



Determining the Geographic Origin of American Honeys: An Analytical Method through Multivariate Analyses

Gay, c “Geographic Origin of Caribbean Honeys: An Analysis of Plant Composition through DNA Metabarcoding” Article in prep

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Why honey origin matters ?

- Origin determines price & consumer trust
- Fraud : mislabeling geographical origin
- New method: **floral fingerprint** with **environmental DNA (eDNA)**





Honey origin identification :

- Melissopalynology: microscopic pollen identification
- Chemical/spectral fingerprinting (proteomics, IR, Isotope ratio, MNR)
- eDNA: high taxonomic resolution, fast, effective on very small and degraded samples



STUDY OBJECTIVES

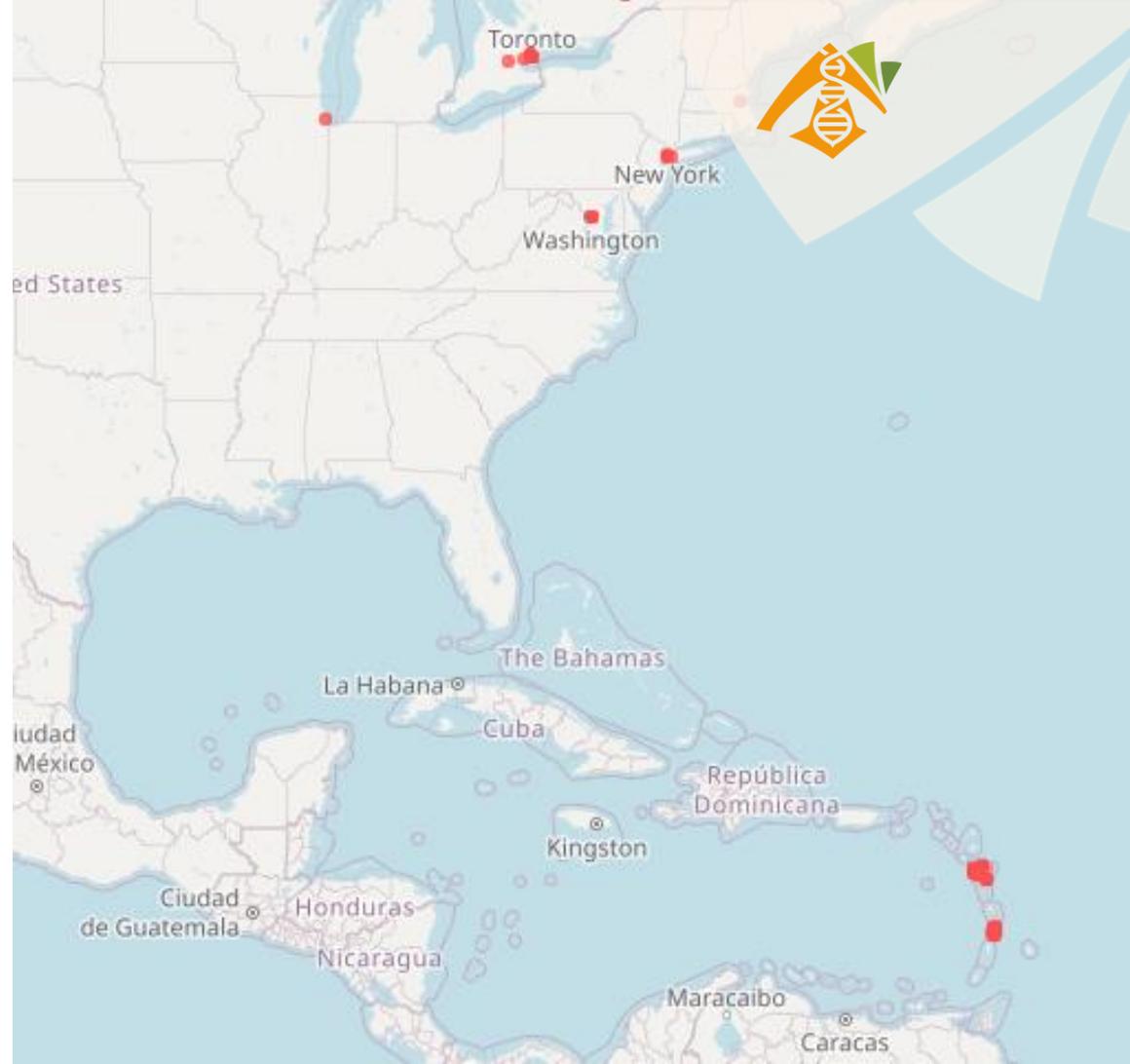
Authentication of the origin of honey from two neighboring Caribbean islands (Saint Lucia / Guadeloupe) using environmental DNA

