Application of Forensic Ecology with Diatoms Living in the Water Masses in Northern Finland

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Introduction:

Diatoms are unicellular organisms with a silica cell wall, called a frustule, that live in aquatic environments. The two classes of diatoms are pennate and centric which are distinguished by shape and size. Centric diatoms are cylindrical in shape and radial symmetry whereas pennate diatoms have bilateral symmetry and vary in shape (Bellinger 2010). These Bacillariophyceae, the class which diatoms fall under, are useful in many ways, such as indicators of environmental change and forensic circumstantial evidence. As circumstantial evidence diatoms are used as an indicator of whether a victim was drowned (Dodds, 2002). A drowned victim will have diatoms living in their lungs where the water also bursts vessels allowing diatoms to be sent throughout the body. However, a victim who was deceased prior to being submerged would lack the deep-rooted diatoms in their organs.

Diatoms make up part of the biofilm, a brown slippery coat found on rocks at the bottom of streams (Cushing & Allan, 2009). A popular forensic case occurred in 1991 where two young men were attacked by multiple assailants (Siver, Lord, & McCarthy, 1994). The leading evidence that was used to link suspects to the crime scene was microorganisms analyzed from sediments found on the footwear of the suspects. The dominant Bacillariophyceae were found both in the common water source and sediments providing enough evidence to tie the suspects to the crime.

Forensic ecology is the use of ecology to develop an understanding of the environment in a criminal investigation. This research will be focused on the diatom species in Kilpisjärvi, and surrounding bodies of water including Lake Saana and Leena's Pond. We are applying the concepts of forensic ecology to identify whether diatoms can be used to specify the location of a crime scene. The use of diatoms in forensic investigations is limited due the lack of scientific research.

Methods:

There were six water samples collected from various areas around the Kilpisjärvi Biological Station. All water locations were chosen based on ease and direction of approach. Collection was done with clean, plastic vials and Whirlpack™ bags which were all stored together at -14 ℃. Water collection devices were cleaned with the water at the specific sites prior to collection. The six locations were:

- Lake Saana
- Lake Kilpis
- Leena's Pond
- Excavation site #1 North of research station
- Excavation site #2 West of research station
- Creek #1 from Mount Saana

After collection, each sample was analyzed under an inverted microscope for classification and identification of diatoms. Into a clean, clear dish 3 mL of sample were placed into the dish for observation. Only three water samples contained different diatom populations. The three used for analysis were Lake Saana, Excavation Site #1 North of research station, and Excavation Site #2 West of research station. Approximately the three contained 10 different types of diatoms.

Results:

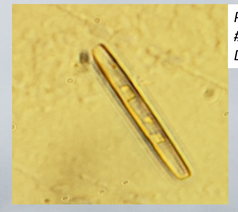
As displayed in Figure 4, there were only three collection sites that contained diatom variation. Of the six water samples collected only three yielded diatom population. The three samples that contained diatom life was from Lake Saana, Excavation Site #1, and Excavation Site #2. Lake Saana contained the most diatom life which were collected from biofilm off a rock which yielded 10 different diatom types. Excavation Site #1 was collected similarly as the biofilm from a rock yielded 8 different diatom types. Excavation Site #2 yielded the least with only 7 different diatom sites from a leaf collected at the bottom of a water site. These results can be viewed in Figure 4.

Figure 2 showcases the observed communities in the populations found in each collection site via pie chart for clear view of the most dominant species. The dark blue mass being the most popular of the sites. The most common population was *Fragilaria* which were found in the Excavation Site #2 and Lake Saana.

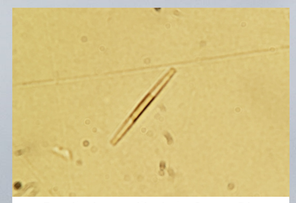
Research Questions and Hypotheses:

If diatom communities are location specific, then their use needs to be further explored. If not, then further research needs to be conducted as to what other uses can diatoms serve in forensic analysis.

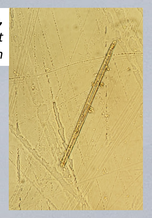
The main research question is: To what extent are diatoms useful in specifying a location? In order to test this question samples of water from different locations were collected and analyzed to identify if there is a population difference per site. The hypothesis is that diatoms are useful in determining water sites based on population but would be better used as supplemental evidence rather than main evidence.



