An investigation of freshwater macroinvertebrates to assess water quality at Lake Viljandi

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Abstract

At first we caught the freshwater macroinvertebrates in Lake Viljandi and a pond connected to it. We tried to identify them, and count the taxons present at both of the sites in a span of 30 minutes. After that we rated the water quality of the sites with a protocol of freshwater invertebrates as bioindicators.

After conducting the experiment in both locations and analysing the information we understood that our first hypothesis, about finding a bigger amount of species of macroinvertebrates in the pond, had been wrong. We caught 19 taxons of freshwater macroinvertebrates in the pond, but we found 22 taxons of freshwater macroinvertebrates in the lake.

Our second hypothesis had been correct. According to the bioindicator protocol, the water quality in the pond had gotten a score of 32 points, meanwhile the lake had gotten a score of 46.

Introduction and Review of Literature

Our project concentrates on comparing the macroinvertebrate fauna of Lake Viljandi and a pond connected to it. We wanted to compare the biodiversity, the amount of organisms, and also what the presence of those organisms indicate about the water quality and the overall environment. The place, where the pond connected to the lake, is about 150m (Google.(n.d.) measure distance, retrieved 18.08.2020 from https://www.google.com/maps/@58.3386356,25.587864 7,18.29z) from the second location, where we conducted the experiment.

This is an important topic to research because macroinvertebrates are easy to examine and can give some information about the environment of the water. Macroinvertebrates are animals that lack a backbone and are visible without a microscope (Michaluk, 2016). If a similar experiment was conducted every year, it could show how the environment of the bodies of water has changed, and helps investigators to make explanations why that is so.

Lake Viljandi is a remnant of a glacial river which means that this lake is of glacial origin. (Republic of Estonia Environmental Agency, 2018). The maximum depth is 11 meters, and the lake's

maximum length is 4000m and the maximum width is 450m. The lake's main inflows are Uueveski, Viiratsi and Valjuoja streams, and the main outflow is Raudna river. The water in the lake is translucent, the transparency is about 1 meter. Near the shore we saw eelwax, bog fern, cowbane, sorrel, water lilies and duckweed. According to “Eesti järved, nende elustik ja elukooslused”, this information says that Lake Viljandi is a dystrophic type of lake. A dystrophic lake is a lake that contains a lot of humic acids and has a natural evolution toward a bog. Their pH is usually 6-3. (EEA, n.d)

We also examined a pond that is connected to Lake Viljandi and is sometimes even considered to be a part of the lake, which means that the conditions in the two are quite similar. However, there are less species of plants in the pond since humans have removed some to keep it from turning into a bog. The area of the pond is about 6,340.37 m² (Google.(n.d.) measure distance, retrieved 18.08.2020 from https://www.google.com/maps/@58.3386356,25.5878647,18.29z).

Research Questions and Hypotheses

We speculated that the pond being apart from the rest of the lake would be warmer and more peaceful, considering that the bigger animals who would want to eat them would not go into the pond.

Henceforth we thought the pond would be a safer environment for the freshwater macroinvertebrates. However we did not consider the fact that the pond is very close to humans, who go swimming, make noise and also sail boats on the pond quite often which can make the aquatic animals’ life harder.

We thought that the lake would be cleaner since even though there were more people swimming and sailing boats there, the pollution would spread out evenly since the lake is a lot bigger than the pond. We wanted to identify the macroinvertebrates to find out how sensitive they were and according to that, find out how clean the water is.

The following research questions are posed:

“From which location will we find more taxons of freshwater macroinvertebrates in 30 minutes?”

“What do the species and biodiversity say about the body of water?”

Our hypotheses were:

“There will be more taxons of freshwater macroinvertebrates in the pond.”

“The species and their sensitivity will tell us that the lake has cleaner water and a more suitable living environment.”

Research Methods and Materials

For the macroinvertebrates, we used a D-net to catch them from the water and mud, three bowls to store and search for them, spoons to transport them between the bowls, cups and little jars with a magnifying lens on top to observe the organisms more closely.

