

Natasha de Vere¹, Laura Jones², Abigail Lowe³

¹Natural History Museum of Denmark, University of Copenhagen, Denmark

²National Botanic Garden of Wales, UK

³UK Centre for Ecology and Hydrology, UK

Background/PURPOSE: Honeybees use a wide range of flowering plants through the year for nectar and pollen. Agricultural intensification and other land use changes have substantially reduced the amount of flower-rich habitat available for foraging.

Problem description:

- How have the flowering plants used by honeybees changed over historical time?
- How do the plants used by honeybees change through the season?
- Which times of year are most likely to lead to food shortages?

METHODOLOGY: We find out which plants honeybees use by identifying the pollen within honey samples using DNA metabarcoding. For the historical investigation, we analysed 441 honey samples collected throughout the UK in 2017 and compared these to 855 honey samples analysed in 1952. For the seasonal investigation, we sampled honey from six colonies within a botanic garden and nature reserve every month from April to September 2016 – 2019. We extracted plant DNA from the honey, amplified and sequenced DNA barcodes (rbcL and ITS2) and compared these to a reference library of DNA barcodes for the UK flora to identify the plants.

Results and CONCLUSION: From 1952 to 2017 changes in agricultural practices have altered the nectar and pollen sources available in the UK. We show a decrease in the use of white clover (*Trifolium repens*) and increase in bramble (*Rubus fruticosus*) as the major forage source for UK honeybees. We show an increase in use of the crop plant, oil seed rape (*Brassica napus*) and the invasive species Himalayan balsam (*Impatiens glandulifera*) as these plants have become abundant in the UK landscape.

By analysing honey samples each month, we show that spring-flowering trees and shrubs are important at the beginning of the season and that when these finish flowering there is a resource gap until bramble and white clover become available. During this, 'June gap' honeybees use a wide variety of different plants in small amounts since none of their preferred resources are available.

Practical implications for beekeepers: We provide a detailed overview of the different plants used by honeybees through the year and make recommendations on the best plants for honeybees.

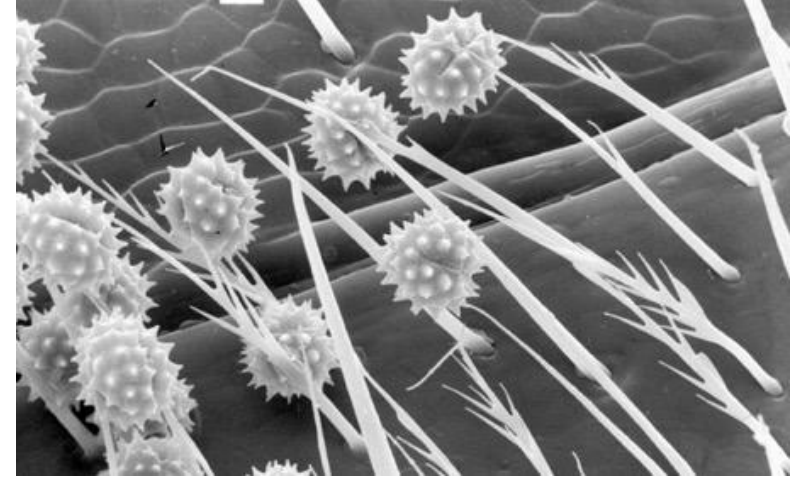
Historical and seasonal changes in the flowering plants used by honeybees

Natasha de Vere
Professor and Curator of Botany
Natural History Museum of Denmark,
University of Copenhagen



Identification of plants used by honeybees

- Observation
- Identification of pollen
- Pollen can be retrieved from the **bodies of bees**, from **pollen loads** or **honey**
- Can use microscopy or DNA-based methods to identify pollen



Pollen DNA metabarcoding

MOLECULAR ECOLOGY

ORIGINAL ARTICLE | Open Access |

Plants, pollinators and their interactions under global ecological change: The role of pollen DNA metabarcoding

