas on the shell surface which may have seasonal deposition rate.

Finally, to complete the validation of deposition rate of growth marks, shells samples have been extracted to measure stable isotopes of oxygen, markers of temperature and / or salinity of the medium in which the shells lived.

The second line of research *Chlamys islandica* is the study of the behavior measures respiration / filtration chamber (Figure 4) as well as the instrumentation of individuals using accelerometers to measure their activity.

In a second phase, research on *Chlamys islandica* focus on behaviour by measuring 1) respiration/filtration under benthic chamber en enceinte (Figure 4) and 2) *Chlamys* activity by accelerometers.



*Figure 4: Benthic chambers used to measure respiration and filtration of *Chlamys islandica* during missions in Svalbard made in May and September 2013.*

The results from these experiments are in progress and we only present the first results obtained from the accelerometers. During the mission made in September 2013, 10 shells were equipped with accelerometers to record continuously their movements during 7 days (Figure 5).



*Figure 5: *Chlamys islandica* equipped with accelerometer*

The compilation of these 7-days recordings shows that *Chlamys islandica* describes variable activity in time. The activity measured as movements number of the valves is inversely correlated with the light received by the shell. Thus, shells have greater activity during night than day (Figure 6). These results will be confronted with the first recordings made during the May mission (characterized by photoperiod of 24 h day) as well as recordings made in April 2014 during a ECOTAB mission. This activity will also be compared to the records of environmental parameters such as temperature, oxygen, basically.

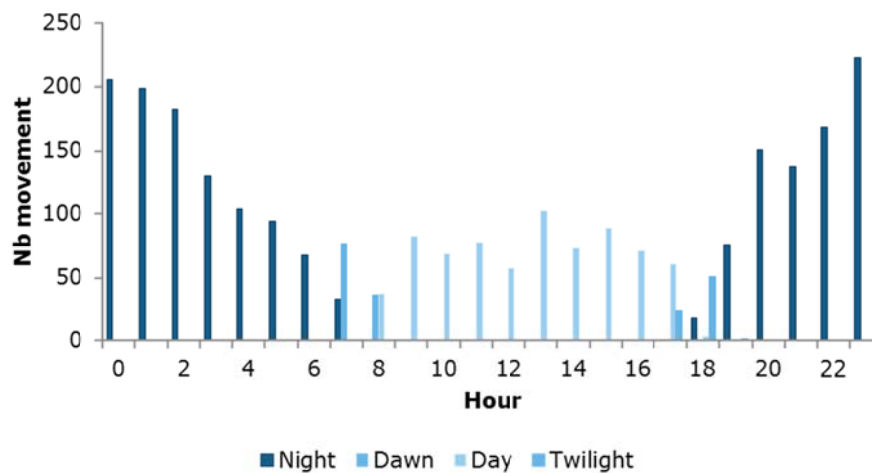


Figure 6: Movements numbers realized per hour by the 10 individuals equipped with accelerometers during 7 days.

Works realized by MNHN in Rimouki and Paris

B. Gaillard thesis:

In 2013, Blandine Gaillard conducted two campaigns in Nuuk (May and September) for sampling *Astarte* spp. and their potential food sources including surface sediment, particulate organic matter in the water column and 6 species of macroalgae. Following these campaigns, B. Gaillard, during mission in the lab ResAqua (MNHN / UMR 7208 BOREA) team, extracted lipids from these samples and then separated, identified and quantified fatty acids. In addition, samples for isotopic analysis were prepared and sent to the University of Davis. The raw results have recently been transmitted and the data are currently being processed. Finally, preliminary tests of fatty acids isotope ratios method were carried out by sending samples to the University of Davis. Data received recently, in good agreement with those of the few publications in the field, encourage us to send as soon as all lipid samples for analysis of isotopic ratios of ^{13}C .