Firstly, we went to the first location, which is a pond connected to Lake Viljandi. The coordinates of the location were: 58,3388290 N; 25,5881030 E (the red mark on Figure 1) .

Figure 1: the map of lake Viljandi with the first (the red mark) and second location (the yellow mark)

Screen capture from https://geoportaal.maaamet.ee/est/Kaardirakendused-p2.html

Before starting the experiment, we wrote down the temperature, sky coverage, cloud types, and the time of starting. This is because the weather might also affect the results in some ways, since the animals might be more active if the water is warmer. Unfortunately, we could not measure the water temperature, since the thermometer we were using did not give us the accurate data.

To catch the macroinvertebrates, we first put water from the pond in the bowls so the animals would feel comfortable in the same water as they are used to living in. Then, we started the 30

minute timer so that we would have the same amount of time in both locations. After that, one of us started catching with the D-net, moving it through the water in between the plants and through the mud, where most of the animals are (Figure 1). Then, they emptied the net into one of the bowls and the rest of the team started looking for the macroinvertebrates in the bowl using spoons. If we found any animals, we put them into another bowl with clear water and also tried to determine the species. (Figure 3) Since it is very hard to identify the exact species, we decided to identify them on a less specific level of taxonomy. For that we used “Pisiloomi magevees ja selle piiril” by A.Tuusti and R. Kristjan and “Insects of Britain and Wetern Europe by M. Chirney. We repeated the process of catching them from the water, searching for them in the bowl and determining the taxon.

Figure 2: Miina using the D-net inthe first location

When the 30 minutes were over, we counted the different taxons and also used the *“Identification guide to freshwater macroinvertebrates of Estonia”* bioindicator protocol. By adding up the amount of points every taxon of macroinvertebrate gave, we found out the water quality score of the pond. We emptied some of the bowls back into the pond but kept some of the more interesting finds in case we wanted to examine them later. We also used the jars with magnifying lenses to observe the smaller animals.

Figure 3: Us trying to determine themacroinvertebrates (photo aken by Agne Jõgis)

After that, we went to the second location at Lake Viljandi, which was about 150 meters from the pond. The second site’s coordinates are: 58,3400238 N; 25,5895712 E (the yellow mark on Figure 1 and Figure 4). There we repeated the same research process as in the first location .

Figure 4: The map of estonia with the locations of the experiment marked (screen capture from https://geoportaal.maaamet.ee/est/Kaardirakendused-p2.html)

Results

The results of the fieldwork were summarised (Table 1) and the two locations were compared to each other.

Table 1: the comparison of the taxons of macroinvertebrates we found in the two locations

The location	The pond	The lake
Air temperature	15.9 C°	18.5 C°
Sky coverage	70%	50%
Most common clouds	Altocumulus, Cumulus	Stratocumulus, Altocumulus
Time of starting catching	10:03	11:34
The properties of the locations	Exposed to the sun, near people, few trees, quite some water plants, many big rocks in the water	Isolated, in the shade, many trees, quiet, pretty shallow water

Taxons of macroinvertebrates, that were found only that location	*Nepa Cinerea , Haemopis Sanguisuga, Platyhelminthes, Asellus*	*Ephemeroptera* larva*,* Argyroneta aquatica (Figure 5), *Erpobdella octoculata, Chironomus plumosus larva, libellula larva, Notonecta glauca, Communis impuneque seligit, Nematomorpha, Dolomedes fimbriatus, Anisoptera larva, Physa fontinalis*
The score of the body of water according to *"Identification guide to freshwater macroinvertebrates of Estonia"* bioindicator protocol	32	46
The condition of the body of water according to *"Identification guide to freshwater macroinvertebrates of Estonia"* bioindicator protocol	*good condition*	*very good condition*

The taxons of macroinvertebrates we found in both locations are: *Hydrachnidia (Figure 6), Lymnaea stagnalis, Tipulidae* larvae*, Viviparus contectus, Dytiscus, Coleoptera* larvae*, Gyrinus, Coleoptera, Trichoptera* larvae*, Gerridae.*

Since we found a lot more different species in the lake, we had suspicions that the lake was a better living environment even before calculating the scores. There were a lot of macroinvertebrates that we found in both locations, because of which we also thought that the living environments and the water quality must have been quite similar. One of the most common macroinvertebrate was *Hydrachindia,* who was the most common animal in both of the locations. Another thing we noticed was that while catching the animals at the second location, with every netful of mud and macroinvertebrates in it, we found more new species, whereas in the pond the taxons of macroinvertebrates we caught were more repetitive.