Karen L. Bell , Katherine J. Turo, Abigail Lowe, Kevin Nota, Alexander Keller, Francisco Encinas-Viso, Laura Parducci, Rodney T. Richardson, Richard M. Leggett, Berry J. Brosi, Kevin S. Burgess, Yoshihisa Suyama, Natasha de Vere ... [See fewer authors](#) ^

First published: 10 September 2022 | <https://doi.org/10.1111/mec.16689> | Citations: 34

Open Access | Editor's Choice | Review

Using DNA Metabarcoding to Identify Floral Visitation by Pollinators

by Abigail Lowe ^{1,2,*} , Laura Jones ¹ , Lucy Witter ^{1,3} , Simon Creer ² and Natasha de Vere ⁴

¹ Science Department, National Botanic Garden of Wales, Llanarthne SA32 8HG, UK

² Molecular Ecology and Evolution Group, School of Natural Sciences, Bangor University, Bangor LL57 2UW, UK

³ Institute of Biological, Environmental and Rural Sciences, Aberystwyth University, Aberystwyth SY23 3FL, UK

⁴ Natural History Museum of Denmark, University of Copenhagen, 1350 Copenhagen K, Denmark

* Author to whom correspondence should be addressed.

Diversity 2022, 14(4), 236; <https://doi.org/10.3390/d14040236>

Submission received: 28 January 2022 / Revised: 8 March 2022 / Accepted: 16 March 2022 /

Published: 24 March 2022

1

- Sample pollen from bee or honey

2

- Extract DNA

3

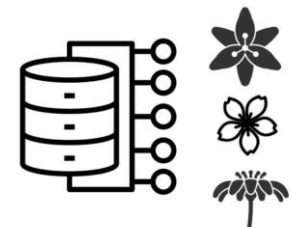
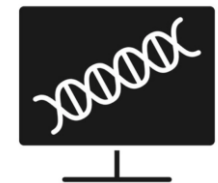
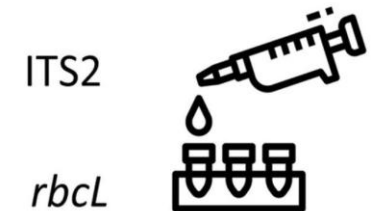
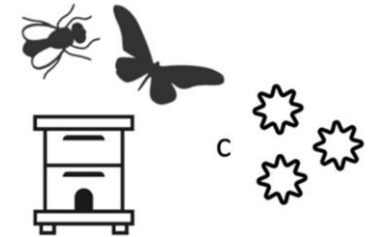
- Amplify DNA barcodes (*rbcL* and ITS2)

4

- Sequence DNA using NGS

5

- Compare to reference library using bioinformatic pipeline



DNA barcode reference libraries: Barcode Wales and Barcode UK



MOLECULAR ECOLOGY RESOURCES

RESOURCE ARTICLE | Open Access |

Barcode UK: A complete DNA barcoding resource for the flowering plants and conifers of the United Kingdom

Laura Jones, Alex D. Twyford, Col R. Ford, Tim C. G. Rich, Helena Davies, Laura L. Forrest, Michelle L. Hart, Heather McHaffie, Max R. Brown, Peter M. Hollingsworth, Natasha de Vere

First published: 22 March 2021 | <https://doi.org/10.1111/1755-0998.13388> | Citations: 52

