# DETERMINING THE FEEDING RATE OF THE *OCINEBRELLUS INORNATUS* ON *MAGALLANA GIGAS*

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## SUB-TITLE

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# Contents

# 1. INTRODUCTION

The RAAK MKB ''Leren leven met de oesterboorder'' project was initiated by the HZ University of Applied Sciences and the Nederlandse Oester Vereninging. A consortium was formed (consisting of the lead HZ University of Applied Sciences, 14 Zeeuwse oyster farms and the interest group Nederlands Oester Vereninging and knowledge institute Wageningen Marine Research and Hogeschool Van Hall Larenstein) to answer the research question ''With what cultivation measures can the revenue of on bottom oyster farming be increased in the production area Zuidwestelijke Delta where the high predation pressure of the Japanese oyster drill is present?'' This project is being executed to help the Dutch oyster farmers with the loss of production due to the Japanese oyster drill (*Ocinebrellus inornatus*) that feeds on the Pacific Oyster (*Magallana gigas*) and Flat Oyster (*Ostrea edulis*) in the Oosterschelde.

## 1.1 BACKGROUND

The Japanese oyster drill was introduced in the Netherlands by imported oysters. In the Netherlands it is considered an invasive species as it has no natural predators and thus can reproduce freely (Titselaar, 2013). The Japanese oyster drill has a shell that can reach 50-60 mm in height (Lützen, Faasse, Gittenberger, Glenner, & Hoffmann, 2012) and has an optimal temperature of 16 to 18 degrees Celsius. The Japanese oyster drill drills a hole in the shell of oysters and then feeds on its flesh (Lord, 2014). The oyster sector is an important part of the Zeeuwse export industry and the loss of oyster farming would have a significant impact from a socio-economic aspect and would damage the image of Zeeland (HZ University of Applied Sciences, 2017). The culturing of oysters in the Netherlands is traditionally done in on-bottom culture plots (VISwijzer, sd). Part of these plots have been designated for oyster cultivation since the time of Napoleon (Nederlandse Oestervereniging, sd). Other then the oyster drill there are cultivation issues such as the Herpes virus (OsHV-1) which slows the growth of oysters. Currently there are ongoing experiments with off-bottom culture being executed. This cultivation method may also be useful to control the oyster drill problem (HZ University of Applied Sciences, 2017).

## 1.2 AIM AND MAIN QUESTION

It is very important to find fitting tools to the problem of decreased revenue, which has estimations of losses from 50% up to 80-90% according to different sources (HZ University of Applied Sciences, 2017). The aim of this research is therefor to provide the oyster sector with practical solutions and to get a scientific baseline of knowledge on the Japanese oyster drill. The following report focusses on determining the feeding rate of the Japanese oyster drill on half format oysters and oyster spat in a lab setting. Determining the feeding rate can be of great importance to finding a tool to counteract the high mortality rate in oyster cultivation currently present. Therefor the following research question has been proposed:

<u>What is the feeding rate of the *Ocinebrellus inornatus* when preying on *Magallana gigas* in a controlled lab setting?</u>

To answer the different aspect of the research question and in order to get a complete overview the following sub questions have been formed:

- What is the average time before the *Ocinebrellus inornatus* starts drilling?
- How long does it take for the *Ocinebrellus inornatus* to drill through the shell of a *Magallana gigas?*
- What is the average movement time on a *Magallana gigas* before the *Ocinebrellus inornatus* start drilling?

# 2. MATERIALS AND METHOD

In the method below a description is given on the experimental set-up. This experiment has been designed to answer the proposed research question. It is a pre-study to determine if the feeding rate, the first moment of drilling, and the moment of puncturing the shell can be found. As previous research has shown that the oyster drill acts differently in a lab environment, it is important to design the method to resemble natural circumstances as much as possible.

## 2.1 ACCLIMATISATION

The experiment was set up in a climate room at the HZ University of Applied Sciences in Vlissingen.

