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Seasonal patterns in abundance differ among ciliate taxa at Martha's Vineyard Coastal Observatory (MVCO)

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Why study ciliate seasonality?

Understanding the seasonal patterns in abundance of the organisms in our world allows us to study how the food web as a whole may shift over the seasons in the future. Plankton, microscopic marine drifters, make up the base of the marine food web, and are integral to the balance of the ecosystem. In this experiment, I am studying ciliates. Part of the phylum *Ciliophora*, all ciliates have cilia, or hair-like structures used for movement and feeding. Because of their wide diversity, delicate nature, and small size, the ciliates are very understudied. With their role as a low-level consumer, understanding how their seasonal patterns in abundance change is crucial to gaining insight in the complex marine food web.

Research questions

1) Are there seasonal communities of ciliates?
2) What is the seasonal pattern for each ciliate taxon?
3) What are the most/least abundant ciliate types in each season?

What do ciliates look like?

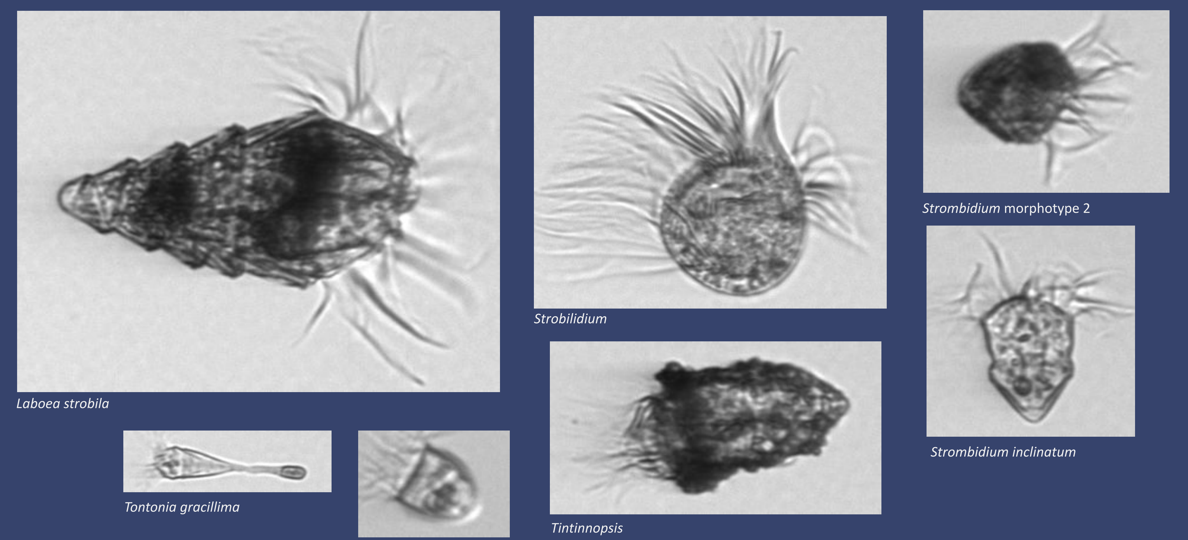

Figure 1: Seven of the thirty ciliate species seen at MVCO, photos via IFCB. From top left to bottom right: *Laboea strobila, Strobilidium, Strombidium morphotype 2, Tontonia gracillima, Balanion, Tintinnopsis, Strombidium inclinatum*. Relative sizes to scale, general range 5-150 μm.

Using IFCB, CNN, and MATLAB

- Imaging FlowCytobot deployed at MVCO, a tower off the coast of Martha's Vineyard (41°19.501'N, 70°34.000'W)
- 150 micron mesh at end of intake, 1 micron resolution
- 2006-2022 time series of imaging data
- Taxa identified in images via a machine learning artificial intelligence auto-classifier (convolutional neural network, CNN), with a thresholding score
- Used MATLAB to examine seasonality and view correlations