Simultaneously, B. Gaillard submitted a first article in the journal *Limnography & Oceanography* which was denied after review on the basis of a doubt some reporters on the annual cyclicity of the growth rings formation (Figure 7). To validate our hypothesis of rings annual formation, we prepared 4 new sections (2 for site Nuuk and 2 for the polynya NOW) to use the method of radiocarbon from nuclear tests in the hemisphere north. As this type of analyse is expensive (U.S. \$

300 per sample), we limit analysis to 16 samples that will be sent before the summer to CAMS (<https://cams.llnl.gov/>).

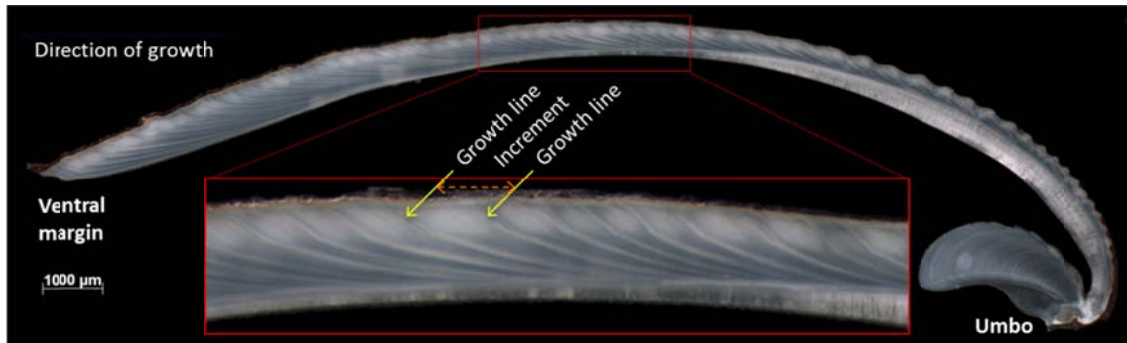


Figure 7: Shell section of *Astarte moerti* used to measure growth rings

This year, B. Gaillard will analyze 26 individuals of *Astarte spp.* collected in 2011 in the Beaufort Sea during missions Arcticnet on NGSS Amundsen. Lipid analysis, isotopic and fatty acids isotopes will be carried out in May. The sclerochemical analyzes (trace elements and stable isotopes of carbon and oxygen) will be held this summer.

In autumn, the data related to shells analysis will be compared to environmental databases to validate the calibration of our study model on the sub-arctic Site (Nuuk). The synthesis of this component will be available in Spring 2015.

S. de Cesare Thesis:

Silvia de Cesare, PhD student at the National Museum of Natural History in Paris (UMR 7208 BOREA), began her thesis in fall 2013 by the lipid analyzes of samples from Svalbard collected in May and September 2013 namely bivalves *Astarte spp.* and their potential food sources including surface sediment, particulate organic matter in the water column, two species of macroalgae and ice algae. S. de Cesare has extracted fatty acids of these samples analyzed by GC / MS (Gas Chromatography-Mass Spectrometry) and has treated resulted chromatograms. Samples from the second model species, *Chlamys islandica*, were also analyzed and the chromatograms are being processed.

In addition, preliminary tests of fatty acids isotope ratios method were performed by the University of Davis on few sources and digestive glands of *Astarte spp.* sampled in Svalbard. The transmitted data are very promising, including sources of ice algae, and encourage us to send as soon as all lipid samples for analysis of isotopic ratios of ^{13}C .

In May, S. de Cesare will realize 5-weeks mission at ISMER (Rimouski) to analyze shell sections *Astarte spp* and analyzed 4 shells sections by LA-ICPMS for trace elements. In return, she will participate with Professor Frédéric Olivier to 2-weeks campaign, similar to the pre-described campaigns in the Young Sund fjord (Greenland) in close collaboration with Dr. Mickaël Sejr (University of Aarhus, Denmark) and Jean Gaumy Magnum Photo. This campaign was made possible by obtaining EC2CO program INSU funding (Sclerarctic, F. Olivier).