The oyster drills used in this experiment where retrieved directly from the Oosterschelde by oyster farmers. The decision was made to use drills that are submerged continuously as there are indications that the condition of these oyster drills is better than the ones from the tidal plots, in the period this experiment was carried out. This is important as the feeding rate might be greatly influenced by the condition of the oyster drills during winter period. The Japanese oysters, half grown format and spat, that were used in this experiment are also provided by the oyster farmers from culture plots in the Oosterschelde. For the oyster drill the sizes were dependent on what the farmers provided. However, a selection was made to keep the sizes as similar as possible, size class of 36 to 47 mm. The size class of the half grown oysters was 44 to 81 mm length. The size class of the oyster spat was between 9 and 19 mm in length

To use controlled settings the organisms had an acclimatisation period before the experiment began in which the water temperature was raised to 18$^oC$ at a rate of 2$^oC$ per day in a climate room to ensure the temperature increased as gradually as possible. This is done to raise the temperature of the oysters and oyster drills from the sea water to the optimal temperature to achieve the highest activity of the oyster drill (Lord, 2014). At the same time a starvation period of a minimum of 4 days took place prior to the start of the experiment. The acclimatisation took place in the plastic cups that were also used for the experimental set up. This to limit the disturbance to the oyster drill at the start of the experiment. The water temperature was increased at the same rate for the oysters, but they were put in a larger tank after which they were placed in the cups when the experiment started. The oysters were fed with an algae (*Tetraselmis suecica*) suspension by hand both during the acclimatisation period as during the experiment. The feeding of the oysters is done once a week to limit disturbance, to keep the amount of faeces as low as possible and to prevent the oysters of spawning. Additionally, oxygen was added throughout the experiment to ensure a surplus to limit the influence of this variable on the experiment. During the experiment new oyster drills and oysters where brought into the climate room, these were acclimatised in a separate container until the water temperature was raised to 18$^oC$ and had a starvation period of 4 days. After this the new oysters and oyster drills where put in the separate back up aquaria with the already present oysters and oyster drills. After 3 weeks the oyster drills from the start of the experiment that had not yet been used were replaced by fresh oyster drills as it was expected that they had started to be conditioned to living in the enclosure.

## 2.2 EXPERIMENTAL SET-UP

One oyster drill was put in a plastic cup together with one oyster for a total of 32 cups (see figure 1). The cups were separated in groups of eight by a barrier to lower the disturbance and stress as much as possible when measurements were done or algae was fed. Additionally, previous research has shown that only small disturbances can cause the oyster drill to stop drilling, so the cups were put on Styrofoam. The Styrofoam mitigates the vibrations caused by for example the air pumps or walking around. By limiting the amount of movement, it is expected that the oyster drills were not disturbed and thus kept feeding until they were done. In addition, an aquarium with 15 oyster and 15 half grown or in the second part of the experiment 30 oyster spat individuals were used to see if there is a difference in feeding rate when competition is present. The aquarium was also separated from the cups with a barrier and put on Styrofoam (see figure 1).

