Urban Wasps and Ecological Change: Wasp Diversity Across Brooklyn Microhabitats

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Abstract

Invasive species shape urban ecosystems, yet their effects on native insect communities remain underexplored. In this research project, we examined the biodiversity and distribution of potter, tube, and mud-dauber wasps in Brooklyn to better understand how native and non-native hymenoptera interact and affect the ecosystems in urban environments. Approximately 25 wasp specimens were collected from a range of habitats, including community gardens, street tree beds, parks, and playgrounds. Species were identified using DNA barcoding with sequences compared to reference databases and iNaturalist observations. Phylogenetic and geographic analyses were used to evaluate species distribution across sites. Species composition was compared across habitats to assess whether factors such as habitat fragmentation, nesting resources, and human disturbance influence biodiversity patterns. This research contributes to understanding how urbanization affects hymenoptera diversity and whether wasps can serve as indicators of ecological change in Brooklyn.

Introduction

Invasive species significantly disrupt ecosystems like community gardens, street tree beds, coastlines, and park areas by posing a threat to the native species and also the ecosystem itself. For instance, they prey on native species and drastically reduce their populations, or they destroy trees and bushes to make their homes. An example of this are spotted lanternfly, which are native to Asia but migrated to North America on a cargo shipment a few years ago. They damage crops and plants by sucking the sap out of them, a process that causes harmful black mold to grow (Osterloff). The goal of the research project is to investigate how invasive bees and wasps affect the ecosystems in Brooklyn. These species settle in urban areas such as parks and gardens, where they have an impact on local flora and fauna (Demeter et al.). As the life cycles of bees and wasps are dependent on seasonal patterns and prey availability, it is critical to understand the consequences that these invasive species have in order to protect the native species (“Wasps and Bees”).

Specific Aims

- Determine the species-level biodiversity of potter, tube, and mud-daubing wasps from multiple Brooklyn neighborhoods.
- Identify any non-native or invasive hymenoptera species present in our samples and compare their distribution across different urban microhabitats (Luo, Li, et al).
- Evaluate whether species composition reflects environmental conditions, such as habitat fragmentation, availability of nesting materials, or levels of human disturbance.

Materials and Methods

Step 1: Sample Collection

To collect our samples, we used electric insect swatters and stored specimens in 70% isopropanol in a refrigerator. Approximately 25 samples were collected.

Step 2: DNA Extraction and PCR

To isolate DNA, we used the Zymo Research Quick-DNA Tissue/Insect Miniprep Kit (50 Preps) D6016. We amplified the Cytochrome Oxidase I (COI) barcode region using the primers LCO1490 and HCO2198.

LCO1490: 5'-GGTCAACAAATCATAAAGATATTGG-3'

HCO2198: 5'-TAAACTTCAGGGTGACCAAAAAATCA-3'