OPEN ACCESS PEER-REVIEWED

RESEARCH ARTICLE

DNA Barcoding the Native Flowering Plants and Conifers of Wales

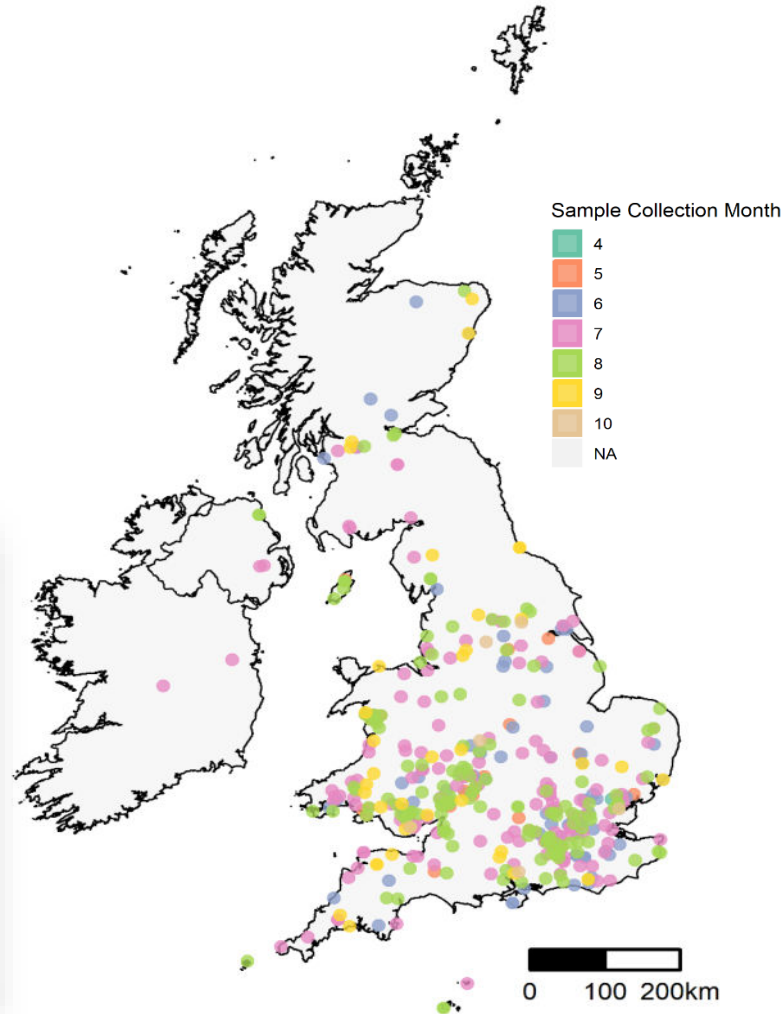
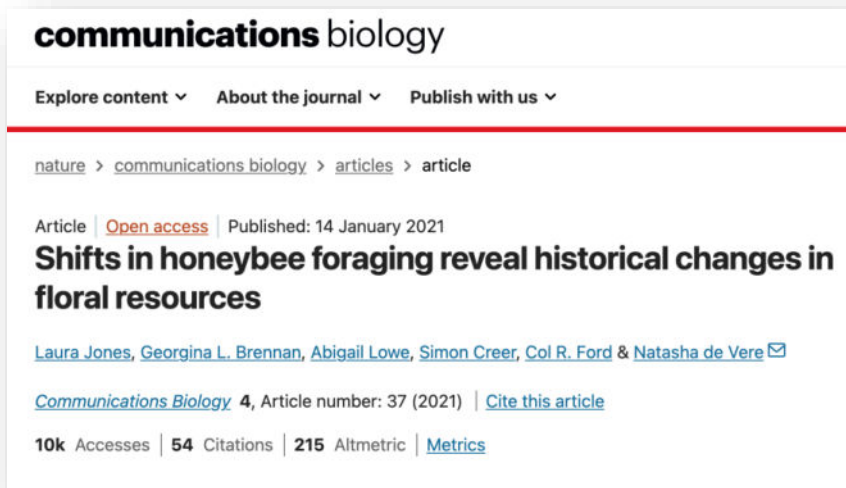
Natasha de Vere , Tim C. G. Rich, Col R. Ford, Sarah A. Trinder, Charlotte Long, Chris W. Moore, Danielle Satterthwaite, Helena Davies, Joel Allainguillaume, Sandra Ronca, Tatiana Tatarinova, Hannah Garbett, Kevin Walker, Mike J. Wilkinson

Published: June 6, 2012 • <https://doi.org/10.1371/journal.pone.0037945>

372 Save	162 Citation
63,535 View	54 Share

Historical changes in honeybee foraging in the UK

- 1952: melissopalynology survey of 885 honey samples
- 2017: DNA metabarcoding 441 honey samples



