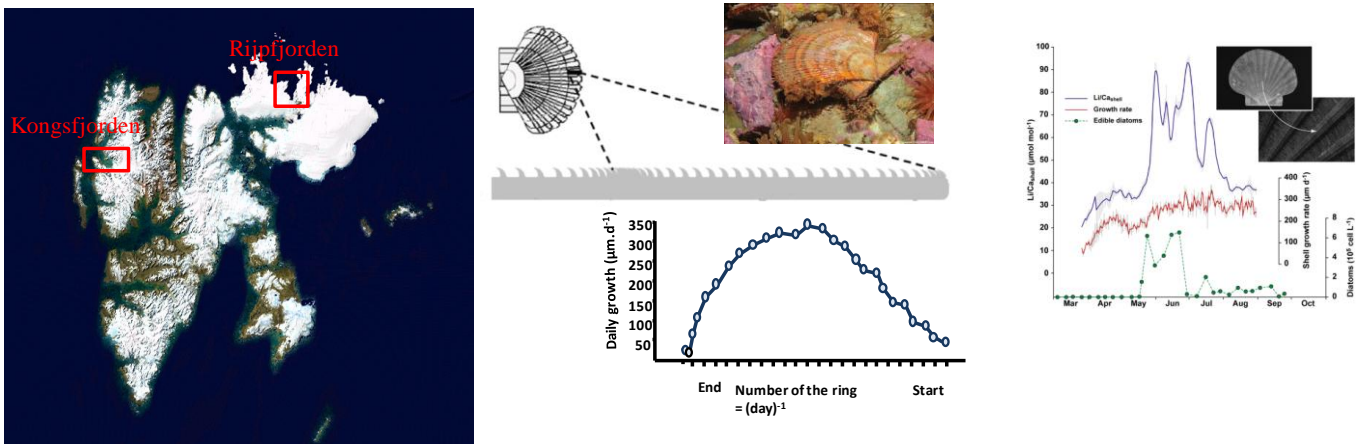


PAN-ARCTIC BIVALVES AS POLAR BIOARCHIVES
BIVALVES PAN-ARCTIQUES COMME BIOARCHIVES POLAIRES
B.B. POLAR

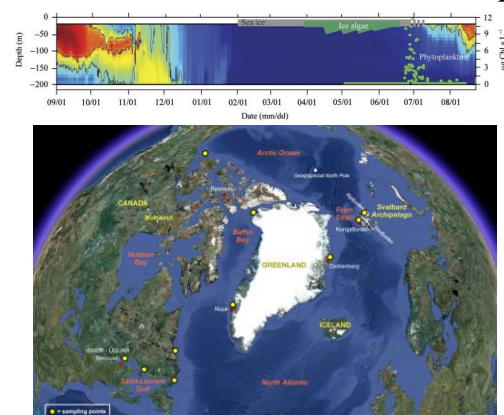
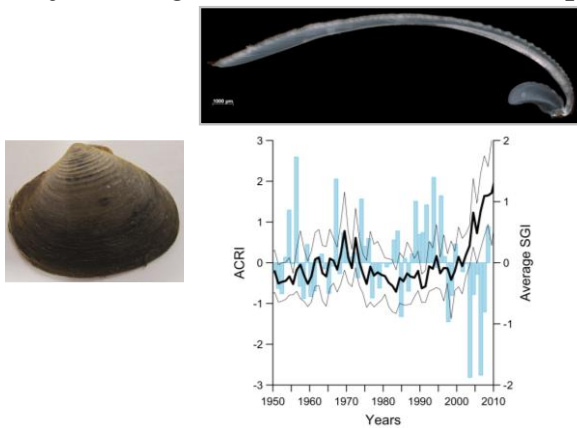
Laurent CHAUVAUD
LEMAR UMR6539

Obj. 1: Proxies' calibration and validation on *Chlamys islandica*



Obj. 2: Long-term environmental description

Obj. 3: Pan-Arctic environmental description



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PROJECT DESCRIPTION

Abstract (300 words):

In the B.B. polar project, we propose a scientific project using marine invertebrates as biological archives of the Arctic environmental variations. Tools will be implemented to monitor environmental parameters of the Arctic ecosystem at different time scales (from the daily to the decadal scales) by using two bivalves species, *Chlamys islandica* and *Astarte spp.*, and at different spatial scales (from the single fjord to a pan-arctic view). Moreover, research in ecology will serve the visual and plastic design. This project will be the occasion for scientists and artists to work together around the climate change issues, transgressing the limits of each discipline.

Keywords:

Arctic bivalves; climate; growth; proxy; biology; marine ecology

Start of the project: 1/03/2013

End of the project: 1/03/2016

Period covered by the report of activities: 1st of March 2013 to 15th of April 2015

Project website:

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

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

Other funding acquired in connection with the project:

- SCLERARCTIC (Using bivalves of the genus *Astarte* spp. as bioarchives of the impact of climate change on the Arctic food webs): EC2CO project– CNRS-INSU 2014
- SCALA (Scallops in the Arctic: tapping of environmental parameters) : IPEV project 2013

PAN-ARCTIC BIVALVES AS POLAR BIOARCHIVES

BIVALVES PAN-ARCTIQUES COMME BIOARCHIVES POLAIRES

B.B. POLAR

I. CONTEXT AND ISSUES

Research to calibrate Arctic bivalves as indicators of environmental variations has been underway for the last decade. In the Observatory at the European Institute of Marine Studies (IUEM), we have demonstrated since 1994 that the King scallop (*Pecten maximus*) provides exceptional biological archives of the temperate environment¹. Our group uses routine sclerochronology and sclerochemistry techniques, which allow us to depict the high frequency (daily) variations of the ecological conditions in the coastal waters of different areas of the planet. Recently, two Arctic bivalves have been added: another Pectinidae species, *Chlamys islandica*, and the *Astarte* spp. complex. For *Astarte* spp., we work in collaboration with our Canadian colleagues from ISMER/UQAR (Institut des Sciences de la Mer/Université du Québec à Rimouski). The originality of this project lies in the alliance of these two pan-Arctic species, allowing us depicting environmental variations at two different time scales. Indeed, *Chlamys islandica* has a life time of a couple of decades and can record the environmental variations at the daily scale whereas *Astarte moerchi* can live as long as a century and record these variations at the annual scale.