At the end of this year, S. de Cesare should have finished processing of all Svalbard samples while those from Young Sund well be being processed. In this regard, we expected to present these results to the future symposium ArcticNet program to be held in Ottawa in November.

Previously, data on lipid analyzes of *Astarte* spp from Nuuk and Svalbard have been the subject of a presentation by F. Olivier during the last symposium ASLO:

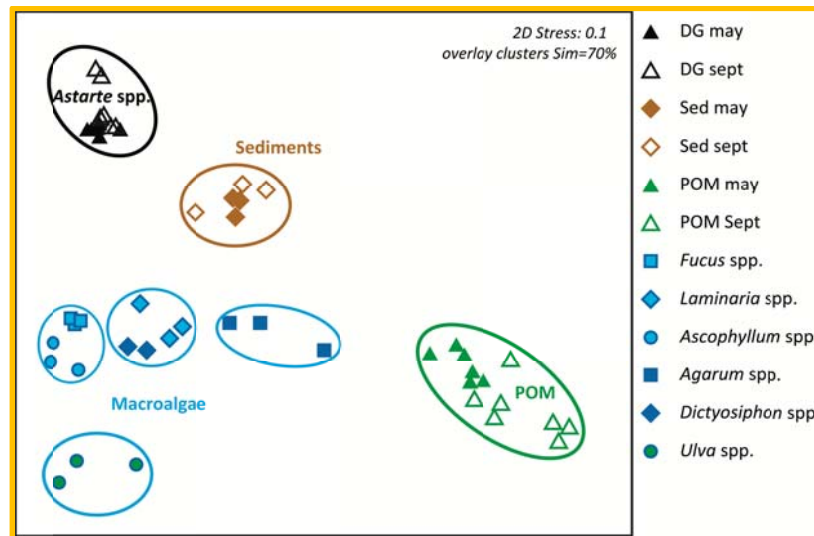


Figure 8 : MDS representation of fatty acid profiles of the *Astarte* spp. digestive glands and potential food sources in two seasons from Nuuk campaigns. Macroalgae have only been sampled in May.

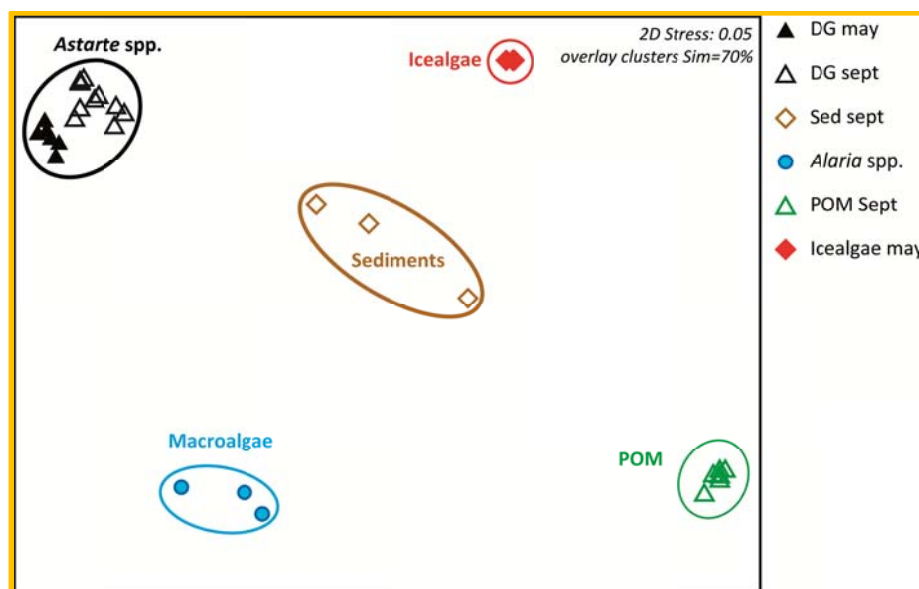


Figure 9 : MDS representation of fatty acids profiles of the *Astarte* spp. digestive glands from Kongsfjorden (Svalbard) during two seasons and potential food sources. Macroalgae, sediments and particular organic matter have only been sampled in September and ice algae in May.