Honeybee plants 1952 vs 2017

- Positive correlation between plant occurrence in 1952 and 2017 (Kendall's $\tau = 0.389$, $p = 0.0002$).
- Same four plant taxa occurred in >50% of samples



Rubus fruticosus



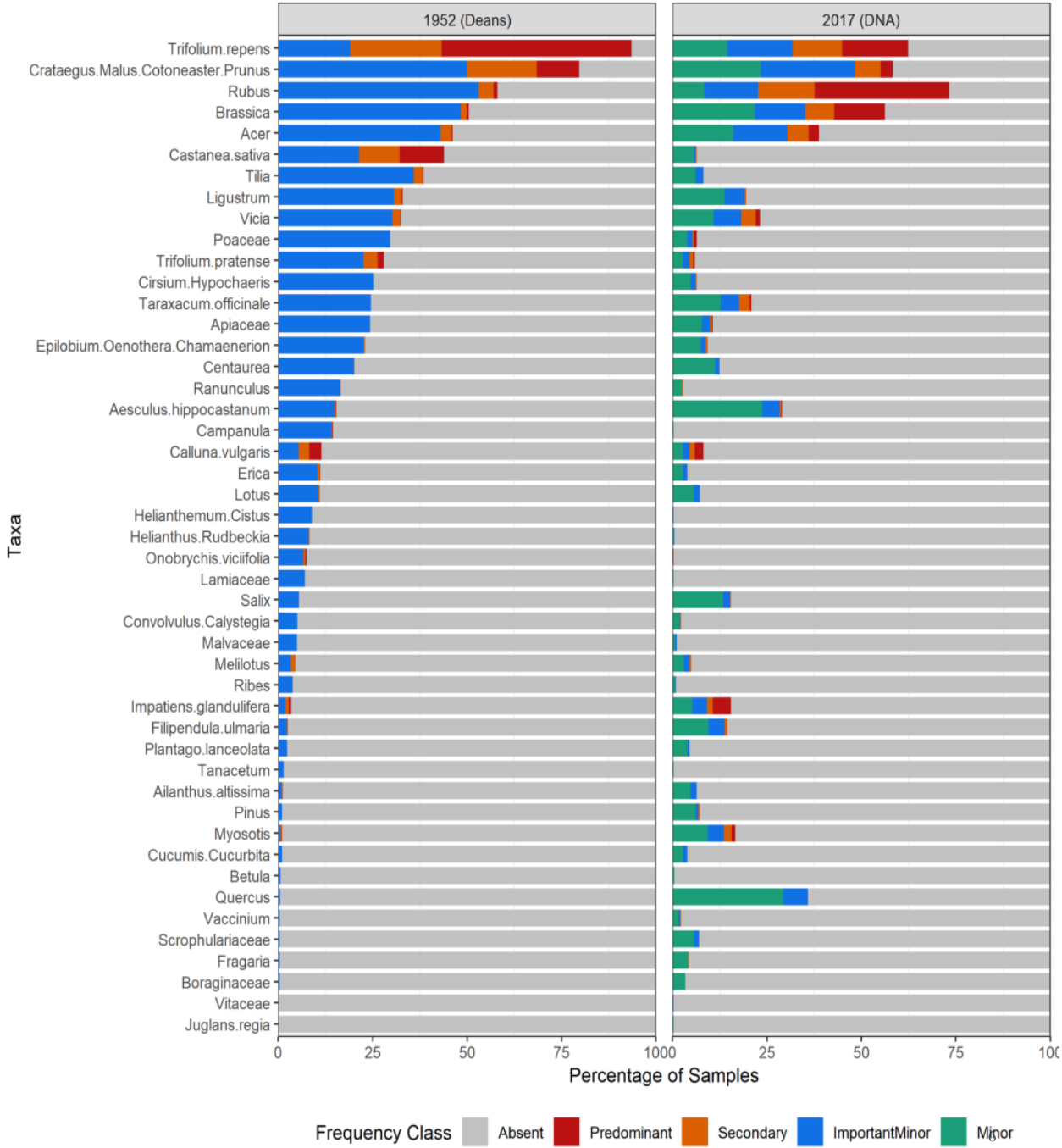
Trifolium repens



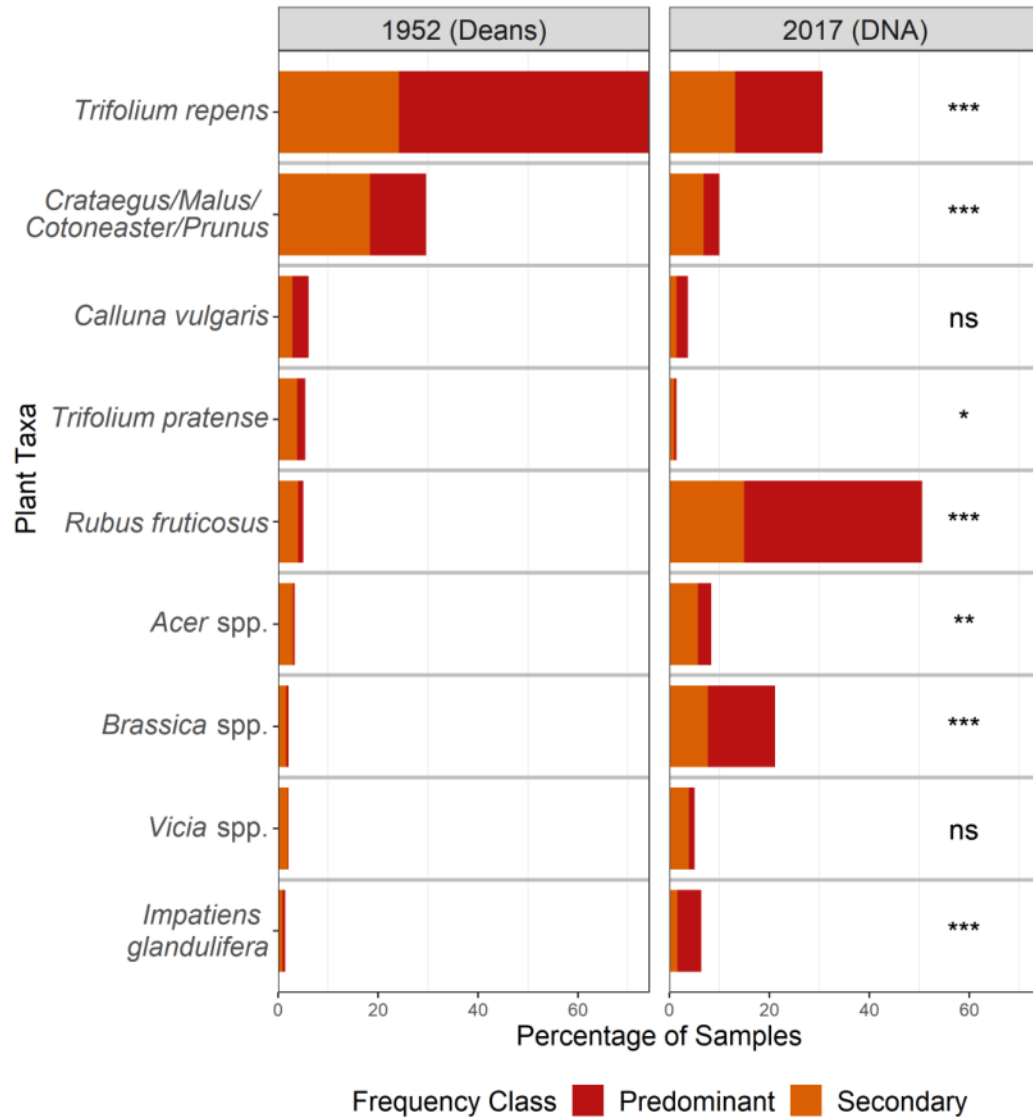
Brassica napus



Crataegus, Malus & Cotoneaster



Changes in major forage use between 1952 and 2017 reflect changes in the UK landscape