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

1. A calibration of the descriptors (so-called "proxies") in the sites already instrumented;
2. An accurate description of the environmental modifications occurred during the last century;
3. The establishment of an inexpensive observatory based on the calibrated method.

B.B Polar is part of programmatic and financial framework already well underway. The oceanographic monitoring equipment already deployed is provided by the platform PLATIM of the European Institute of Marine Studies. Norwegian (from University of Svalbard, UNIS) and French (Laboratoire d'Océanographie et du Climat, LOCEAN) teams are in charge of the deployment of deep-sea probes in the sites of study. For the Canadian part of the project, the ISMER/UQAR and the MNHN (Muséum National d'Histoires Naturelles) are in charge of the *Astarte* spp. sampling and of the related chemical and biochemical analyses (SCLERARCTIC project; EC2CO-INSU 2012). The SCALA project (LEFE-INSU 2012) will apply the same approach on *Chlamys islandica* in Svalbard.

Yet, to be able to gather both type of studies and to go much further in realizing the first description of the environmental modifications at the Pan-Arctic scale, we are soliciting from the TOTAL Foundation the support to extend the project on both species within two geographical areas in the Arctic Region.

¹ <http://www-iuem.univ-brest.fr/observatoire/evecos.php>

II. FIELD WORK

Before the beginning of the project, Frédéric Olivier and Philippe Archambault were part of the Amundsen cruises in 2010-2011 where they sampled *Astarte* spp. in the Baffin Bay and in the Beaufort Sea. On the Lance cruise in summer 2012, Joëlle Richard sampled *Chlamys islandica* and *Astarte* spp. in Rijpfjorden.

During the first 24 months of the B.B.Polar project, much time was devoted to the missions (Table 1) to instrument sites and to collect the different samples. The two missions in Svalbard were achieved with the help of the IPEV who granted us access to the Franco-German base (AWIPEV) located in the village of Ny-Ålesund (SCALA - IPEV). An additional mission in what was intended was achieved in Daneborg, Northeast Greenland through project partners and grant acquired with SCLERARCTIC project (CNRS-INSU). Moreover, the project SCLERARCTIC has been funded for a second year and a second mission at Daneborg mission is scheduled for August 2015.

Table 1: Missions realised

<i>Site</i>	<i>Period</i>	<i>People on mission</i>
Baffin Bay, Canada	7 to 22 October 2010	Philippe Archambault (Researcher) Frédéric Olivier (Researcher)
Beaufort Sea, Canada	7 to 22 September 2011	Philippe Archambault (Researcher) Frédéric Olivier (Researcher)
Rijpfjorden, Svalbard	12 to 21 July 2012	Joëlle Richard (Researcher)
Kongsfjorden, Svalbard	30 April to 17 May 2013	Erwan Amice (Engineer) Laurent Chauvaud (Researcher) Joëlle Richard (Researcher) Øivind Strand (Researcher) Tore Strohmeier (Researcher)
Nuuk, Greenland	9 to 23 May 2013	Blandine Gaillard (PhD)
Nuuk, Greenland	24 August au 5 September 2013	Blandine Gaillard (PhD)
Kongsfjorden, Svalbard	23 September to 7 October 2013	Erwan Amice (Engineer) Laurent Chauvaud (Researcher) Jean Gaumy (Photographer) Sandrine Paumelle (Visual artist) Joëlle Richard (Researcher) Julien Thébault (Researcher)
Daneborg, Greenland	28 July au 13 August 2014	Silvia De Cesare (PhD) Jean Gaumy (Photographer) Frédéric Olivier (Researcher)
Daneborg, Greenland	October 2014	Mikael Sejr (Researcher)
Baffin Bay	October 2014	Jean-Pierre Aubé (Artist)

The five missions during 2013-2014 allowed us to acquire the majority of samples necessary to meet the objectives set by the B.B.Polar project. Analyses of these samples were started in parallel to the campaigns but part of the work remains to be done (see Annex II).

III. INTERNSHIP – PHD - POSTDOC

Several students and one postdoc are part of the project:

- Thomas Andro : Master 1 de l'Université de Bretagne Occidentale (January – February 2014) + June 2014 (funding Fondation TOTAL, B.B.Polar)
- Blandine Gaillard : PhD Université de Québec à Rimouski (2011-2015, funding 50% UQAR, 50% Fondation TOTAL, B.B.Polar)
- Silvia De Cesare : PhD Muséum National d'Histoire Naturelle de Paris (2013 – 2016, funding Ecole Normale Supérieure / Muséum National d'Histoire Naturelle)
- Joëlle Richard : postdoc CNRS at LEMAR Brest (2014-2015, funding Fondation TOTAL, B.B.Polar)

IV. MEETING

A one week meeting was organised at Dinard where all the partners of the project were invited to join. Moreover, a new artist from Québec has joined the meeting, Emmanuelle Léonard (www.emmanuelleleonard.org). She will probably be part of the exhibition project. Dominique Lapointe was also invited to organise the two last days of the week to help to create the exhibition project. The first three days of the meeting were dedicated to the discussion of the scientific results of the project. The last two days were then used to create the base of the exhibition. The people present to the meeting were:

NAME	POSITION	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Erwan AMICE	Engineer, LEMAR, France				√	√
Michael CARROLL	Researcher, Akvaplan-Niva, Norway	√	√			
Laurent CHAUVAUD	Researcher, LEMAR, France	√	√	√	√	√
Silvia DE CESARE	PhD, BOREA, France	√	√	√	√	√
Blandine GAILLARD	PhD, UQAR, Canada	√	√	√		
Jean GAUMY	Photographer, Magnum Photos, France				√	√
Michelle GAUMY	Artist, France					√
Emmanuelle HASCOET	Head Exhibitions & Cultural development Manager, Magnum Photos, independent curator, France	√	√	√	√	√
Agnès IATZOURA	Exhibitions planning manager, MNHN, France				√	√
Dominique LAPOINTE	Cultural officer, Conseil de la culture du Bas-St-Laurent, Canada	√	√	√	√	√
Emmanuelle LEONARD	Visual artist, Canada			√	√	√
Tarik MEZIANE	Researcher, BOREA, France		√			
Franck MICHEL	Independent curator, Canada	√	√	√	√	√
Frédéric OLIVIER	Researcher, BOREA, France	√	√	√	√	√
Sandrine PAUMELLE	Visual artist, France				√	√
Tony QUEMERE	Sound recorder, Bonne idée production, France				√	√
Joëlle RICHARD	Postdoc, LEMAR, France	√	√	√	√	√
Julien THEBAULT	Researcher, LEMAR, France	√	√	√	√	√
Marion VASSEUR	French professor, France				√	√
Jean-Manuel WARNET	Researcher, UBO, France				√	√
Gesche WINKLER	Researcher, UQAR, Canada	√	√	√	√	√

The planning of the meeting is in Annex 1. The following parts of this report (Parts V and VI) correspond to the minute of this workshop. Moreover, all the workshop presentations are available to the B.B.Polar partners on the B.B.Polar dropbox.



V. SCIENTIFIC RESULTS (THREE FIRST DAYS OF THE MEETING)

V.1 ENVIRONMENTAL KNOWLEDGE

The workshop began with the environmental description of the different sites studied in the context of the B.B.Polar project. There are one site in the Baffin Bay (NOW) and one in the Beaufort sea, two fjords in Greenland (Kobbefjord and Yung Sund), and two fjords in Svalbard (Kongsfjorden and Rijpfjorden). The list of the available environmental is presented in Table 2. In the B.B.Polar project, the contact for the Canadian and Greenland data is Frédéric Olivier and the one for the Svalbard data is Joëlle Richard.

Table 2: Environmental data available from annual survey on the different sites

<i>Country</i>	<i>Site</i>	<i>Type of data</i>	<i>Period</i>
Svalbard	Kongsfjorden	Mooring: - Temperature - Salinity - Pressure - Light - Fluorescence - Current	2002-2006 2008-2013
Svalbard	Rijpfjorden	Mooring: - Temperature - Salinity - Pressure - Light - Fluorescence - Current	2006-2007 2009-2013
Greenland	Godthåbsfjord next to Kobbefjord	Monthly sampling: - CTD profile - Temperature - Salinity - Fluorescence - Light - Oxygen - Turbidity - Nitrate - Phosphate - Silicate - Chlorophyll	2005-2013
Greenland	Yung Sund	2 Moorings: - Temperature - Salinity - Pressure - Sedimentation	2005-2013
Canada	Baffin Bay	Mooring: - Temperature	2005-2006
Canada	Cambridge Bay	Underwater instrument: - Temperature - Salinity - Fluorescence - Light - Oxygen - Turbidity	From 2012

V.2 SHELL SESSION

The shell session began with a presentation on the tools used in sclerochronology and sclerochemistry. This presentation was done so all the people present could follow the next presentations on the results acquired from the reading of the bivalves shell.

At the beginning of the B.B.Polar project, one of the objectives was first to calibrate the growth of the bivalves genus studied: *Astarte* spp. and *Chlamys islandica*. Growth rhythm calibration of *Astarte moerchi* was realised using $\Delta^{14}\text{C}$ technique. 4 shells of *Astarte moerchi* from the Northern Baffin Bay (NOW polynia) were analysed assuming that each growth line represents on year. They were sampled on the 16th of October 2010 at 568 meters depth. Thanks to this technique, the growth rate of one growth line per year was validated (Figure 1). Moreover, complementary samples are actually analysed.

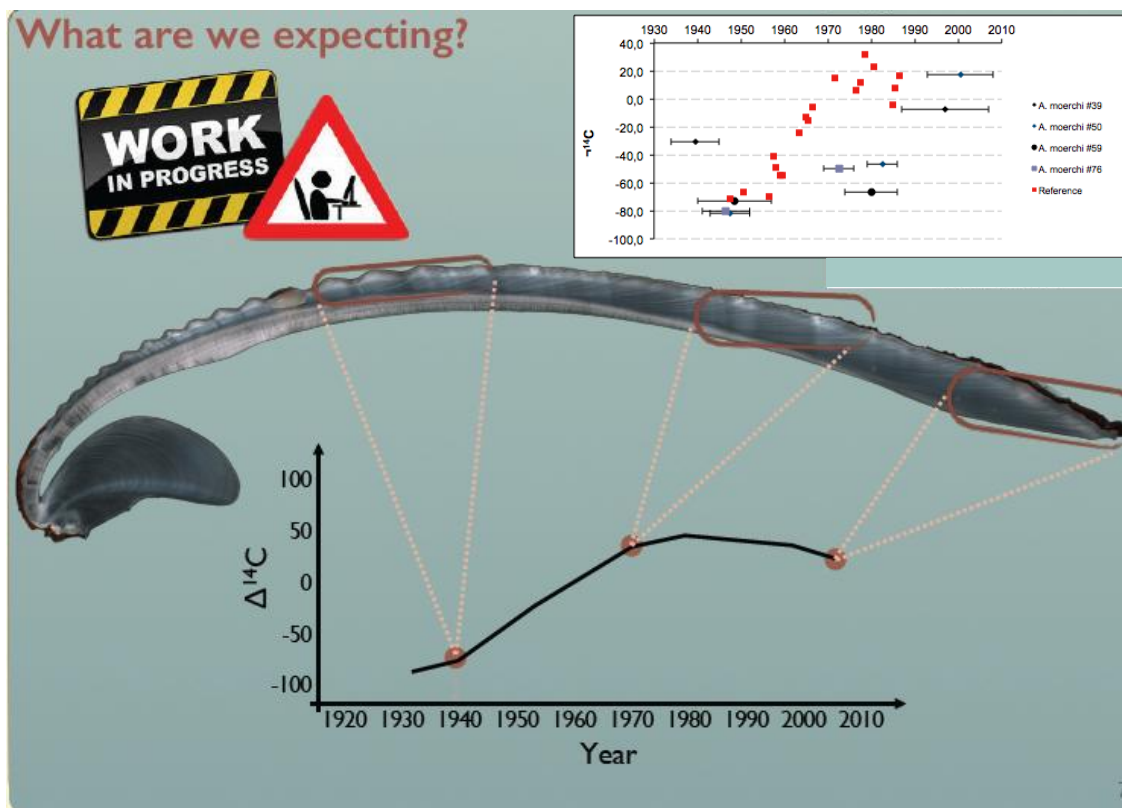


Figure 1: Dorso-ventral cut of an *Astarte moerchi* shell and position of the carbonate samples. The graph under the shell represents what we were expecting in case of validation of the growth rhythm and the graph above the shell represents the results obtained.