Different ciliate taxa have distinct seasonality

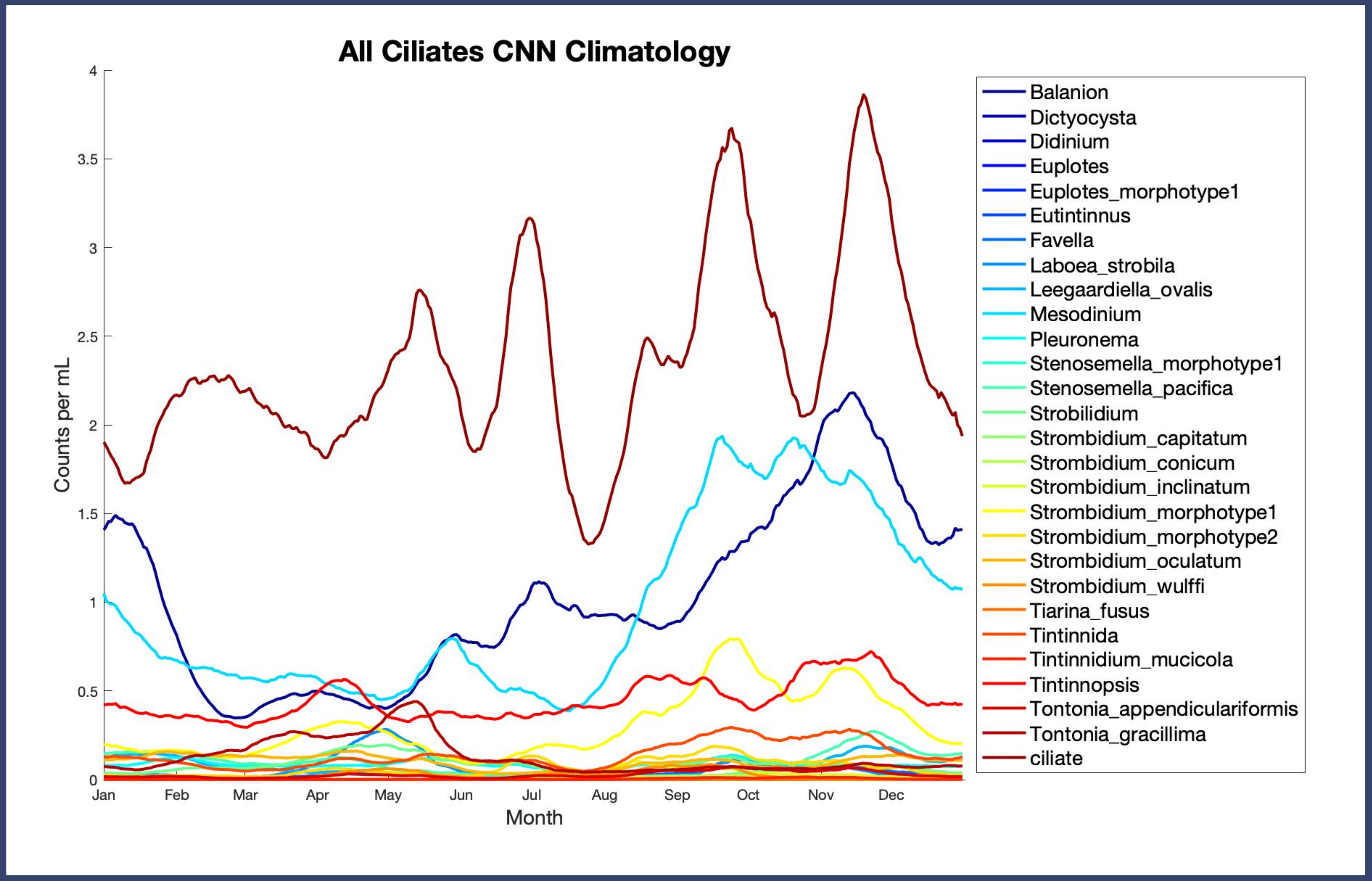

Figure 2: Mean counts per mL over 2006-2022 for all ciliate taxa at MVCO. *Mean counts have been 4th root transformed to more accurately represent the true mean value by decreasing the impact of outliers.*