Trifolium repens ↓



Rubus fruticosus ↑



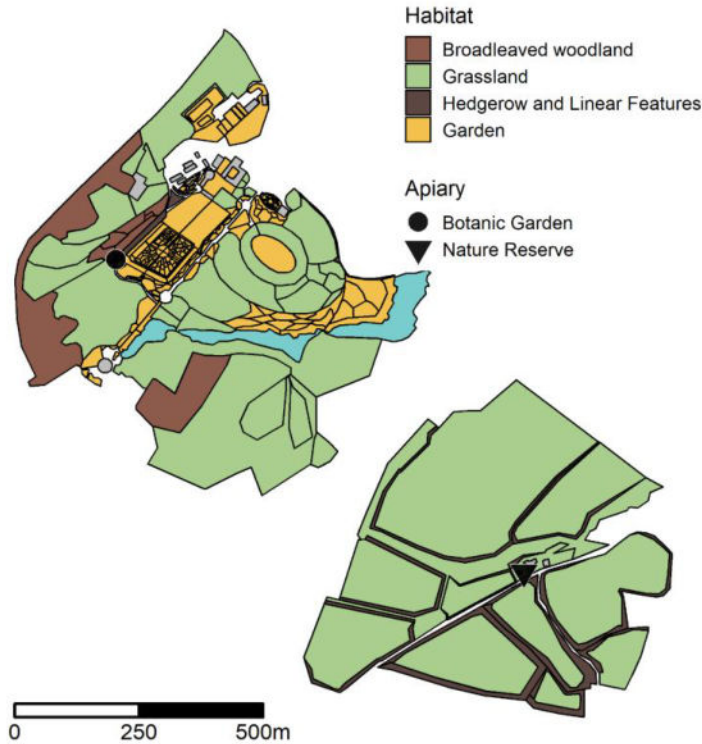
Brassica napus ↑



Impatiens glandulifera ↑

Plants used by honeybees through the year

National Botanic Garden of Wales, UK.
Six honeybee colonies honey sampled
April – September for two years.



JOURNAL ARTICLE

Temporal Patterns of Honeybee Foraging in a Diverse Floral Landscape Revealed Using Pollen DNA Metabarcoding of Honey

Laura Jones, Abigail Lowe, Col R Ford, Lynda Christie, Simon Creer, Natasha de Vere ✉

Integrative and Comparative Biology, Volume 62, Issue 2, August 2022, Pages 199–210,

<https://doi.org/10.1093/icb/icac029>

Published: 10 May 2022 Article history ▼

Plants used through the year

Honeybees use a small number of key plants that change through the season.



