TNA PROJECT REPORT

1. Project Information

Proposal reference number	JN_CALL_2_3
Project Acronym (ID)	ReMoBiB
Title of the project	Real time Monitoring of Bivalve Behavior
Host Research Infrastructure	Underwater Node Helgoland (COSYNA_UNH)
Starting date - End date	20/02/2018 - 23/02/2019
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2. Project objectives

Over the very short term, the aim of the project was to demonstrate the possibility to use shell valve gape as a bio-monitor in addition to more traditional environmental monitoring techniques. At the same time we wanted to test the possibility to connect this equipment to the COSYNA underwater node at Helgoland. For this, the existing stand-alone equipment developed by NIOZ had to be adapted to enable connection and data transfer.

On the medium term, the scientific aim of the project is to establish, from these tests, the relationship between shell gape (filtration activity) of *Arctica islandica* and environmental factors (Salinity, Temperature, Chlorophyll, light) at the southern limit of its distribution. This by collecting a continuous observational time series on shell gaping behaviour covering at least an entire year, while at the same time high resolution environmental data are being collected from the underwater node to which the gape recorder is connected. Within the project it is aimed to develop an online visualisation of real time valve gape activity on the NIOZ and AWI website as means to raise awareness about sea life among the broader public and show that the shells are living creatures reacting to their environment.

On the longer term, the aim is to show that the online monitoring of the gaping behaviour of bivalves adds an extra dimension to environmental monitoring especially for ecological studies. Results are likely to illustrate the role of (extreme) environmental conditions on the feeding behaviour of individuals and the variation therein. It is anticipated that this project will lead to intensified cooperation and joint benthic ecological studies between NIOZ and AWI.

The activity described in this report has received funding from European Commission's H2020 Framework Programme under JERICO-NEXT project, grant agreement No. 654410.

3. Main achievements and difficulties encountered

Since its deployment on February 20th 2018 the equipment technically worked fine up to the beginning of July 2018, although we observed that over that period valve gape signals from individual shells were lost one by one. In July we did a major maintenance action, i.e. we recovered the entire setup from the sea floor and replaced shells and electronic hardware. It appeared that predation by crabs and lobsters have a destructive effect on the setup. Shells were lost from the cups, other shells had died. To protect the shells from predation we mounted a plastic 1 × 1 cm mesh over the setup. On July 23rd the setup was redeployed.

Since then the set up was running fine until October 25th when all signal and connection with the underwater node was lost. This had to do with loss of power to the underwater station. It took until mid December that the connection could be re-established.

So far we have collected data series of valve gape with a minute resolution up to the end of May, from end of July until October 25th and in a third period from December 13th up to February 23rd. Although the technical part of the equipment is working fine, the gradual loss of signals, i.e. as time passed by is partly unexplained. This signal loss of certain channels can partly be attributed to crabs and lobsters, which is confirmed by a diving inspection showing the damaged and torn apart mesh over the setup.

The data collected in spring show a gradual increase in gape activity in early spring. The limited dataset collected in autumn supports the observations made in northern Norway that the shells become dormant in winter and autumn and are only intermittently active for short periods of time.

4. Dissemination of the results

Early attempts to get the NIOZ ICT department making an application to visualise the data, a shortage of manpower made it necessary to organise this differently. Therefore a R script has been written which automatically downloads the data from the AWI server. This first application which has been build can be incorporated into any website to visualise the most recent gaping activity of the clams (**http://www.rforscience.com/vg/1/** and **http://www.rforscience.com/vg/2/**.)
Further dissemination of results will take place in the form of scientific articles and presentation at the international conference on sclerochronology 2019 (http://jadran.izor.hr/isc2019/index.html).

Other possible submission deals with day-night changes in species composition at Smartbay.

5. Technical and Scientific preliminary Outcomes

Introduction

Arctica islandica as a bivalve has to open its valves a bit, to feed and respire. By measuring valve gape one thus can get an impression of the activity of a bivalve over time, i.e. a behavioural response. Insight in the response to variations in the environment can thus give insight in the factors which regulate the functioning and growth of bivalves. Ultimately such behavioral responses can be used for environmental monitoring of for instance water quality.

The experiment conducted here had a two fold intention: first test whether the newly designed equipment is working properly and could be connected to the Helgoland underwater node and secondly to collect time series of valve gape to be compared to similar series collected in northern Norway.

Method

Valve gape has been determined by measuring the electromagnetical field between two electronic coils glued on to the shell at the siphon side of the shell. The strength of the electromagnetic field between the coils is a measure for the distance that the coils are separated and thus how far the both valves are apart from each other. Valve gape is expressed as fraction open, i.e. for comparison of different animals the signals are rescaled to vary between 0 and 1.

Valve gape opening has been measured with a ~1 second frequency. These ultra high resolution data have been saved and collected in data files representing 1 hour periods. For data analyses the "seconds" data have been aggregated to minute data by calculating the average valve gape in that minute. For further analyses the minute data have been aggregated to daily data. A brief comparison has been made between the averaged daily valve gape signal and the environmental variables.