To validate the growth rate of *Chlamys islandica*, two techniques were used: calcein marking and oxygen stable isotopes ($\delta^{18}\text{O}$) of the shell. First, 21 *Chlamys islandica* from Kongsfjorden were marked *in situ* with calcein on the 11th of May and recaptured in the 25th of September 2013. The calcein mark could be observed under a binocular and the growth after the mark has been measure (Figure 2).

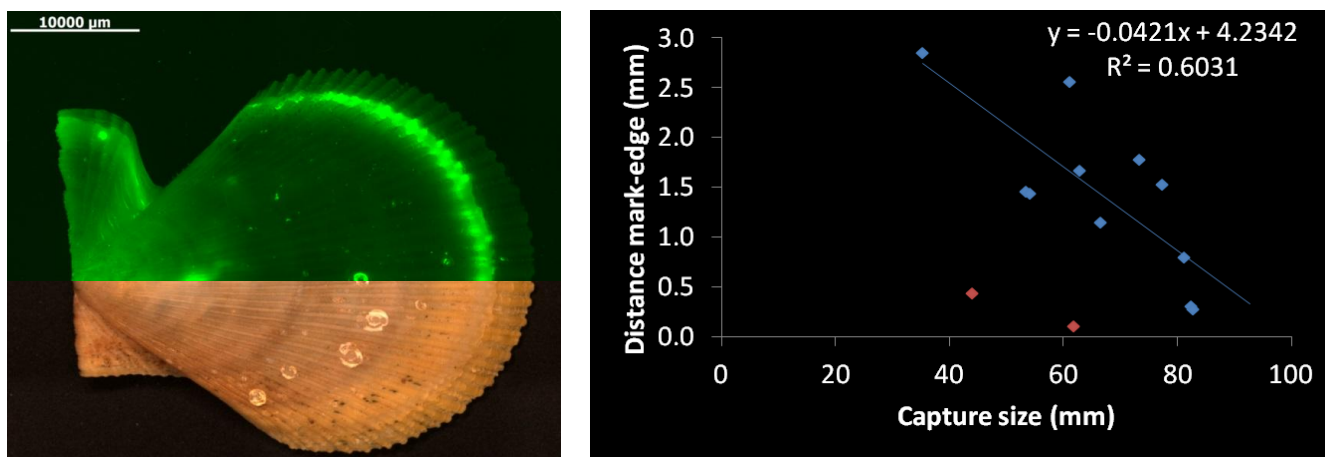


Figure 2: *Chlamys islandica* shell under reflected light and UV. The green line represents the date of the calcein tagging. The graph represents the relationship between growth after the calcein tagging and the capture size.

Carbonate samples were realised along the dorso-ventral axis of the *Chlamys islandica* shells to analyse the oxygen stable isotope composition of it (Figure 3). A total of 9 individuals were analysed, 3 from Kongsfjorden, 3 from Rijpfjorden and 3 from Kobbefjord. A total of 35 samples were analysed per individual. This enabled us to confirm the results found using calcein tagging.

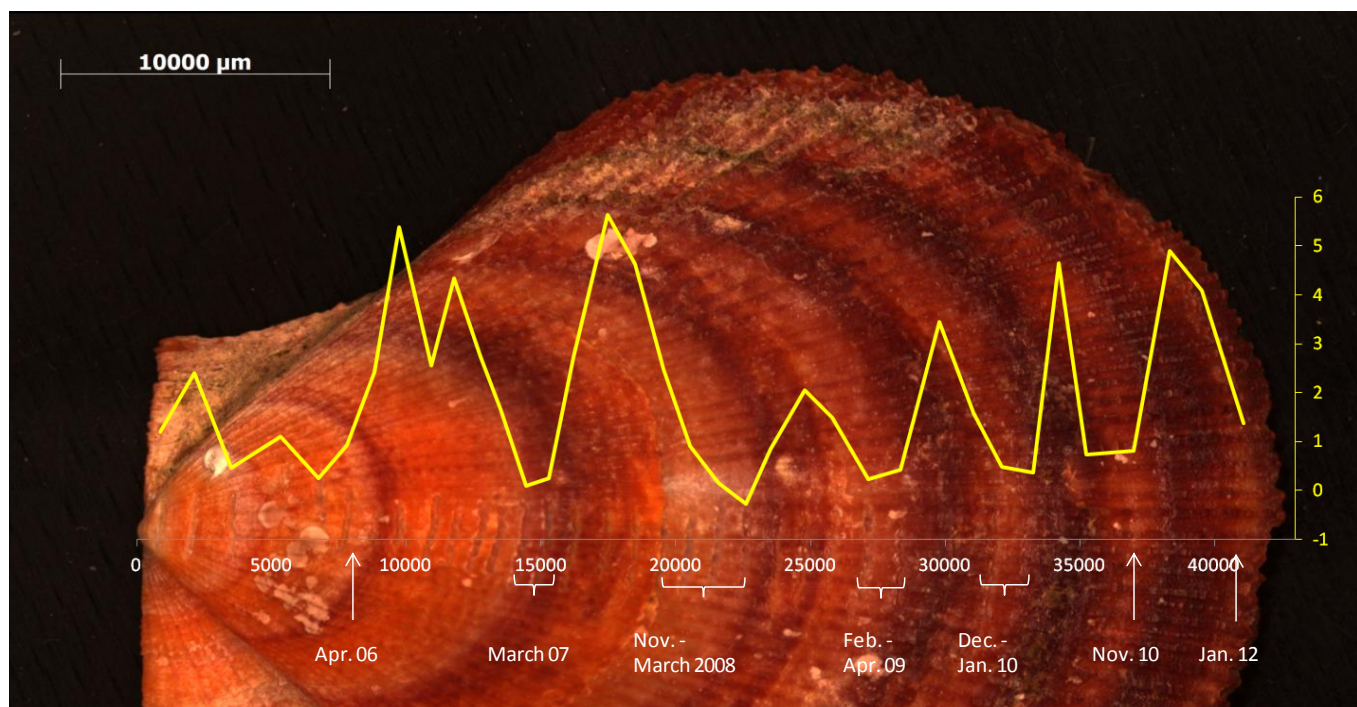


Figure 3: *Chlamys islandica* shell from Rijpfjorden sampled for stable oxygen isotope analysis. The yellow curve shows the temperature calculated from the $\delta^{18}\text{O}$ of the carbonate samples.