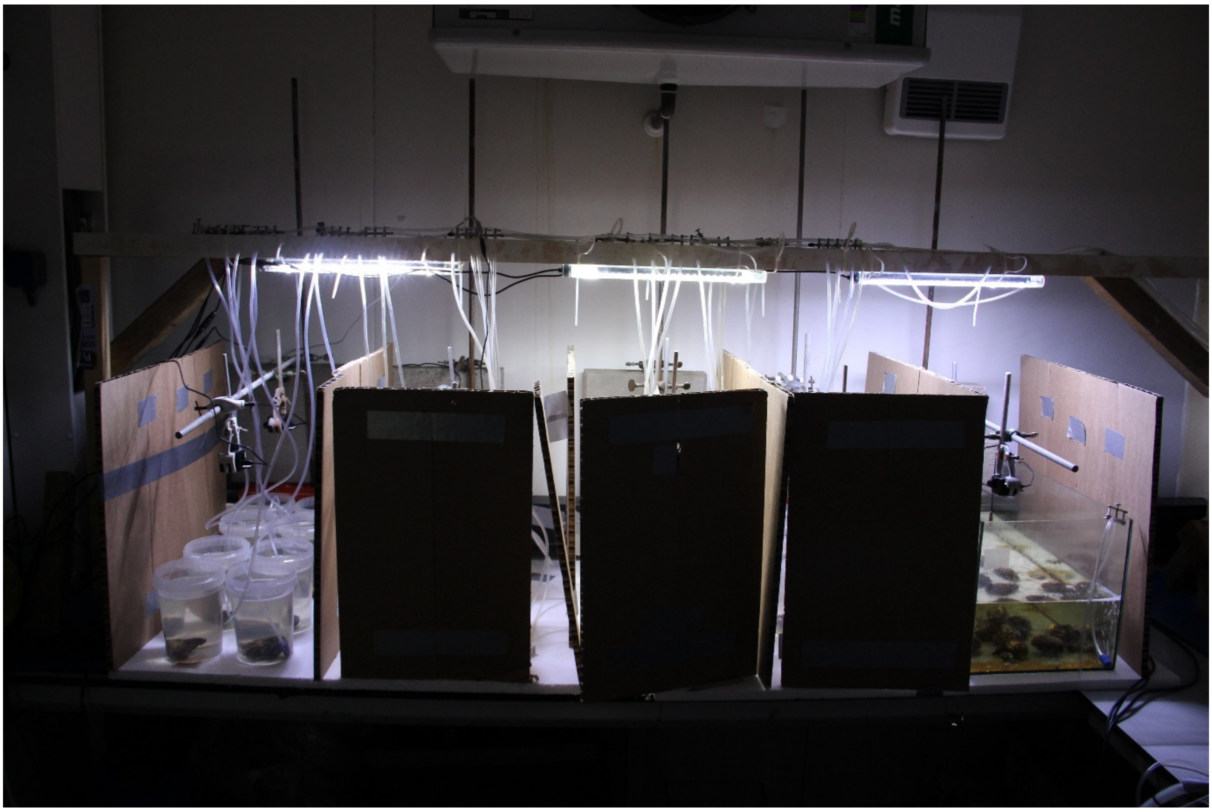
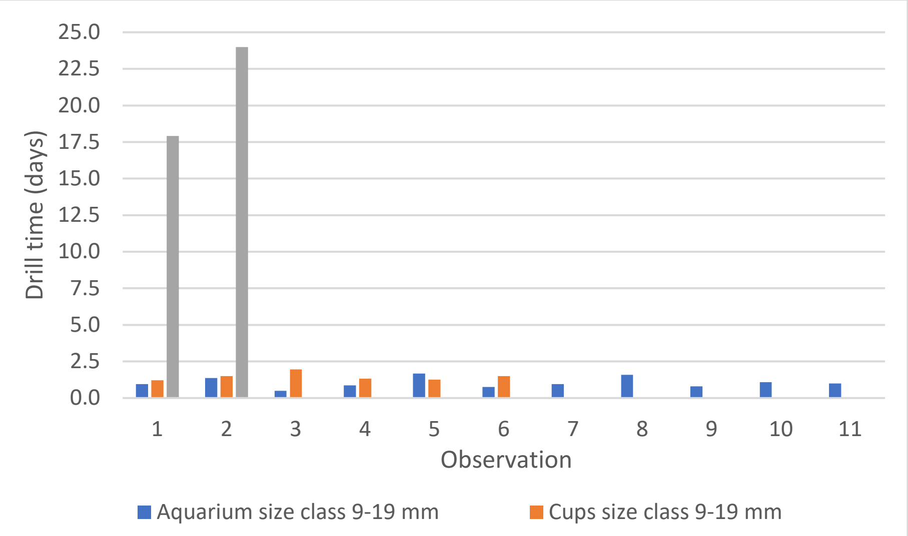


**Figure 1: The experimental set-up** ***(Source: Luc Kauhl)***

The experiment duration was dependent on the time that the oyster drills needed to feed. To determine how long it takes for an oyster drill to drill through the oyster a sampling plan is set. With the use of a GoPro (Hero session and Hero session 5), mounted above the cups there should be first determined when an oyster drill has been sitting in one location on the oyster. If the oyster drill is sitting for 24 hours on the same location on the oyster, the cup will be taken out of the experiment. The oyster drill and the oyster will be visually checked on possible drilling. To determine if the dimensions are of influence on the drilling the dimensions of the oyster drill and oyster are measured. The measured dimensions are fresh wet weight (g) length and width (mm), and for the oyster also thickness (mm). In addition to this, the depth of the drilled hole was measured by using a toothpick, which was placed in the hole, marked and measured with a calliper. The sampling will have intervals of 24 hours and the first measurement moment will be at 24 hours. The interval of 24 hours was repeated until a hole was found. The decision was made to put a light source above the experiment that gives a continuous light intensity to ensure the pictures the GoPro's makes pictures that are as clear as possible. The memory cards of the GoPro's where also emptied after they were full (2 days) during the afternoon to keep disturbance limited and regular. In addition to the GoPro's a ledger was kept with visual observations on when the oyster drill went onto an oyster and to keep any interesting observations organised. For each time period multiple samples will be taken to ensure validity of the experiment and to provide with a clear time line on when the drilling starts, when they drill through the shell and when they finish feeding. The experiment is of a destructive nature, the oyster drills that are taken out will not be re used to prevent conditioning.