These results demonstrate: 1) a good identification of sources and bivalves digestive glands, 2) a significant but little marked change in lipid profiles depending on seasons and 3) dominance of fatty acids characteristic of micro-macro algae in the filter diet. Comparing these results with isotopic data will be essential to distinguish potentially phytoplankton sources to epontic microalgae in the diet of our biological model.

Description of project progress – Artistic Part

Beyond the scientific objectives, the project's originality lies in BB Polar transdisciplinary approach: ecological research in the service of the visual and plastic creation. This project is an opportunity for scientists and artists to work together around knowledge climate change and creation.

Both artists are involved in the project and have been associated with the scientific mission to Svalbard from September 23 to October 7, 2013. Jean Gaumy, photographer of Magnum Photos agency, realized a photographic project resulting in large format color landscape photographs as well as Black and White photographs of the scientific team. An overview of his work is available in Appendix 1. Sandrine Paumelle, visual artist, has chosen to install his art studio in the heart of the Svalbard station in order to perform her creations around the concept of "safe haven". His exhibition project and his first works are given in Appendix 2. Initial projects of these two artists were transmitted during the project submission and are available on the website : <http://www-ium.univ-brest.fr/observatoire/observation-outr-mer/spitzberg/b-b-polar-en/actualite/observation-outr-mer/spitzberg/b-b-polar-en/artistic-project>



Figure 10: Presentation of the two artistic projects developed during the mission in Svalbard in September 2013

Erwan Amice, engineer assistant and diver (LEMAR-CNRS) part of the scientific team, also realized a series of underwater photographs. These photographs firstly documented research teams works and will also be displayed and used within the library (CNRS <http://phototheque.cnrs.fr/>). A first set of pictures related to missions in 2013, has already been proposed at the CNRS and is being prepared for distribution.

Prospects for the art project:

Jean Gaumy will participate to the Greenland mission in Zackenberg associated to Frédéric Olivier and Silvia Cesare from the Museum of Natural History. This second mission will be the opportunity of a new photographic project complementary to that performed in Svalbard.

An international exhibition project is being prepared gathering creations of:

- Jean Gaumy / France
- Sandrine Paumelle / France
- Erwan Amice / France
- Jean-Pierre Aubé/ Quebec (<http://www.kloud.org/>)
- Jacynthe Carrier / Quebec (<http://jacynthecarrier.com/>)

In such multi art project, it needs a curator. Franck Michel held this position. Indeed, through the diversity of artistic practices and the multitude of possible works interpretations, the role of the curator is to make sense, direct reading, make works coexist in a coherent whole with a thematic or a given theoretical concept. The Curator shall establish a significant dialogue between works. To do so, he develops a central idea and approach, accompanies and supports artists in their efforts and also ensures the space in the exhibition space. Its mandate is to establish a bridge between the works and the public by providing key readings and interpretation to facilitate access to works.

Approached locations to host this project are:

- Paris - Museum of Natural History, Paris
- Brest - Océanopolis
- Brest - Passerelle
- Lyon - Confluence Museum
- Montreal, Quebec, Toronto, Rimouski
- Norway - Tromso, Oslo (please specify)

Provisional timetable for the exhibition:

New meeting with Franck Michel	June 2014
Funding research	End June 2014
Finalization of project design and scenography	January 2015
Creations production (individual and communal)	February à December 2015
Tour begins	January 2016

Consortium meetings

Members of BB Polar project had the opportunity to meet twice during the first year of the project.