These two techniques enable us to say that one pigmented + one non-pigmented bands correspond to one year of growth so we can use alternation of pigmented / non pigmented areas to estimate age of the individuals. The non-pigmented bands are formed between January and March. *Chlamys islandica* seems to stop growing when the temperature of the water is below 0°C.

Now that we have validated the growth rate of *Astarte* spp. and *Chlamys islandica*, we can start to apply the tools of sclerochronology and sclerochemistry to compare the different Arctic sites studied in the B.B.Polar project. Table 3 presents the *Astarte* spp. analysed using these techniques.

Table 3: Samples of *Astarte* spp. for sclerochronology and sclerochemistry

SITE	SPECIES	SCLEROCHRONOLOGY	SCLEROCHEMISTRY
Beaufort Sea Shelf	<i>A. moerchi</i> (n = 30)	Growth anomalies time-series analysis	Trace elements analysis
Baffin Bay	<i>A. moerchi</i> (n = 30)	Growth anomalies time-series analysis	Isotopes analysis Trace elements analysis Bomb-radiocarbon dating
Kobbefjord (S.-O. Greenland)	<i>A. elliptica</i> (n = 50)	Growth anomalies time-series analysis	Trace elements analysis
Young Sound (N.-E. Greenland)	<i>A. borealis</i> (n = 60)	Growth anomalies time-series analysis	Isotopes analysis Trace elements analysis
Kongsfjorden (Svalbard)	<i>A. borealis</i> (n = 30)	Growth anomalies time-series analysis	Isotopes analysis Trace elements analysis

All the shells are prepared for sclerochronology analysis. However, the reading of growth lines was not easy. Another method will be applied to facilitate the reading, acetate peel. The trace elements analysis has been realised on the sampled *Astarte* spp. The work left is now to analyse the results to compare the different sites.

Concerning *Chlamys islandica*, the growth reading has been realised on all sites. Table 4 present the samples treated for the different sites. Growth curves has been realised for the different study sites. Moreover, 3 individuals per site (Kongsfjorden, Rijpfjorden and Kobbefjord) have been analysed for carbon stable isotopes and trace elements. These data are not treated yet. In addition to these techniques, analyse of pigments on shells surface has been performed using Raman spectroscopy. This technique seems to give promising results.

Table 4: Size and number of shells of *Chlamys islandica* analysed per site

Site	Depth	Nb of shells	Size (mm)
Kongsfjorden	20 m	11	33 – 64
Rijpfjorden	20 m	11	36 – 63
Kapp Mitra	62 m	4	51 – 61
Nuuk (Greenland)	55 m	10	26 - 66

V.3 SOFT TISSUE + METABOLISM SESSION

For the same reason that the one for shell session, this part of the meeting began with a presentation of the different tools used in the soft tissue analyses. Diet characterisation of *Astarte* spp. has been performed in Kongsfjorden, Kobbefjord and Yung sund using fatty acid trophic markers (FATM), bulk isotopes ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) and compound specific stable C isotope of FA ($\delta^{13}\text{CFA}$). Digestive gland and muscle have been analysed together with the different potential food sources (particular organic matter, ice algae, organic matter at the surface of the sediment and macroalgae). From the results obtained up to now, we can say that *Astarte* spp. diet is similar in Kongsfjorden and Kobbefjord. It is composed of a diatom contribution in May and more diversified sources in September (dinoflagellates, bacteria, macroalgae and zooplankton). Macroalgae seems to play a major role in these two sites. We expect differences between the two sub-arctic sites and the Young sund (Arctic site), where *Astarte* spp. Diet seems to be strongly related to diatoms in two seasons.

For the moment, the diet characterisation of *Chlamys islandica* has been performed only in Kongsfjorden. The diatom contribution to the diet is bigger in May than in September. In September, the diet is also composed of dinoflagellates and macroalgae.

Metabolism of *Chlamys islandica* has been studied in Kongsfjorden looking at respiration rate, filtration rate and behaviour in May and September 2013. Respiration rate does not seem to be different between spring and autumn. However, a big inter-individual variability is observed in term of respiration and filtration rate. A positive relationship was observed between the valve gape (space between the two valves) and the clearance rate. We have now to put together the data obtain on respiration and filtration rates and the behaviour. The results obtained during the survey of the scallop behaviour during one week in September show that this species seems to have a behaviour punctuated by the light intensity and the tide. Other relationships with the behaviour have to be look at: tide + filtration, light/dark + respiration, oxygen variation related to the light, link between tide and current on the UNIS mooring.

V.4 COUPLING SHELL AND SOFT TISSUE DATA

The ultimate goal of the B.B.Polar project is to couple data issued of the shell and the soft tissues of the bivalves studied to better understand the pelages-benthos coupling in different sites of the Arctic. The

only species for which this objective is almost achieved for the moment is *Astarte moerchi* on one site, Northern Baffin Bay (North Water Polynya). The sclerochronology data gave an increase of growth since the 2000s compare to the time period from 1950 to 2000. The question is which environmental signals could explain these differences in growth? The sclerochemistry data in term of stable oxygen isotopes indicate a relatively stable environment in term of temperature and salinity. The soft tissues analysis for fatty acids indicate that this species uses diversified sources of food (microalgae, zooplankton and bacteria) but a high levels of FA markers of diatom indicate their dominance in microalgal sources and their export from the euphotic zone to the seafloor. Knowing this information on the diet, trace elements analyses have been performed on the shell. A strong inter-annual variability has been observed in term of barium-to-calcium ratio, a proxy for primary productivity. This inter-annual variability is higher during the last two decades, probably related to the microalgal dynamics but has to be confirmed. In conclusion, a strong positive growth anomaly since the 2000s has been observed in a relatively stable environment in term of temperature and salinity. This could be explained by a higher export of food to the seafloor which could be due to *i)* sea ice dynamics or *ii)* spatio-temporal mismatch between phytoplankton and zooplankton.