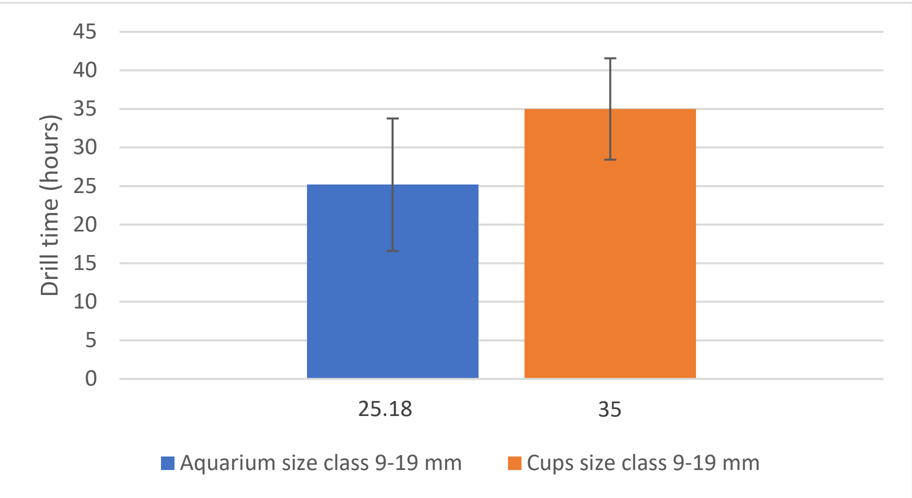
# 3. RESULTS

In graph 1 the results that have been gather up to this moment can be found. The size class 9-19 mm are the here fore called oyster spat and the size class 64-81 mm are the here for called half grown oyster. The graph shows the time each oyster drill needed to fully puncture the shell. Graph 1 also shows that there is a higher response rate for oyster spat, which has 17 eaten individuals, then for half grown oysters which only has 2 eaten individuals. As can be seen the half grown oysters takes a longer time to be punctured and eaten then the spat. The average time for the 2 oyster drills that have punctured the shell is 21 days. The average time for the 17 oyster spat that have been punctured is only 30 hours. It should also be taken into account that the half grown oysters where in the experiment for 6 weeks and the oyster spat only for 2 weeks.




**Graph 1: The drill time per size class for each observation**

Graph 2 shows the average drill time of the oyster drill on oyster spat. The standard deviation for the aquarium is 6.6 hours and for the cups is 8.6 hours. In total 11 oysters where drilled through in the aquarium and 6 where drilled though in the cups. There is a difference visible between the time it drills in the aquarium and the time it drills in the cups. On average the oyster drills in the aquarium needs less time to puncture and eat the oyster. It was also noted during photo analysis to determine drilling time that in the aquarium a number of oyster drills pushed each other of the oyster when it was punctured.




**Graph 2: The average drill time on size class 9-19 mm**

# 4. DISCUSSION

The results have been gathered in lab circumstance to be better able to monitor and regulate the experiment. The results show that there is a relatively large difference between drill time on oyster spat and on half grown oysters (30 hours for spat and 503 hours for half grown oysters). The amount of half grown oysters that where drilled through however is to low to draw a conclusion of that is significantly supported by the underlying data.

The average drilling time on the oyster spat in the aquarium (25 hours) and in the cups (35 hours) show that there is most likely a relation between drilling time and competition. The oyster drills in the aquarium also showed they pushed each other of the oyster to eat the oyster itself and after they went of the shell was found empty after only sitting on it for 3 hours in one case. This strengthens the expectation that there is competition between the oyster drills. The standard deviation, 7.5 hours for the oyster spat and 103 hours for half grown oysters, of the results is still relatively high and further research should be conducted to find a better relation. As was stated in the results the timespan the different size classes have run is also different, this means that if the oyster spat trail has run the same time as the half grown oysters it will become clear how much more oyster spat has been punctured in relation to the half format oysters. In addition, only the fully punctured holes have been considered as there was not enough data available to draw any conclusions of the not fully drilled holes.

When comparing the drill speed with *Nucella lapillus* (Dog whelk) a similar feeding rate is found. The dog whelk, with an average size of 1.97 cm at a temperature of 20 degrees Celsius, needed on average 63 hours to drill and feed on a *Mytilus edulis* of 2.6 cm length on average (Bayne & Scullard, 1978). The size of the prey is larger and the dog whelk is smaller than the individuals used in this research however. The difference in prey and size makes it difficult to draw any definitive conclusions from this.

