The Implementation of eDNA Analysis to Determine the Biodiversity of Honey

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Introduction

•Honey production is a multifaceted process with significant economic, environmental, and social effects. For instance, floral sources used to make honey can influence the flavor, color, and consistency of honey (1).

•The process involves bees collecting nectar, transforming it into honey through regurgitation and evaporation, then storing the product within the hive, which beekeepers then extract and refine.

•In 2020, the Florida beekeeping industry generated over 93 million dollars in revenue, primarily from honey bee product sale and pollination services offered by the state (2).

•It's vital to understand the genetic perspective when examining the scope of honey production as it can reveal floral sources
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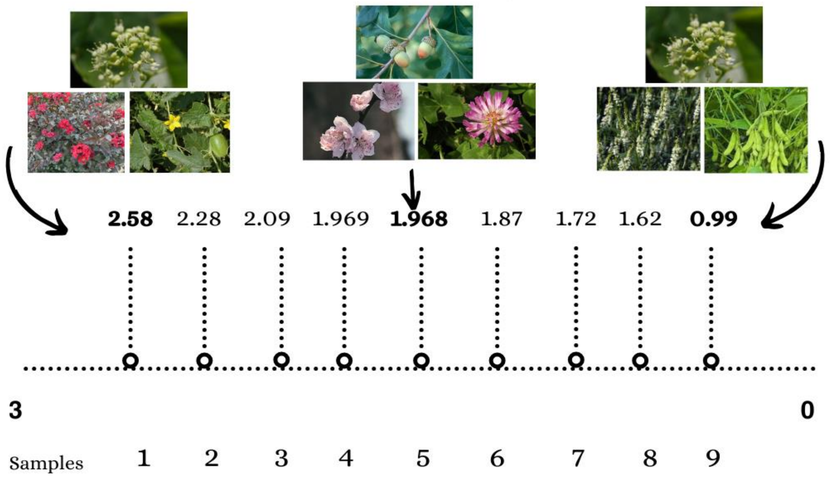
•Previous methods for floral sourcing including identifying pollen grains under a microscope.

•New methods use **environmental DNA** (genetic remnants left behind in the environment) which is a faster and, hopefully, more accurate method.

•After collecting environmental samples (honey), floral sources are analyzed using DNA metabarcoding. This is the analysis of DNA in order to identify the taxonomic rank of the sample.

•This study investigated environmental DNA left behind in a honey sample to identify the place of origin and floral preference.

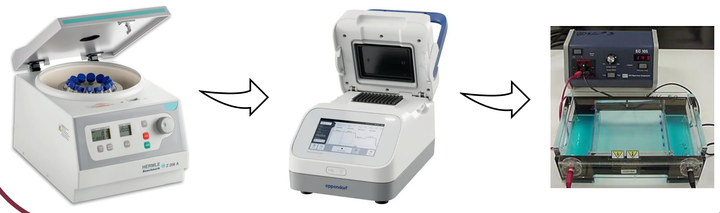
Shannon Diversity Index



The chart above demonstrates the Shannon Index Value calculated for each sample, arranged in order from most diverse (highest Shannon Value) to least diverse (lowest Shannon Value). Explanation of Shannon Value provided on the right side of the poster.

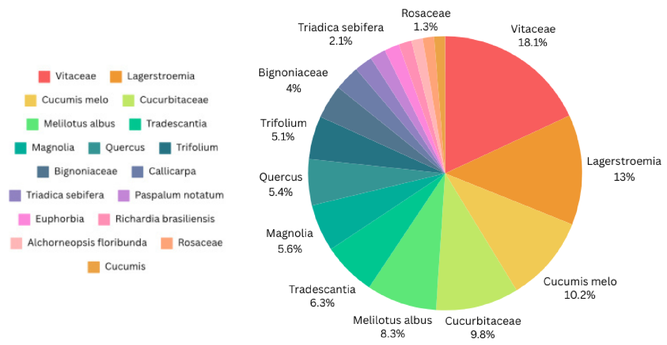
Methods

- The honey samples were collected from hives throughout Northwest Florida in early 2024 by various local beekeepers affiliated with the Tupelo Beekeepers' Association of Bay County.
- Samples were packaged and shipped to Jonah Ventures Boulder, Colorado,
- where they were processed from September to November.
- Samples were extracted, amplified through polymerase chain reaction (PCR), visualized in gel electrophoresis, and sequenced.
- FSU PC students received the DNA sequences and samples for analysis through BLAST nucleotide database and FL Plant Atlas to determine floral sourcing for each sample.