The first meeting was held September 13, 2013 with a representative of all scientific and artistic project partners. This meeting was an opportunity:

- exchange between the partners after 6 months of project
- evaluate the two missions realized in May 2013 and organize the next two for the end of 2013 and 2014
- Present the artistic partners projects

The second meeting was held on 6 March 2014 allowing scientists, artists, photographers, coordinators and organizers of the project to discuss following the mission in Svalbard in September 2013. This meeting was an opportunity to:

- Share this common experience
- To present the status of various artistic projects: Jean Gaumy, Sandrine Paumelle and Erwan Amice
- Present the exhibition projects and the possibility to product a book.

Publication et congrès

Communications scientifiques

1. *Sclérochronologie des mollusques polaires pour l'observation des variations environnementales* (2013) Colloque «Arctique : les grands enjeux scientifiques» acte fondateur du Chantier Arctique, 3 au 5 juin 2013 au Collège de France, à Paris
2. *Bivalves Pan-Arctiques comme bioarchives polaires : Projet scientifique B.B Polar* (2013) Colloque «Arctique : les grands enjeux scientifiques» acte fondateur du Chantier Arctique, 3 au 5 juin 2013 au Collège de France, à Paris
3. *Effets du couplage pélago-benthique sur la dynamique des populations du bivalve filtreur *Batharca glacialis* (J E Gray, 1824) d'environnements contrastés de l'Arctique Canadien* (2013) Colloque «Arctique : les grands enjeux scientifiques» acte fondateur du Chantier Arctique, 3 au 5 juin 2013 au Collège de France, à Paris
4. *Pan-Arctic Bivalves as polar bioarchives* (2014) Bivarc Workshop « Bivalves in Artic » in Tromsø, Norway, 18-19th of February 2014
5. *Ecophysiological study of the bivalve, *Chlamys islandica*, in situ versus ex situ approaches* (2014) Bivarc Workshop « Bivalves in Artic » in Tromsø, Norway, 18-19th of February 2014
6. *Chlamys islandica* biology studied in field experiments (2014) « Kongsfjorden Ecosystem – new views after more than a decade of research», Workshop in Hamn i Senja, Norway, 10-17 March 2014
7. *Coupling multi-trophic markers and sclera-chronology/-chemistry methods on arctic bivalves to assess climate change effects on the pelagic-benthic coupling* (2014) Ocean Sciences Meeting in Hononulu, Hawaii, USA, 23-28 February 2014

Communications artistiques

1. *Bivalves Pan-Arctiques comme bioarchives polaires : Projet artistique B.B Polar* (2013) Colloque «Arctique : les grands enjeux scientifiques» acte fondateur du Chantier Arctique, 3 au 5 juin 2013 au Collège de France, à Paris
2. Sandrine Paumelle dans la revue Artension (n° 121, Septembre - Octobre 2013)
3. Sandrine Paumelle dans la revue Artension (n°122, Novembre - Décembre 2013)

Other outreach

The mission to Svalbard, which took place in September 2013, was an opportunity to develop exchanges between two classes of sixth grade (6th D and E) of Jules Ferry college in Haubourdin and two mission members: Sandrine Paumelle, artist, and Joëlle Richard, scientific. These discussions have resulted in numerous productions by students from Erwan Amice photos, available on the project website (<http://www-iuem.univ-brest.fr/observatoire/observation-outr-mer/spitzberg/b-b-polar/projet-scolaire>). These creations will be exhibited in the college in June 2014.



On dirait une étoile de mer
Qui aurait la varicelle
Au fond de l'eau
Là où il n'y a pas d'oiseaux.
Elle a plusieurs couleurs
Pas comme les chercheurs.
Posée sur quelque chose
Comme la planète Mars
Avec des trous arrondis,
Elle est noyée dans l'eau.

Mathilde

Figure 11: Example of creation realized by a student of Jules Ferry College in Haubourdin

Appendix

Appendix 1: Jean Gaumy's project

Appendix 2 : Sandrine Paumelle's project