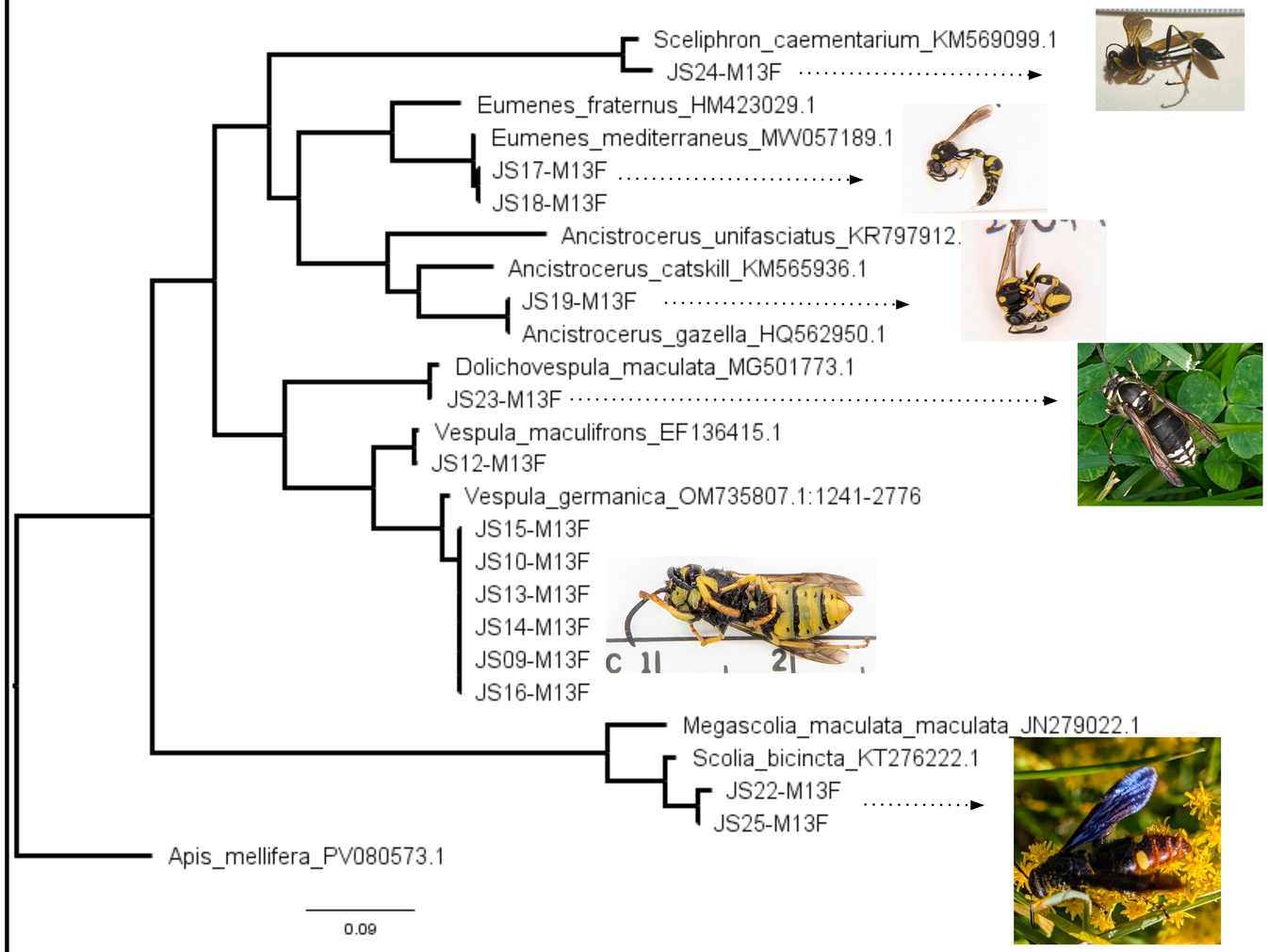
Step 3: Species Identification Testing

PCR products were sequenced and compared to reference databases using BLAST. Species identifications were based on the closest available genetic matches in GenBank and were compared with iNaturalist observations to evaluate similarities between molecular and visual identification methods.

Step 4: Data Analysis

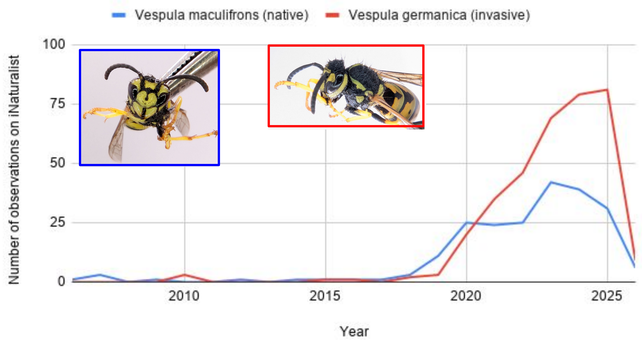
Sequence analysis and phylogenetic tree generation were conducted using MUSCLE and PhyML within the UniPro UGENE platform.

Phylogenetic Tree of Collected Wasp Specimens Based on DNA Barcoding

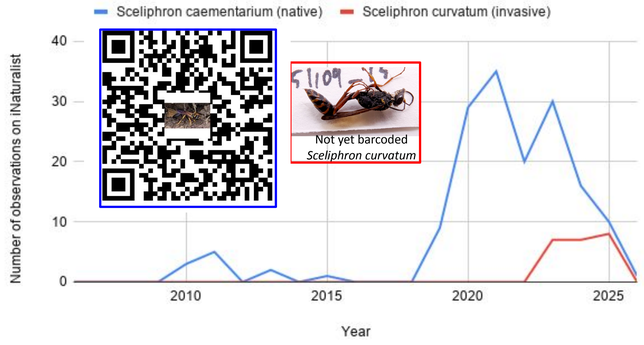


iNaturalist Observation Trends of Native and Invasive Wasps in Brooklyn

Native vs. Invasive Species of Yellowjackets in Brooklyn



Native vs. Invasive Species of Mud-Dauber Wasps in Brooklyn



Results

The results showed clear differences in the abundance and distribution of native and invasive wasp species within Brooklyn’s urban environment. iNaturalist observations revealed that the invasive yellowjacket Vespula germanica increased more rapidly over time and appeared more frequently than the native Vespula maculifrons. By the early 2020s, observations of V. germanica exceeded those of the native species, suggesting strong adaptation to urban conditions. A similar pattern was observed among mud-dauber wasps. The native Sceliphron caementarium was initially more common, but the invasive Sceliphron curvatum began appearing in recent years and showed signs of increasing presence in Brooklyn. Additionally, one specimen believed to be Scolia dubia lacked an exact reference sequence in GenBank, highlighting how incomplete genetic databases can limit species identification even when DNA barcoding is successfully performed.

DNA barcoding and phylogenetic analysis confirmed species identification and grouped specimens into distinct clusters, including members of the genera Vespula, Ancistrocerus, and Sceliphron. Several collected specimens clustered closely with urban-associated or invasive taxa, supporting the idea that urban ecosystems may favor species with flexible nesting and behavioral adaptations.

Overall, the data suggest that urbanization influences Hymenoptera biodiversity by favoring invasive or highly adaptable species within Brooklyn’s urban environment.

Discussion

Our findings suggest that wasp biodiversity in Brooklyn is shaped by urban environmental conditions, with invasive and urban-adapted species becoming increasingly common over time. The higher number of observations of Vespula germanica compared to the native Vespula maculifrons suggests that some non-native species may be better suited to highly developed urban habitats.

The appearance and gradual increase of Sceliphron curvatum further supports the idea that urban environments can facilitate the spread of non-native Hymenoptera species. Behavioral flexibility, including the ability to use man-made structures for nesting, may contribute to this success.

Using both iNaturalist observations and DNA barcoding provided different ways to study biodiversity. iNaturalist data helped track long-term trends in species observations, while DNA barcoding allowed for more accurate species identification and helped distinguish closely related species.

Overall, these findings support the idea that Hymenoptera biodiversity can reflect environmental change in urban ecosystems. Combining observation data with DNA analysis provides a clearer understanding of how urbanization affects ecological communities in Brooklyn.

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