Ecological interactions and climate change: a test case of pollinators and flowers

Rachael Winfree

Dept of Ecology, Evolution and Natural Resources, Rutgers University
Mutualistic interactions underlie life on earth
Figure 1

Examples of the primary pollinator taxa. (a) Bumblebee (*Bombus* sp.), (b) solitary bee in the tribe Augochlorini, (c) hawk moth (*Macroglossum stellatarum*, Sphingidae), (d) monarch butterfly (*Danaus plexippus*, Nymphalidae), (e) syrphid fly (*Syrphidae*), (f) sunbird (*Aethopyga bella*, Nectariniidae), (g) bat (*Glossophaga soricina*, Phyllostomidae), and (h) hummingbird (*Calypte anna*, Trochilidae). Photo
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Are mutualist partners shifting their phenologies at similar rates?
Climate-associated phenological advances in bee pollinators and bee-pollinated plants

Ignasi Bartomeus\textsuperscript{a}, John S. Ascher\textsuperscript{b}, David Wagner\textsuperscript{c}, Bryan N. Danforth\textsuperscript{d}, Sheila Colla\textsuperscript{e}, Sarah Kornbluth\textsuperscript{b}, and Rachael Winfree\textsuperscript{a}

\textsuperscript{a}Department of Entomology, Rutgers University, New Brunswick, NJ 08901; \textsuperscript{b}Division of Invertebrate Zoology, American Museum of Natural History, New York, NY 10024; \textsuperscript{c}Department of Ecology and Evolutionary Biology, University of Connecticut, Storrs, CT 06269; \textsuperscript{d}Department of Entomology, Cornell University, Ithaca, NY 14853; and \textsuperscript{e}Department of Biology, York University, Toronto, ON, Canada M3J 1P3

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days from 1 January
days from 1 January
10 days of mean advance since 1870

P < 0.001
faster advance the last 40 years

P < 0.001
Bartomeus, Ascher, Wagner, Danforth, Colla, Winfree. 2011. PNAS
Can bee biodiversity buffer pollination against climate change?
A line graph showing the relationship between Bee Abundance and the Gradient of Anthropogenic Driver. The x-axis represents Low Intensity on the left and High Intensity on the right. The y-axis represents Bee Abundance with a dashed line at the top. Lines for different species of bees are plotted, indicating varying responses to different intensities of anthropogenic drivers.
Biodiversity ensures plant–pollinator phenological synchrony against climate change

Abstract
Climate change has the potential to alter the phenological synchrony between interacting mutualists, such as plants and their pollinators. However, high levels of biodiversity might buffer the negative effects of species-specific phenological shifts and maintain synchrony at the community level, as predicted by the biodiversity insurance hypothesis. Here, we explore how biodiversity might enhance and stabilise phenological synchrony between a valuable crop, apple and its native pollinators. We combine 46 years of data on apple flowering phenology with historical records of bee pollinators over the same period. When the key apple...
Can bee biodiversity buffer pollination against climate change?
Native bees buffer the negative impact of climate warming on honey bee pollination of watermelon crops

ROMINA RADER*, JAMES REILLY*†, IGNASI BARTOMEUS*† and RACHAEL WINFREE*†

*Department of Entomology, Rutgers, The State University of New Jersey, 93 Lipman Drive, New Brunswick, NJ 08901, USA,
†Department of Ecology, Evolution and Natural Resources, Rutgers, The State University of New Jersey, 93 Lipman Drive,
New Brunswick, NJ 08901, USA
4 years of data from 18 farms
>16,000 bee visits to >46,000 flowers
471 pollen deposition experiments
estimate pollination provided per bee species group
Bumble bees
(98% *Bombus impatiens*)

Green bees
(89% *Augochlora pura*)

Honey bee
(*Apis mellifera*)

*Melissodes bimaculata*

*Peponapis pruinosa*

*Ceratina* (3 species)

Small dark (15 species)

Tiny dark (7 species)
Future climate scenario IPCC A1
Biodiversity buffers crop pollination against climate change

Rader, Reilly, Bartomeus and Winfree, 2013  Global Change
Biodiversity buffers crop pollination against climate change

The 8 groups range from ↓19% to ↑82%
Biodiversity buffers crop pollination against climate change

The 8 groups range from ↓ 19% to ↑ 82%

Aggregate pollination services ↑ 5%
Pollinators and climate change: the link to human health
75% of crops
breakfast without pollinators
Wild Pollinators Enhance Fruit Set of Crops Regardless of Honey Bee Abundance

Lucas A. Garibaldi, Ingolf Steffan-Dewenter, Rachael Winfree, Marcelo A. Aizen, Riccardo Bommarco, Saul A. Cunningham, Claire Kremen, Luísa G. Carvalheiro
Thank you