# 5. CONCLUSION AND RECOMMENDATIONS

To conclude, the feeding rate is highly dependent on the size class of oyster. For the half grown oysters the feeding rate has been determined to be on average 503 hours, for the oyster spat without competition it is determined at 35 hours and for oyster spat where competition is present the feeding rate is determined to be 25 hours. There is a relation present between feeding rate if competition is present. The sub questions of this report cannot be fully answered yet. It is therefor recommended that the research is continued with a focus on the following aspects: there should be determined more accurately what the feeding rate when preying on the half grown oysters. This can be done by continuing the current experiment to get more results increasing the accuracy. The same should be done for the oyster spat, increasing the number of observations of fully drilled spat will further strengthen the accuracy of the feeding rate. The time intervals of the observations should also be lowered to 2 hours to find when the oyster drill starts drilling and when it starts feeding. In addition to strengthening the results further research should be conducted to see what the influence of competition is both on oyster spat as on half grown oysters. This could be important to finding tools to handle the oyster drills as lower competition may decrease the amount of oysters being eaten due to longer feeding rates. Further research should also be conducted on finding alternative ways of determining the feeding rate in the field. At this moment it is unclear if there are any differences between the feeding rate in the lab and in the field which can be solved if a comparison can be made by finding a method which can be applied in both settings.

# 6. REFLECTION

In this chapter I will reflect on what I could have done better in relation to my learning goal. The decision was made to use the following 21st century skill to improve over the duration of this minor program: ''10.B.1.b Manages time and projects effectively''. I think this is a good skill to improve for myself as I tend to lose focus on what I should be doing and therefor not make my deadlines. This chapter will include a SMART description of the learning goal and a reflection on what went well and what I need to improve.

## 6.1 SMART LEARING GOAL

| | |
|---|---|
| Specific | Because of the short period of my minor and the fact that I want to do an experiment it is very important to plan the project thoroughly. The aim is to determine the feeding rate by setting up a lab experiment. This experiment needs to be monitored on a regular basis and analysis needs to be done at the same time. At the end of the experiment a final report needs to be written.<br>My goal is to finish this experiment and write my report meeting the deadlines which where set at the start of the minor. |
| Measurable | Progress can be measured by looking at if the results are being processed continuously and by seeing if I can achieve the deadlines without having to move them. Additionally, progress of the experiment can be monitored. As soon as something has to be done or prepared it should be done as soon as possible and be prioritized correctly. |
| Achievable | The set goal is achievable. I will need to improve my prioritization and time management skills by continuously looking what I can do or improve. This includes seeing if there is anything to do at moments that I do not have any practical work such as organizing results or interpreting them. It is also important that I make a list for myself of what is most important that day and what can wait and update that every day. |
| Relevant | It is important to learn how to make and follow a good planning and how to prioritize tasks in order to be able to conclude a project in the time available. If time management is not properly performed, then it will not be possible to complete a research in the allotted time. If this happens a part of the research cannot be completed. |
| Timely | I want to achieve my goal before the end of my experiment. This gives me time to make a planning and have a couple of reflection moments. During these reflection moments I will have to look at what I can improve and how to do that.<br>I think this goal is achievable in the time that is available. |

# 6.2 CRITICAL SELF-ASSESSMENT

During the first week of the experiment I had some difficulties in following the planning and prioritizing what was most important. I had not considered unexpected set backs while that should have been in my planning as this often happens in practical experiments. I had also not put my planning on paper meaning that I forgot about certain things and it was a lot more difficult to prioritize correctly. In the end I did manage to complete all the tasks that where important such as completing the set-up and starting the monitoring, but it was not done in the most efficient way and cost more time than necessary.

The second week I changed a few things in my approach. To start I made a word document in which I made a list of things I had to do daily and which priority they had. This improved the efficiency of my daily routine but if there where unexpected events I still found it difficult to decide on what to do first and this lead to having some minor problems on the longer term such as not having enough water that was brought to the correct temperature to restart the aquarium.

During the final weeks of the experiment I think I managed to think ahead more efficiently. I made a long-term planning in which I incorporated time for unexpected events such as going into the field or helping someone with their experiment. I think I also got more efficient and flexible in my day to day planning, I was better able to put aside things that where less important at that specific time to be able to do what was important.

I think that in the end I achieved my learning goal of managing time and projects efficiently. There are still some things to improve. I think that in the future it is important that I start writing my report earlier in the experiment and to find a more efficient way of asking questions to my supervisor. During this period, I have waited with writing my report until the end of my minor period, and although I do have enough time left, it is better to start earlier to cope with unforeseen circumstances. In addition to this I think that it would be better to save my questions and ask them all at once. This would further increase the efficiency of using my available time. However, I think that I managed to improve a lot as well. I was able to make a planning that was efficient and practical. I also was able to be flexible when necessary and still do what I had to do each day and think ahead of what I needed to do the next day as well and whenever possible prepare for that.

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