Crataegus, Malus & Cotoneaster



Rubus fruticosus



Impatiens glandulifera



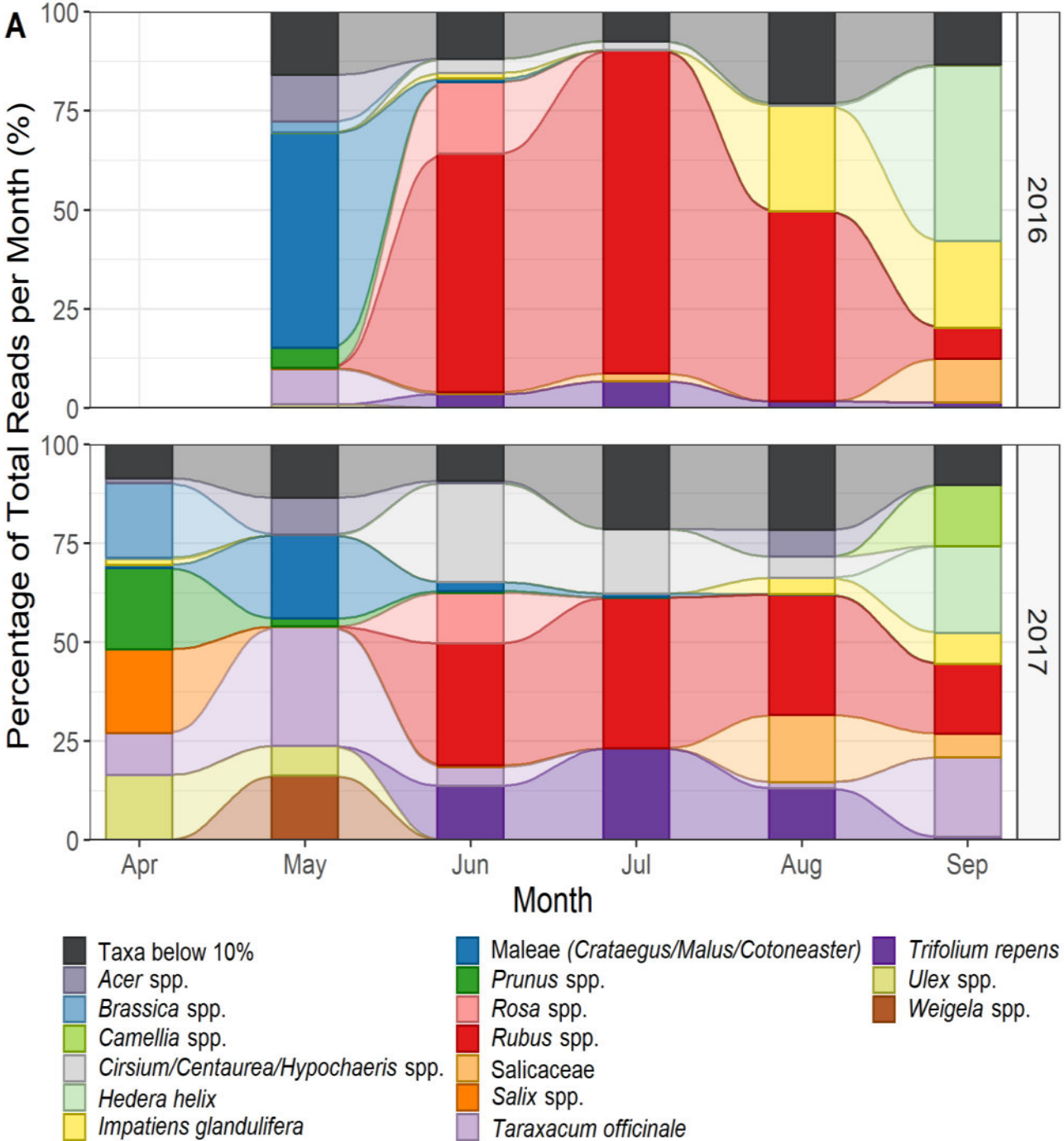
Taraxacum officinale



Trifolium repens



Hedera helix



Honeybee floral resource limitation

National Botanic Garden of Wales, UK. Six honeybee colonies honey sampled April – September for two years.



MOLECULAR ECOLOGY

ORIGINAL ARTICLE | [Open Access](#) |

Temporal change in floral availability leads to periods of resource limitation and affects diet specificity in a generalist pollinator

Abigail Lowe, Laura Jones, Georgina Brennan, Simon Creer, Lynda Christie, Natasha de Vere

First published: 06 October 2022 | <https://doi.org/10.1111/mec.16719> | Citations: 14

Handling Editor: Rosemary Gillespie

Honeybee floral resource limitation

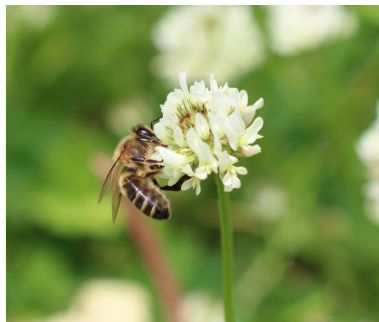
- In April and May honeybees using flowering shrubs and trees
- In June there is a food shortage with different colonies using different floral resources in small amounts (June Gap)
- In July *Rubus fruticosus* and *Trifolium repens* flower and all the colonies use them
- Important to look at networks through time to see when periods of vulnerability occur