Figure 5 :The Argyroneta aquatica we found in the lake (left) (picture taken by Grete Käärik)

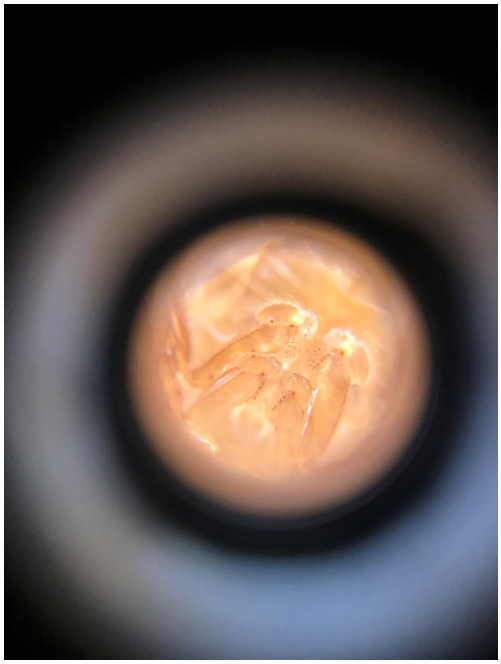

Figure 6: The Hydrachnidia we found (right) (picture taken by Grete Käärik)

Discussion

The answer to our first research question (From which location will we find more taxons of freshwater macroinvertebrates in 30 minutes?) is that we found more taxons of macroinvertebrates in the lake. This proves our hypotheses wrong (There will be more taxons of freshwater macroinvertebrates in the pond).Upon reflection, the result is quite logical since the pond is more polluted by people swimming there and using boats. It is smaller and people riding pedal boats on the pond does not make the animals' life better. It is also quite noisy and the bottom of the pond does not have as much mud in which some animals like to be. Hamerlik and his colleagues (2013) investigated if the amount of macroinvertebrates in ponds and lakes differ.

The lake on the other hand is very big, and at the place, where we caught the macroinvertebrates, was very peaceful and quiet. However, we had not thought about that much and concentrated on the assumption that the pond is probably warmer, since it is smaller and the water does not move as much. Considering the fact that macroinvertebrates are exothermic (Michaluck, 2016), they should be more active in warm water since they do not use their energy to heat themselves up and depend on the environment. We did not think about the matter that all the animals do not like warmth and may be adapted to colder temperatures, which may mean the lake would be a more comfortable environment for them.

The answer to our second research question (What do the species and biodiversity say about the body of water?) is that the taxons of macroinvertebrates can say many things about the water quality. For example, if in the body of water under observation there are some taxons of macroinvertebrates that are very sensitive and require a clean environment to live, the quality of the water should be quite good. The protocol we used (*"Identification guide to freshwater macroinvertebrates of Estonia")* works on a similar principle. The protocol has a list of some more sensitive animals that live in the Estonian waters and gives a certain amount of points for them, giving more points for the more sensitive ones. We counted how many of the ones mentioned there we found and added up the points. Then, we looked at the scale that said what the amount of points says about the water quality.

Therefore, our second hypothesis (The species and their sensitivity will tell us that the lake has cleaner water and a more suitable living environment.) was true. After adding up the points that the lake got according to the bioindicator scale, the result was 46, while the pond's result was 32, which is a lot less. Although both of the results are considered *good*, the lake's result is considered *very good*. This is not very surprising since most ponds are usually more polluted or less clean than some bigger bodies of water. However, the day before our fieldwork another team had found two macroinvertebrates in the pond that would have raised the pond's score significantly, so that its water quality would have been considered *very good* as well.