The same kind of work is also performed by Norwegian partners of the B.B.Polar project on other species (*Serripes groenlandicus* and *Clinocardium ciliatum*) in the Svalbard archipelago. At the end of the project, we hope we could couples data from all sites and species.

V.5 MOLECULAR DATA

In the B.B.Polar project, we had planned to use molecular tools on *Astarte* spp. because it is known to be a complex of species almost impossible to identify only with morphological analysis. The sequencing of the mitochondrial DNA gene cytochrome oxydase 1 subunit was used to look at the different individuals of *Astarte* spp. collected in the different sites (Beaufort Sea, Baffin Bay, Kobbefjord, Yung Sund (Daneborg + Zackenberg) and Kongsfjorden). 10 haplotypes were identified on the 30 individuals sequenced. In Kobbefjord, it seems to be a different species than on the other sites, *Astarte elliptica*. Over the Arctic, 3 groups are identified for *Astarte borealis*. The genetic diversity seems to be higher in Svalbard. In Young sund, two groups of *Astarte borealis* co-exist.

VI. EXHIBITION PROJECT (LAST TWO DAYS OF THE MEETING)

VI.1 PRESENTATION OF THE SCIENTIFIC AND ARTISTIC PROJECTS

The scientists began to present their scientific findings (results above) to the artists in the most comprehensive way. Then, the artists present their realisation in the course of the two days (Sandrine Paumelle, Jean Gaumy and Erwan Amice). Jean-Pierre Aubé and Emmanuelle Léonard are two Canadian artists who join the B.B.Polar project. Jean-Pierre Aubé embarked on the Canadian icebreaker (Amundsen) in October 2014. He realised a video and presented to us by skype. Emmanuelle Léonard just joined the project and was present at Dinard to evaluate how she could integrate her work in the project. This is still to be determined. Moreover, Emmanuelle Hascoët, one of the curators of the show and the cultural project coordinator explained the key points to build an exhibition and presented the exhibition schedule.

VI.2 WORKSHOPS

We invited Dominique Lapointe from Québec to help us to build the exhibition. She is currently an agent of development for the artistic succession of the Council of the culture of Bas-St-Laurent. She planned two workshops for that. The first one, the collective story, had for objectives to collectively highlight the central axes from the human and professional experience of B.B.Polar participating scientists and artists. Then contribute from this data to trace the exhibition guidelines. The second one had for objectives to outline the content of the exhibition.

VI.3 Assessment of the two days and flowing steps

With the help of Dominique Lapointe, project stakeholders met to work together in Dinard to examine and compare their experiences in the field and their conceptions of the fundamental research, the environment and the creation, common to them. The week was fruitful and helped to consolidate the group, make the point on the ongoing research and sensitize everyone on this exceptional “human laboratory”.

This experience should lead to a joint creation which will take the form of an exhibition. Ideally, this exhibition would be presented at the Museum of Natural History in Paris. Agnès Iatzoura, responsible of the exhibition programming of the National Museum of Natural History was present at Dinard. She was there because she is really enthusiastic about the idea of a common exhibition (art and sciences) on the Arctic.

The exhibition should offer unusual links between science and art. It will reflect the experience of artists and scientists in the Arctic and will also explore the commonalities between artistic and scientific approaches. This exhibition will invite visitors to experience this immersion in the polar landscape, to experience the landscape as a sensitive area where its various properties are taken into account: light, temperature, smells, texture, sounds, etc. He will be brought to perceive surrounds otherwise, to sharpen its sensitivity to its environment, to enrich his biological, geopolitical and historical knowledge of this environment and to understand the experimental, mathematical and research methods. Although, the aims and methods used are very different, research and creation approaches of the scientific and artist communities are not that far apart. Artists and scientists, in their own way, leaving the real to bring new visions, new reading of the landscape sometimes go see the invisible, or at least the “hidden” visible. To do so, scientific experimental installations and artistic creations will complement in the course of the exhibition.

At this time, the exhibition script is being written. Funding research will be launched and discussions are ongoing with various potential locations.

VII. COMMUNICATIONS

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, Collège de France, 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, Collège de France, Paris
3. *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, Collège de France, Paris
4. *Effets du couplage pélogo-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, Collège de France, Paris
5. Sandrine Paumelle dans la revue Artension (n° 121, Septembre - Octobre 2013)
6. Sandrine Paumelle dans la revue Artension (n°122, Novembre - Décembre 2013)
7. *Pan-Arctic Bivalves as polar bioarchives* (2014) Bivarc Workshop « Bivalves in Artic », Tromsø, Norvège, 18 au 19 février 2014
8. *Ecophysiological study of the bivalve, *Chlamys islandica*, in situ versus ex situ approaches* (2014) Bivarc Workshop « Bivalves in Artic », Tromsø, Norvège, 18 au 19 février 2014
9. *Chlamys islandica* biology studied in field experiments (2014) « Kongsfjorden Ecosystem – new views after more than a decade of research», Hamn i Senja, Norvège, 10 au 17 Mars 2014
10. *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, Hononulu, Hawaii, USA, 23 au 28 février 2014

11. Exposition de Jean Gaumy "*La Tentation du Paysage*", Abbaye de Jumièges, 29 mai au 21 septembre 2014
12. Exposition "*Jeunes Reporters des Arts et des Sciences*", Océanopolis, Brest, 2 au 6 juin 2014