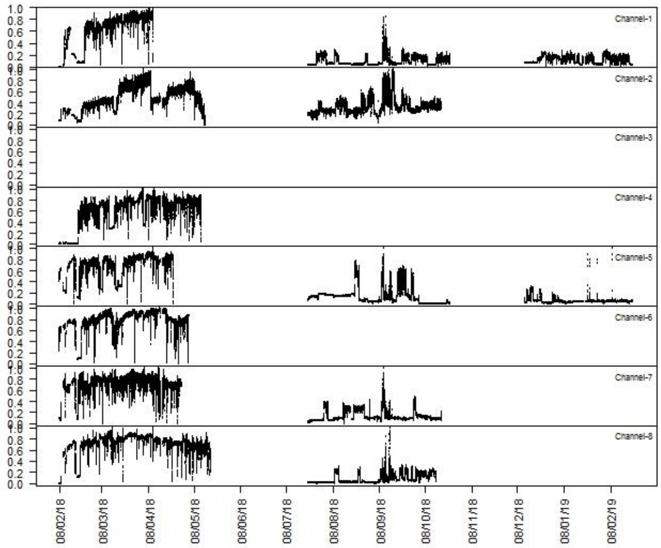

Fig.1. Raw Gape data

Results

Figure 1 depicts the valve gape data (by minute) which has been collected in the period between February 2018 and February 2019. There are two main gaps in the data. The first gap falls between end of May 2018 and end of July 2018. The second gap falls between October 25th 2018 and December 13th 2018. The first gap in 2018 is related to damage to the set up caused by predating crabs or lobsters. The second gap is related to the loss of power because the supply cable to the underwater node was abraded.

Apart from these gaps is also visible that some of the individual measurement channels had problems as well. Channel 3 for instance never functioned properly. Channels 4 and 6 only yielded data between February and end of May. Channel 2, 7 and 8 did yield reliable signals since the power cut in October. In the spring period most channels show a tendency of increasing valve gape over time. Especially the data gap in spring is a pity as this is the most interesting period in terms of changing hydrographical conditions.

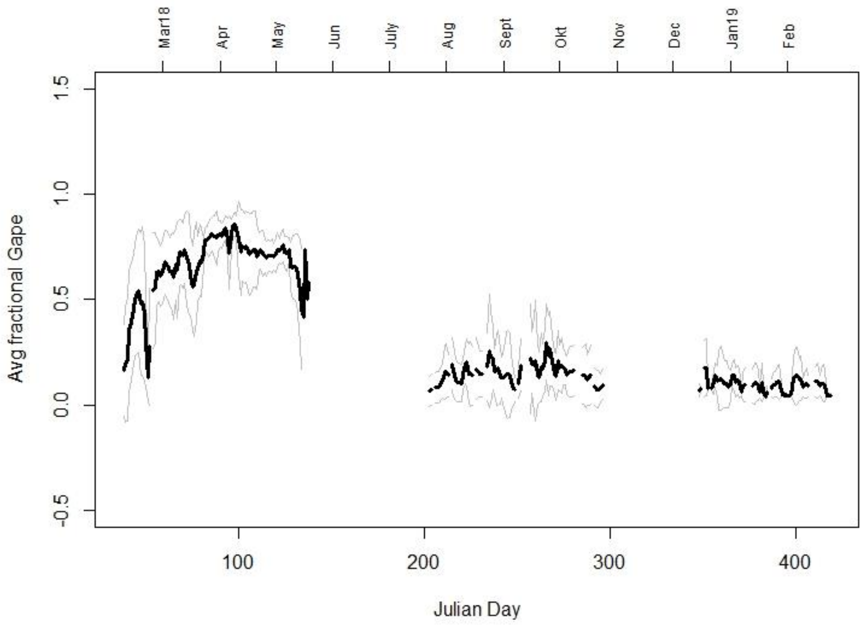

Fig 2. Aggregated Gape data. Black line average Valve gape values. Grey lines indicate standard deviation.

Figure 2 gives the daily averaged valve gape for all specimens together. The pattern up to the end of May shows first a gradual increase in average valve gape values followed by a gradual closing. The average gape in the spring period was 65%. Between July 2018 and February 2019 the average valve gape fraction was only 0.13. This pattern supports what has been found in northern Norway.

Numerical analyses (Fig. 3) of these average gape values against the main environmental parameters (Temperature, Salinity, Chlorophyll and Turbidity) shows an inverse relationship between Gape and Temperature and a linear relationship between Gape and Salinity. Salinity and Temperature are strongly correlated with each other so it is impossible to separate between the effects of these two.

Arctica islandica is a boreal species, with an upper temperature limit of approximately 16°C. The strong decrease in average valve gape in the summer when compared to the early spring is therefore not unexpected and could well fit with the biology of this species. The low correlation between Gape and Chlorophyll was however unexpected and might suggest that either food supply is not limiting, or other factors play in this setting a more important role.

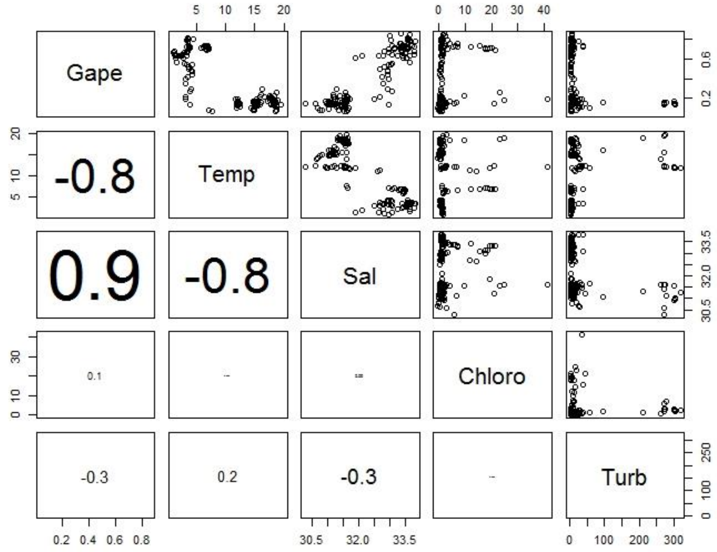

Figure 3. Pairs plot showing the correlation between the average valve gape (as depicted in figure 2) against the main environmental variables measured at the Helgoland underwater node.

SUBMITTED, 11 MARCH 2019