One of the macroinvertebrates that we only found in the pond was *Nepa Cinerea,* who is actually capable of flight although they usually do not do that since their flying muscles are too weak. Sometimes they fly to another habitat if it is necessary. ("Aquatic Heteroptera Recording Scheme for Britain and Ireland";"Nepa Cinerea"; n.d.)

Another macroinvertebrate we only found in the pond was *Haemopis Sanguisuga* who is also quite sensitive to some chemical traces in the water and lives in clean freshwater bodies. (Naturespot; ”Horse Leech”; n.d.)

Some of the macroinvertebrates were only found in the lake, such as *Ephemeroptera* larvae, who are quite sensitive to water quality changes, and because of that gave 10 points in the bioindicator protocol. They have many nymph stages and two flying stages which are the subimago and imago. They are unique since they also have three caudal filaments or tails. (Salles, 2000). *Argyroneta aquatica*, another macroinvertebrate, we found in the lake uses the hair around their abdomen to create an air bubble and use it as an oxygen reserve since the breathing organs are located in their abdomen (Bristowe, 1958).

Our research also has some weaknesses. For example, we only had 30 minutes in both of the locations, which may have led to us finding less different taxons of macroinvertebrates than if we would have caught them over a longer time period. This is supported by the fact that on the previous day of the expedition another team had found more taxons of macroinvertebrates in the pond than we had. Also, their work at the same location on the previous day might have disturbed life in the pond, affecting our results. The results also would have been more diverse if we had had more experience with catching them, which may also be a reason we found less different taxons in the pond, which was our first location.

If we would have to repeat the project, there are some things we would do differently. Firstly, we would like to choose more locations where to do the fieldwork or choose sites that are not connected, like the pond and lake were. By doing that, the data would be more thorough and the results might turn out more different and interesting. We also would like to give ourselves more time to catch the macroinvertebrates so we could find more of the species that live in the water bodies. We were not sure how much time it would take to get accurate results. At first we thought five minutes would be enough, but fortunately we raised the time limit to 30 minutes which still may have been too little time. The next time we would also have more experience, since when we started catching the animals at the pond we did not really know what we were doing and this might be a reason why we found a lot more organisms at the second location. Finally, something we should have done in the interest of the macroinvertebrates is not leaving them in the bowls while we were away because when we came back to take pictures, most of them were already eaten by the others and the *Dolomedes fimbriatus* had walked away.

The results of the project would be more trustworthy and interesting if we checked the water’s quality with some other indicators (such as chemical indicators) to see how accurate the bioindicators are since there may be other factors that affect the animals besides the water quality. For that we would also have to take samples of the water at the locations where we caught them. By doing that we could find out which aspects of the water affect the macroinvertebrates the most and what exactly makes the water quality good. It would be a good idea to consult with one of the other groups of the expedition, whose topic was water chemistry and see if they took any samples near our investigation spots and if we could draw any conclusions with their data.

Conclusion

The results of our project show many things about the two bodies of water we examined and inspected.

The results show that the lake's environment is suitable for a lot of different macroinvertebrates, and according to *"Identification guide to freshwater macroinvertebrates of Estonia"* the water quality there is very good. The fact that the living environment in the lake is better may not be only because of the water quality being better. The location by the lake was a lot quieter and isolated from humans, who make noise and might disturb and drive away aquatic animals.

Since we found less different macroinvertebrates and less sensitive ones in the pond, the pond's living environment is not that good. That may be caused by the holiday village being quite near to the pond and people making noise. It could also be caused by the water quality, but since the bioindicators only tell us about the quality of the whole environment, we can not be sure, whether it is caused by human activity or the quality of the water. That is why it would be interesting to also study the chemical indicators of the water in both locations.

Unfortunately there is not a lot of public information about the macroinvertebrates that live in Lake Viljandi, or about the quality of its water as a living environment for animals. Because of that it is hard to compare our conclusions about the lake with someone else's. However, it has been stated many times that Lake Viljandi has great water for swimming and is quite clean, which supports our conclusion that the water quality there is very good.

It would also be interesting to run the same experiment near the public beach in the City of Viljandi. Probably we would not find many macroinvertebrates there because of the amount of human activity.

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