PLANNING FOR THE B.B.POLAR MEETING

DINARD, 9TH TO 13TH OF FEBRUARY 2015

MONDAY 9TH OF FEBRUARY

11h00	Arrival time at Dinard
12h00 – 13h45	Lunch break at the manor
13h45 – 14h00	
Laurent Chauvaud Joëlle Richard	<i>Title:</i> Presentation of the planning and the objectives of the week
<u>ENVIRONMENTAL KNOWLEDGE</u>	
14h00 – 14h15	<i>Title:</i> Biotic and abiotic environmental data: Knowledge in Greenland (Godthåbsfjord, Kobberfjord and Yung Sund), Baffin Bay (North Water Polynya (NOW)) and Beaufort Sea
Laurent Chauvaud	
14h00 – 14h15	<i>Title:</i> Svalbard environmental knowledge
Joëlle Richard	
14h30 – 15h00	Discussion
<u>SHELL SESSION</u>	
15h00 – 15h30	<i>Title:</i> Bivalve shells as geochemical archives of paleo-ecological processes in coastal ecosystems: stories from the Bay of Brest... and beyond
Julien Thébault	
15h30 – 15h45	<i>Title:</i> <i>Astarte moerchi</i> : calibration of the growth rate
Blandine Gaillard	
15h45 – 16h00	<i>Title:</i> <i>Chlamys islandica</i> growth rhythm calibration
Joëlle Richard	
16h00 – 16h30	Coffee break
16h30 – 17h00	<i>Title:</i> <i>Astarte spp.</i> sclerochronology and sclerochemistry
Blandine Gaillard	
17h00 – 17h30	<i>Title:</i> <i>Chlamys islandica</i> growth patterns
Joëlle Richard	
17h30 – 18h00	Discussion
20h00	Dinner at a Dinard restaurant

TUESDAY 10TH OF FEBRUARY

SOFT TISSUE + METABOLISM SESSION

- 9h00 – 9h30
Tarik Meziane and Frédéric Olivier *Title: Interests and limits of multi-trophic markers, methods applied to benthic species*
- 9h30 – 10h00
Silvia De Cesare and Blandine Gaillard *Title: Diet characterisation of bivalve *Astarte* spp. in two sub-arctic fjords (Kongsfjorden and Kobberfjord)*
- 10h00 – 10h30
Silvia De Cesare *Title: Diet characterisation of bivalve *Chlamys islandica* in a sub-arctic fjord (Kongsfjorden)*
- 10h30 – 11h00 Coffee break
- 11h00 – 11h30
Joëlle Richard *Title: Ecophysiological study of the bivalve, *Chlamys islandica**
- 11h30 – 12h00
Joëlle Richard Behavioral study by Accelerometry
- 12h00 – 13h45 Lunch break at the manor
- 13h45 – 15h00 Discussion

COUPLING SHELL AND SOFT TISSUE DATA

- 15h00 – 15h30
Blandine Gaillard *Title: Coupling trophic markers and sclero-chronology / -chemistry methods on Arctic bivalves*
- 15h30 – 16h00
Michael Carroll *Title: Sclerochronology of Arctic Bivalves: Patterns and Drivers*
- 16h00 – 16h30 Coffee break

MOLECULAR DATA

- 16h30 – 17h00
Gesche Winkler *Title: *Astarte* species confirmation and genetic diversity in the Arctic*
- 17h00 – 18h00 Discussion
- 20h00 Dinner at the manor

WEDNESDAY 11TH OF FEBRUARY

OTHER DATA AVAILABLE

9h00 – 9h15 Laurent Chauvaud	<i>Title:</i> Microphytobenthic primary production
9h15 – 9h30 Laurent Chauvaud	<i>Title:</i> Passive acoustic potential for marine ecology studies
9h30 – 9h45 Joëlle Richard	<i>Title:</i> Under the pole in Greenland
10h00 – 10h30	Coffee break
10h30 – 12h00	Discussion concerning the next steps
12h00 – 13h45	Lunch break at the manor
13h45 – 18h00	Discussion on the work left and on the publications
20h00	Dinner at the manor

THURSDAY 12TH OF FEBRUARY

THE COLLECTIVE STORY

WORKSHOP I CONDUCTED BY DOMINIQUE LAPOINTE

*“La véritable liberté s’insère là où il y a de l’imprévisible et du brassage entre les êtres.
Si on était identiques on aurait rien à se dire, d’où la nécessité d’apprendre à se rencontrer.”*
Albert Jacquard, généticien

Goal: this workshop will be referred to collectively highlight the central axes from the human and professional experience of B.B.Polar participating scientists and artists. Then contribute from this data to trace the exhibition guidelines.

9h00 – 9h10	Presentation of the course of the day
9h10 – 9h35	Sandrine Paumelle project
9h40 – 12h00	I. Phenomenological story 15’ Approach presentation: closer to the singular experience to learn how to meet (<i>articulation of I – We</i>) 10’ Theme: A time when you were in the right place with the right people, doing the right thing (<i>kairos (Galvani): The time T of the opportunity</i>) Instruction and assistance 15’ Individual writing on paper (1 to 1.5 page) 75’ Share: reading and listening resonance 20’ Feedback
12h00 – 13h10	Lunch break at the manor
13h10 – 13h45	Jean-Pierre Aubé by Skype Project presentation
13h45 – 16h30	II. Collective story 20’ Approach presentation: the team is invited to tell his story 130’ Theme: Unlikely encounters (<i>The unpredictable</i>) Listening and resonance 20’ Feedback on the experience
16h30 – 17h00	Coffee break
17h00 – 17h30	Balance sheet of the workshops (<i>work in triad on large sheets</i>) <i>Which is to retain the brewing between people</i>
17h30 – 17h50	Jean Gaumy project
17h50 – 18h20	Emmanuelle Léonard project
20h00	Dinner at a Dinar restaurant