- Compare plant **abundance** vs **presence–absence** data
- Apply **multivariate statistics models** to separate origins



Study Regions

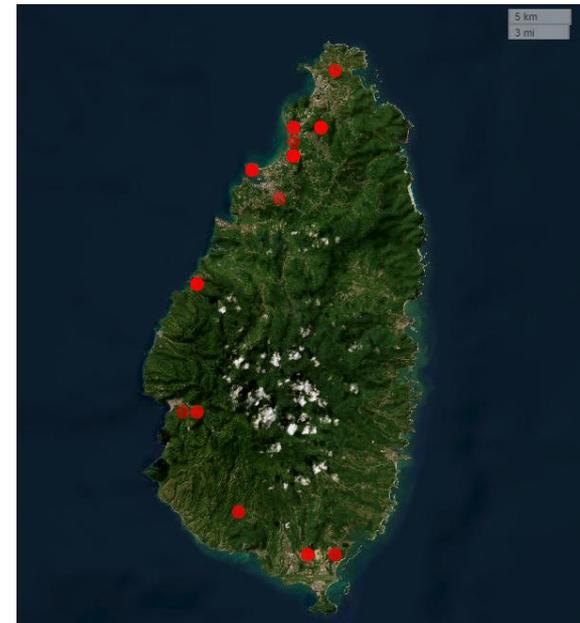
- Saint Lucia – 19 sites
- Guadeloupe – 19 sites
- North America – 19 sites



Saint Lucia / Guadeloupe islands

Sampling Map

- Multiple ecosystems: coastal forest, dry forest, mixed agriculture
- Different elevations and habitats to capture differences in floral availability.
- March–October sampling





North America Sampling Map

- Sites in USA & Canada:
Eastern Temperate
Forests
- April–October sampling





Sampling Protocol

- Honey collected directly from hive frames to ensure floral DNA signature reflects foraging environment





Lab Workflow

DNA extraction

PCR with **trnL g-h** and **trnL c-h** primers (markers)

Sequencing (Illumina MiSeq)

Species identification via reference database (NCBI Nt database)

Filters for impossible species : <0.1% abundance + % identity (95%) + *E*-value cut-off of $1e^{-10}$ + query cover (95%) + presence plausibility via literature

Botanical Composition: Most abundant species

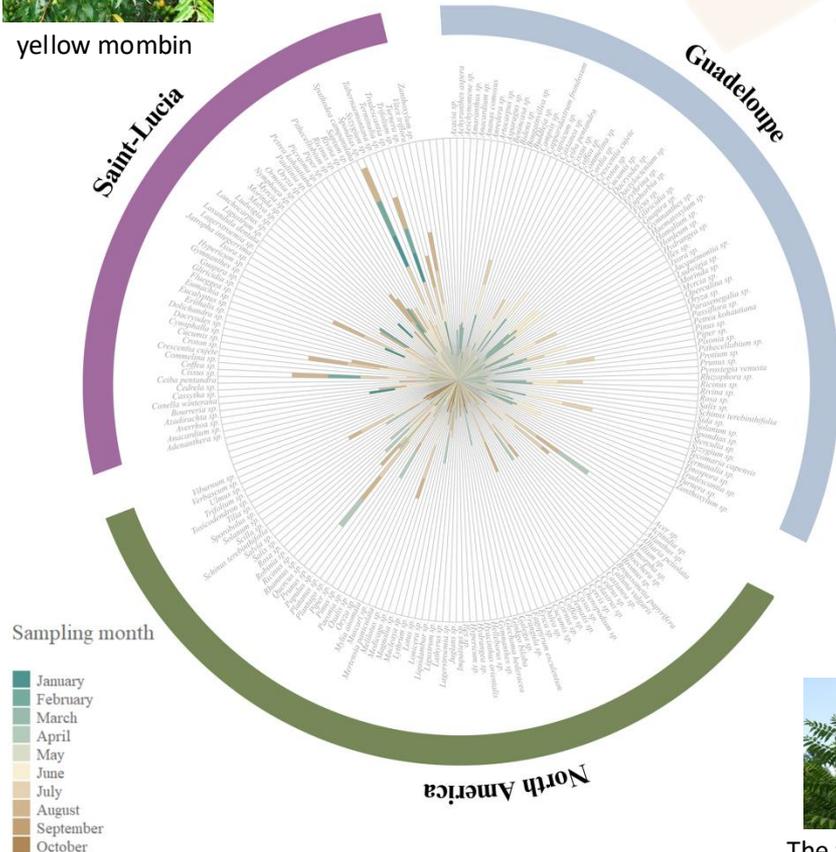
- **North America:** *Ailanthus altissima*, *Lythrum salicaria*
- **Guadeloupe:** *Bursera simaruba*, *Gymnanthes lucida*, *Homalium racemosum*
- **Saint Lucia:** *Spondias mombin*, *Guapira discolor*, *Croton hircinus*
- Some species common to all regions : melon (*Cucumis melo*)