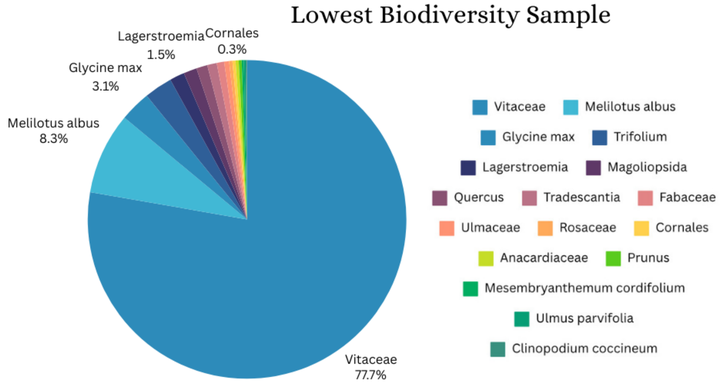


Results

Highest Biodiversity Sample



Lowest Biodiversity Sample



The two pie charts above represent the top 19 unique taxonomic representatives of the highest biodiversity sample (top chart) and lowest biodiversity sample (bottom chart).

Discussion

•The eDNA extracted from honey could be an accurate indicator of floral biodiversity, showcasing the range of plant species that bees visit and the ecological richness of their environments. Future studies will need to work with local beekeepers to confirm accuracy.

•Extracting environmental DNA is less invasive than other methods and can gain valuable information about organism diversity and the presence of invasive species (3). This process promotes conservation of the environment and provides insight on native species that could be threatened.

•The variety in biodiversity of the results could have stemmed from a sample's place of origin containing invasive species used for landscaping or aesthetic purposes.

• eDNA analysis also provides information to determine correlations between flavor profile and origin of honey. Unique flavors encourages the public to buy from their local beekeepers, strengthening that area's economy.

•Another approach that could produce results with higher levels of biodiversity is sampling from a wider range of locations, such as North Dakota and Montana, which are both significant honey-producing states (4).

•In future studies, beekeepers should explain each step of the process in extreme detail, especially the procedure, as collection errors could alter results. Also, beekeepers providing floral inventory near their hives could help with ground truthing.

- The level of biodiversity was determined using the Shannon Diversity Index. This mathematical equation determines the level of biodiversity according to species richness and evenness.
  - Values less than 1.5 indicate **low** biodiversity
  - Values between 1.5 and 2 indicate **moderate** biodiversity
  - Values above 2.5 indicate **high** biodiversity

- We found abnormal results within one sample that displayed only two taxonomic groups, producing an index of -0.4. In order to maintain consistent results, this sample was removed from analysis.

$$H' = -\sum_{i=1}^{S} pi \ln pi$$

Conclusions

By implementing strategies that prioritize the biodiversity of a location, beekeepers can provide essential resources that ultimately enhance bee health while optimizing taste and production efficiency.

References

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(2) Court, C., Hodges, A., Vu, A., Roberts, L., Carney, T., Ellis, J., Athearn, K., Ferreira, J., McDaid, K., Oster, C., & Prouty, C. (2022). Economic Contributions of the FLORIDA BEEKEEPING INDUSTRY IN 2020.
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(4)Smith, D., Davis, A., Hitaj, C., Hellerstein, D., Preslicka, A., Kogge, E., Musher, D., & Lonsdorf, E. (2021). *The contribution of land cover change to the decline of honey yields in the Northern Great Plains*.
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