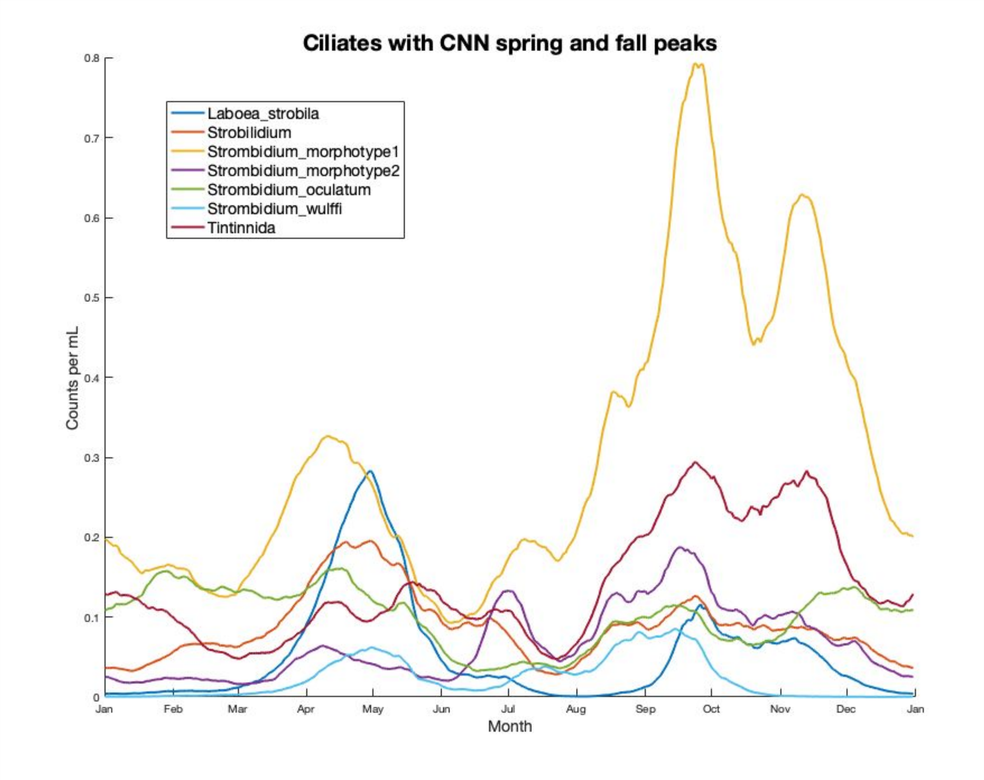

Figure 3: Mean counts per mL over 2006-2022 for ciliates with spring and fall blooms at MVCO. *Mean counts have been 4th root transformed to more accurately represent the true mean value by decreasing the impact of outliers.*

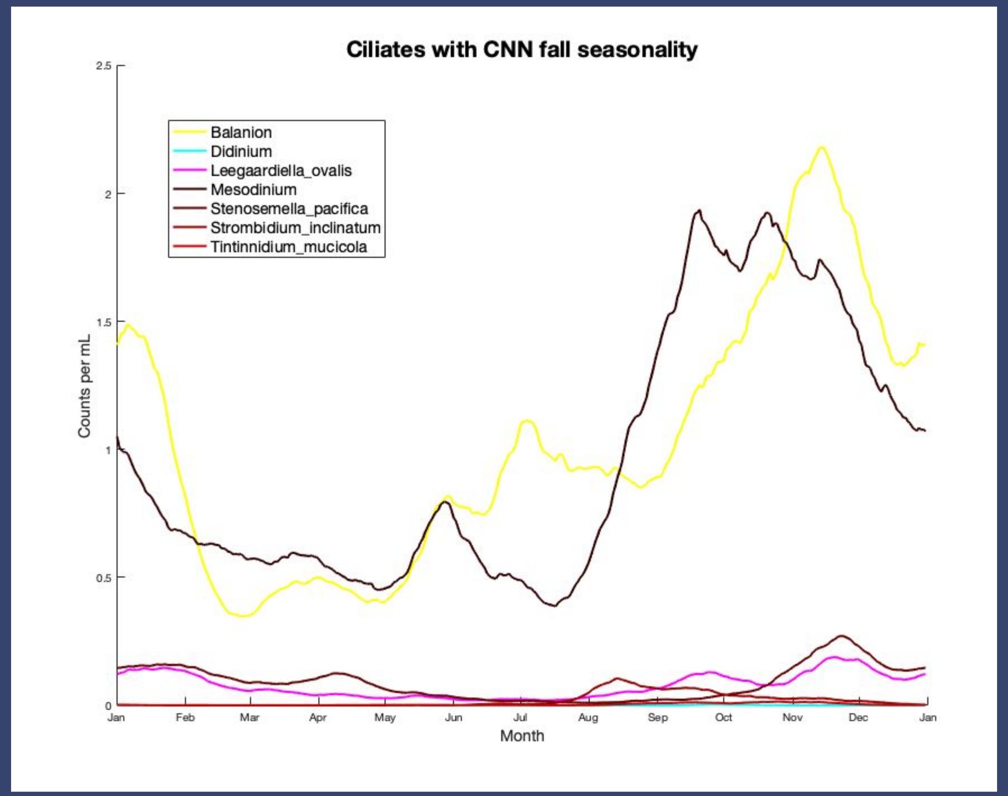

Figure 4: Mean counts per mL over 2006-2022 for ciliates with fall blooms at MVCO. *Mean counts have been 4th root transformed to more accurately represent the true mean value by decreasing the impact of outliers.*

Results

- We found evidence that ciliate taxa do not have random seasonal distributions.
- There is a distinct seasonality within the ciliate types, meaning not all of the taxa are present at the same time.
- There are seasonal communities of ciliates based on the data: particularly taxa that bloom in both the spring and fall, and another group that only blooms in the fall.
- Even though some ciliates have extremely low abundance, knowing their seasonal patterns is important because they may have unique roles within their ecosystem.

Future directions

In the future, I hope to use thresholding scores to optimize the results of the CNN. I would also like to study the abiotic factors of the ocean, such as temperature and salinity, and explore if these characteristics have an impact on the seasonality or abundance of ciliate taxa. I plan on writing a senior thesis on ciliate ecology, with expansions on temperature, salinity, grazing, diversity, and more. Knowing how the seasonality of ciliate taxa changes is helpful to better understand the marine food web.

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Acknowledgements: Stace Beaulieu, Dylan Catlett, Emily Brownlee, other members of Sosik lab, PEP 2022 cohort