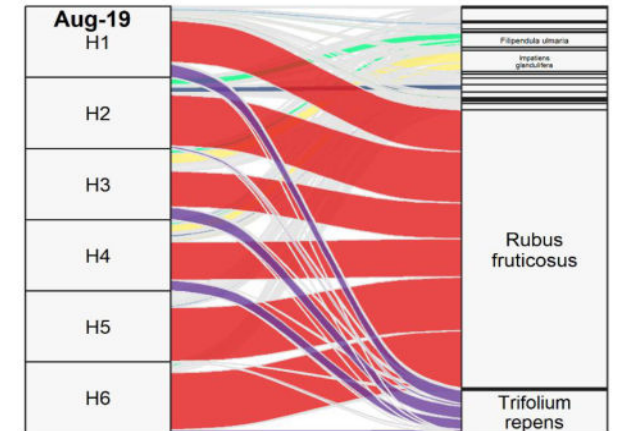
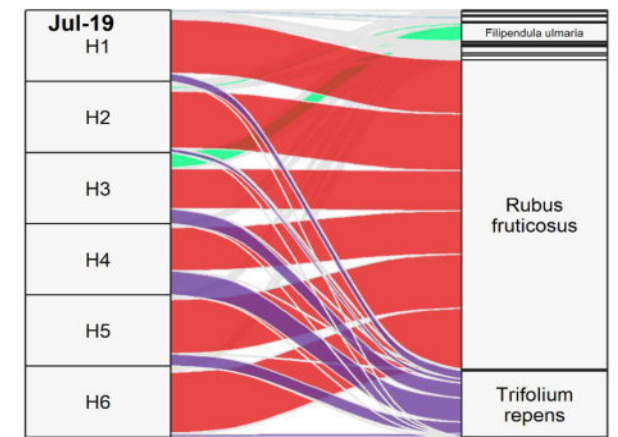
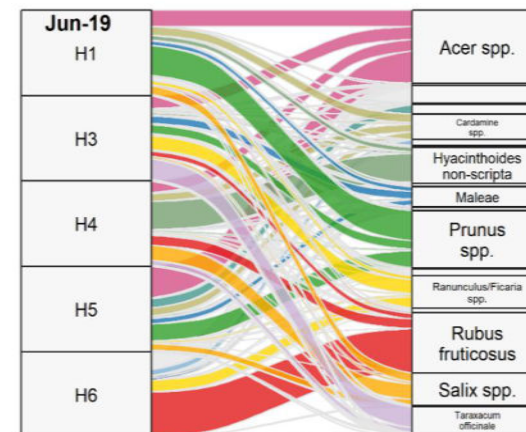
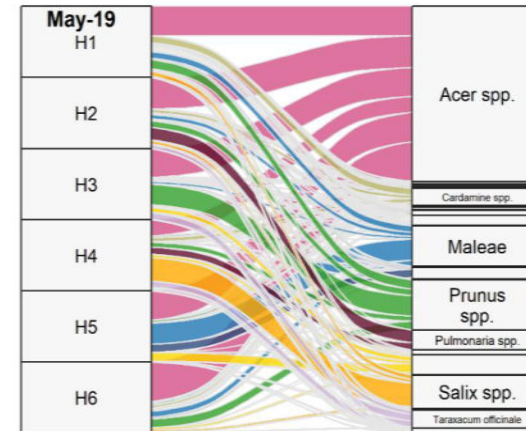
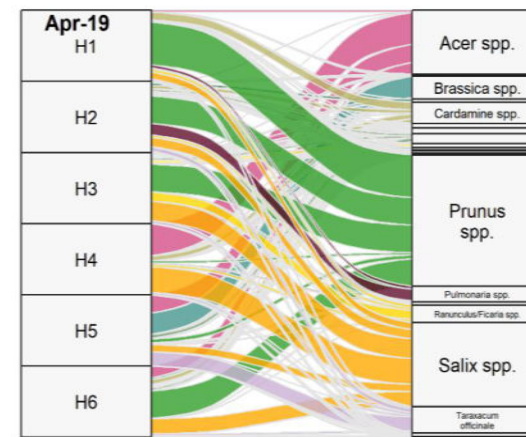
Salix caprea



Rubus fruticosus



Trifolium repens



Thank you