yellow mombin



gumbo-limbo



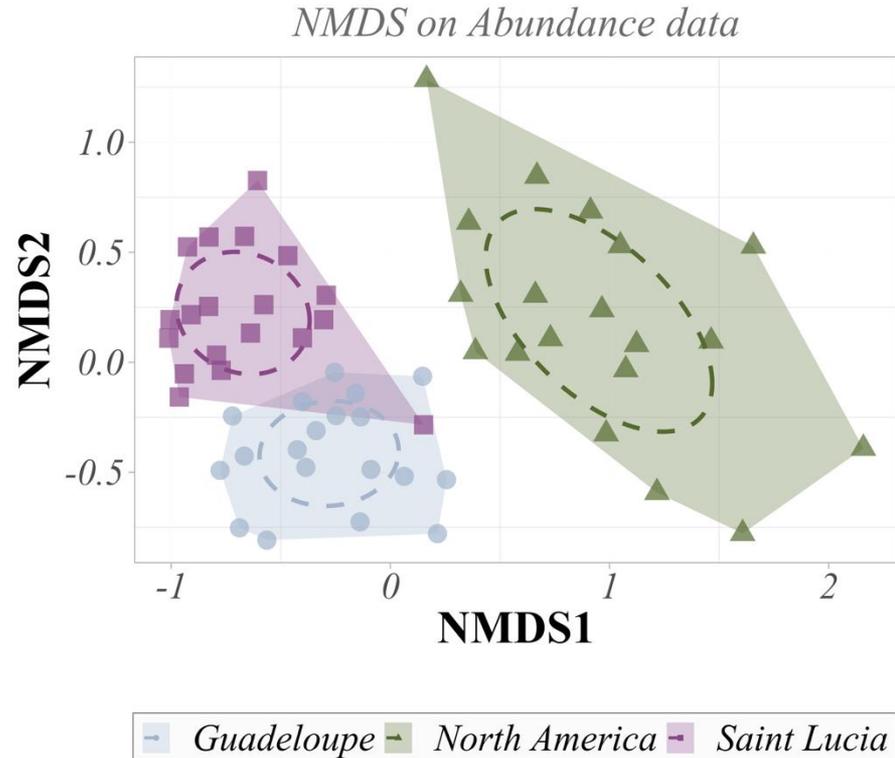
The tree of heaven



Multivariate statistics approach :

NMDS Analysis on abundance data

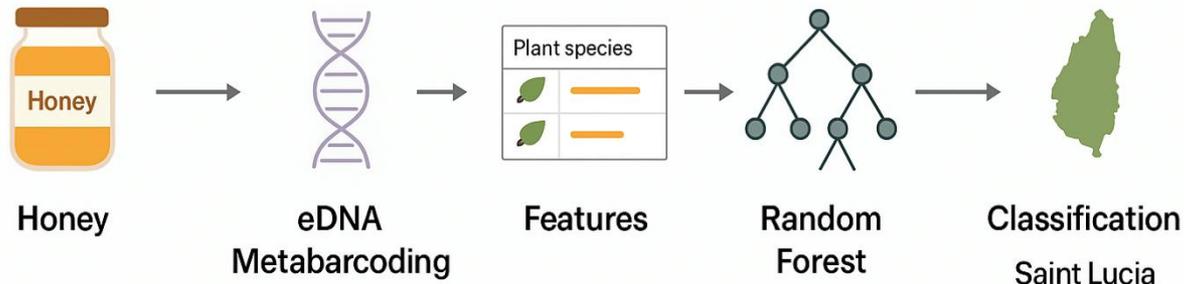
- NMDS model shows similarity/difference in plant compositions
- NA distinct, Guadeloupe and SL show a small overlaps
- Statistical tests (anosim) confirm significant differences





Next Step: Machine Learning for Honey Origin Authentication

- Train machine learning models on global eDNA data (>1000 samples).
- Tested algorithm: **Random Forest**
- Preliminary results : **72% correct classification** for continent and climate origine. Up to **83%** for Caribbean samples





Implications



Science:

- improved regional discrimination
- new tool for fraud detection



Beekeepers:

- origin certification
- market value
- consumer trust



Conclusion

- Environmental DNA makes it possible to distinguish between honeys from Caribbean neighboring regions.
- Complementary to traditional methods and need to be integrated to international standards (Codex and ISO)
- A promising tool for assessing fraud and adulteration and certify labels

Thanks !



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