FRIDAY 13TH OF FEBRUARY

ON THE WAY TO THE EXHIBITION

WORKSHOP II CONDUCTED BY DOMINIQUE LAPOINTE

Goal: outline the content of the exhibition

9h00 – 9h10	Presentation of the course of the day
9h10 – 9h30	Erwan Amice photography
9h30 – 10h30 Laurent Chauvaud	Scientific project, results and tools
10h30 – 10h45 Marion Vasseur	Educational project
10h45 – 11h15 Emmanuelle Hascoët	The possibility of an exhibition
11h15 – 12h00	Exhibition 1 Reflection and exchange around the content and formatting (world coffee) Questions and discussion
12h00 – 13h10	Lunch break at the manor
13h10 – 14h30	Exhibition 2 Reflection and exchange around the tools, challenges and itinerary (world coffee) Questions and discussion
14h30 – 16h00	Assessment of the week, following steps and conclusion
16h00	Goodbye and thanks
17h00	Departure

ANNEX II: TO DO LIST

BLANDINE GAILLARD:

- Sclerochronology Nuuk *Astarte*
 - o Growth lines reading (Acetate peel LEMAR)
 - o Sclerochemistry: Trace elements (already done)
Stable isotopes (to be done)
- Sclerochronology Beaufort Sea *Astarte* (see who will do it, Master student?)
 - o Growth lines reading (Acetate peel LEMAR)
 - o Sclerochemistry: Trace elements (already done)
Stable isotopes (to be done)

SILVIA DE CESARE:

- Fatty acids:
 - o Svalbard: *Chlamys* + *Astarte* + food sources (done)
 - o Daneborg: *Astarte* + sources (done)
Astarte elliptica (to be done, see who will do it, Master student?)
- Stable isotopes:
 - o Svalbard: *Chlamys* + *Astarte* + food sources (sent to Davis)
 - o Daneborg: *Astarte* + sources (sent to Davis)
- Stable isotopes on FA:
 - o Svalbard: *Chlamys* + *Astarte* + food sources (Analysed, to see)
 - o Daneborg: *Astarte* + sources (to be sent)
- Sclerochronology Kongsfjorden *Astarte*
 - o Growth lines reading (Acetate peel LEMAR)
 - o Sclerochemistry: Trace elements (done at Rimouski)
Stable isotopes (to be done at Brest for sampling, to see), See AWIPEV
Underwater Observatory data to decide of the interest
- Sclerochronology Yung sund (2 sites: Daneborg + Zackenberg) *Astarte*
 - o Growth lines reading (to be done)
 - o Sclerochemistry: Trace elements (to be done)
Stable isotopes (to be done)

WARNING: Zackenberg is at 50Km away of the environmental measurements, so privilege Daneborg.
Astarte borealis + *Astarte elliptica* (*A. elliptica* will not be analysed, to see, Master student?)

AURELIE JOLIVET AND JULIEN THEBAULT:

- RAMAN *Chlamys islandica* (collaboration with Bardeau, Le Mans)
See coupling with pigments HPLC of the sources and/or the digestive gland of *Chlamys islandica* (collaboration with Anne Donval, LEMAR)
- $\delta^{18}\text{O}$ high frequency + RAMAN *Chlamys islandica* for growth validation
- Reading growth lines on *Chlamys islandica* ligament (see with Jean-Marie or Eric for tuning of the method)

GESCHE WINKLER:

- Genetic on *Astarte* spp.
 - *A. borealis*: 26 individuals (done)
 - *A. elliptica*: 4 individuals (done)
- To be added:
 - *A. elliptica* + *A. borealis* at Daneborg (to be sample on summer 2015)
 - *A. borealis* Svalbard, add the individuals left over (samples to be sent to Gesche)
 - Ask to Mike Carroll if other *Astarte* samples possible at Rjipfjorden
 - Ask to IPEV engineer if other *Astarte* samples possible at Kongsfjorden

Ask Janne Søreide what kind of analyses have been performed on the sources collected at Rjipfjorden in July 2012

LIST OF THE DIFFERENT SITES:

- Greenland
 - Nuuk
 - Daneborg
 - Zackenberg
- Svalbard
 - Kongsfjorden
 - Harbor: *Astarte* at 10m depth
 - Nezet: *Chlamys islandica* at 15-20m depth
 - Kap Mitra: *Chlamys islandica* + *Astarte* at 60-80m depth
 - Rjipfjorden: *Chlamys islandica* + *Astarte*

LEADER BLANDINE GAILLARD:

1. Sclerochronology, sclerochemistry and trophic (fatty acids) on *Astarte borealis* in the Baffin Bay (NOW)
2. Multi-trophic markers on *Astarte elliptica* at Nuuk
3. *Bathyrca* from the Beaufort Sea to the Polynya (5 sites), pelagos-benthos coupling + trophic + physiology (polar lipids)
4. Sclerochronology, sclerochemistry on *Astarte elliptica* at Nuuk (calibration with environmental parameters)

LEADER SILVIA DE CESARE:

5. Multi-trophic markers in Svalbard (Kongsfjorden) + Yung sund on *Astarte borealis*
6. Sclerochronology (growth), sclerochemistry (trace elements + stable isotopes) on fossil *Astarte* from Yung sund

LEADERS SILVIA DE CESARE AND JULIEN THÉBAULT:

7. Sclerochronology, sclerochemistry *Astarte elliptica* + *Astarte borealis* at Daneborg + Zackenberg. Put in parallel with paper n°4.
Collaboration with a Master II on *Astarte elliptica* Yung sund
8. Sclerochronology, sclerochemistry on *Chlamys islandica* at Kongsfjorden (Nezet + Kap Mitra), Rijpfjorden and Nuuk

LEADERS JULIEN THÉBAULT AND AURÉLIE JOLIVET:

9. Validation sclerochronology *Chlamys islandica* ($\delta^{18}\text{O}$ high frequency + RAMAN)

LEADER AURÉLIE JOLIVET:

10. *Chlamys islandica* behaviour (accelerometry)

LEADERS TORE STROHMEIER, JOËLLE RICHARD AND AURÉLIE JOLIVET:

11. Metabolism on *Chlamys islandica*

LEADER CÉDRIC:

12. Acoustic in Kongsfjorden

LEADER GESCHE WINKLER:

13. Population genetic on *Astarte* spp.
Depending on the funding asked at Labex

TEAM PUBLICATIONS:

14. Review on *Astarte* spp., *Chlamys islandica*, *Serripes groenlandicus* and *Clinocardium ciliatum*