P.similiformis, Excavation Site #1 North of research station Diatom



Fragilaria gracilis, Lake Saana Diatom



Fragilaria capucina, Excavation Site #2 West of research station

Discussion:

The question for this research was to what extent are diatoms a viable use of evidence in specifying location. First, of the diatoms found, the most common were the Fragilaria species which was found in both Lake Saana and Excavation site #2. This species could be further investigated to see how common they are in Arctic waters. In response to the hypothesis, the results from this research only answers part of the question since the data only reflects locations near the Kilpisjärvi research station. The observed individual diatoms were capped at 15 due to the lack of diatom life from the collected sites. What can be concluded in this research is that of the three collected sites there is a significant difference between water sites, which answers the research question that diatoms are useful in specifying a location of a crime scene with dominant diatom species. Thus, we can accept the proposed hypothesis. The differences in majority and frequency reveals a new question which is how these can be applied to further forensic investigations.

Errors that occurred was the method of collection, as there was a correlation between biofilm and diatom life with all water sites. The three collection sites where no diatoms were observed lacked biofilm environments, whereas the other three contained biofilm sites at or near the collection site. This also led to a suggestion for further investigation, which is to observe the correlation of diatom yield and location in the water sites, for example on rocks within the water or at the bottom of the body of water.

A suggestion for further research would be to see how well these diatoms adhere to clothing, since diatoms were mostly found on surfaces in water rather than in the water itself. Further research should include comparisons to waters not connected like Mount Saana and the excavation sites. The use of a scanning electron microscope could provide a better image for identifying a diatom species by comparison. Also the use of an inverted microscope with a camera would limit human error in inaccurately identifying a species or overlooking a diatom.

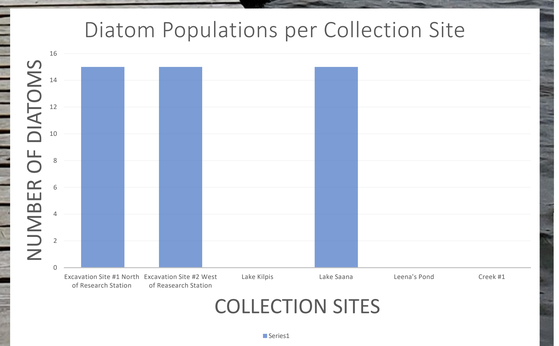


Figure 1: Graph of the water collection sites that yielded diatom life. Observed was 15 individual diatoms in three of the collected sample sites.

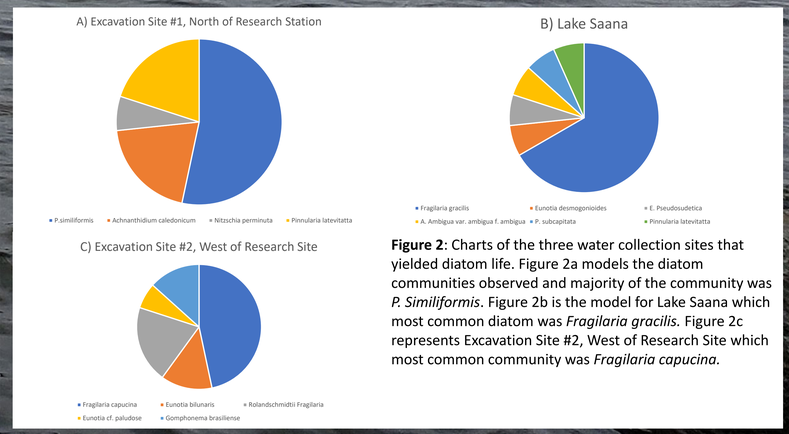


Figure 2: Charts of the three water collection sites that yielded diatom life. Figure 2a models the diatom communities observed and majority of the community was *P. Similiformis*. Figure 2b is the model for Lake Saana which most common diatom was *Fragilaria gracilis.* Figure 2c represents Excavation Site #2, West of Research Site which most common community was *Fragilaria capucina.*

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