

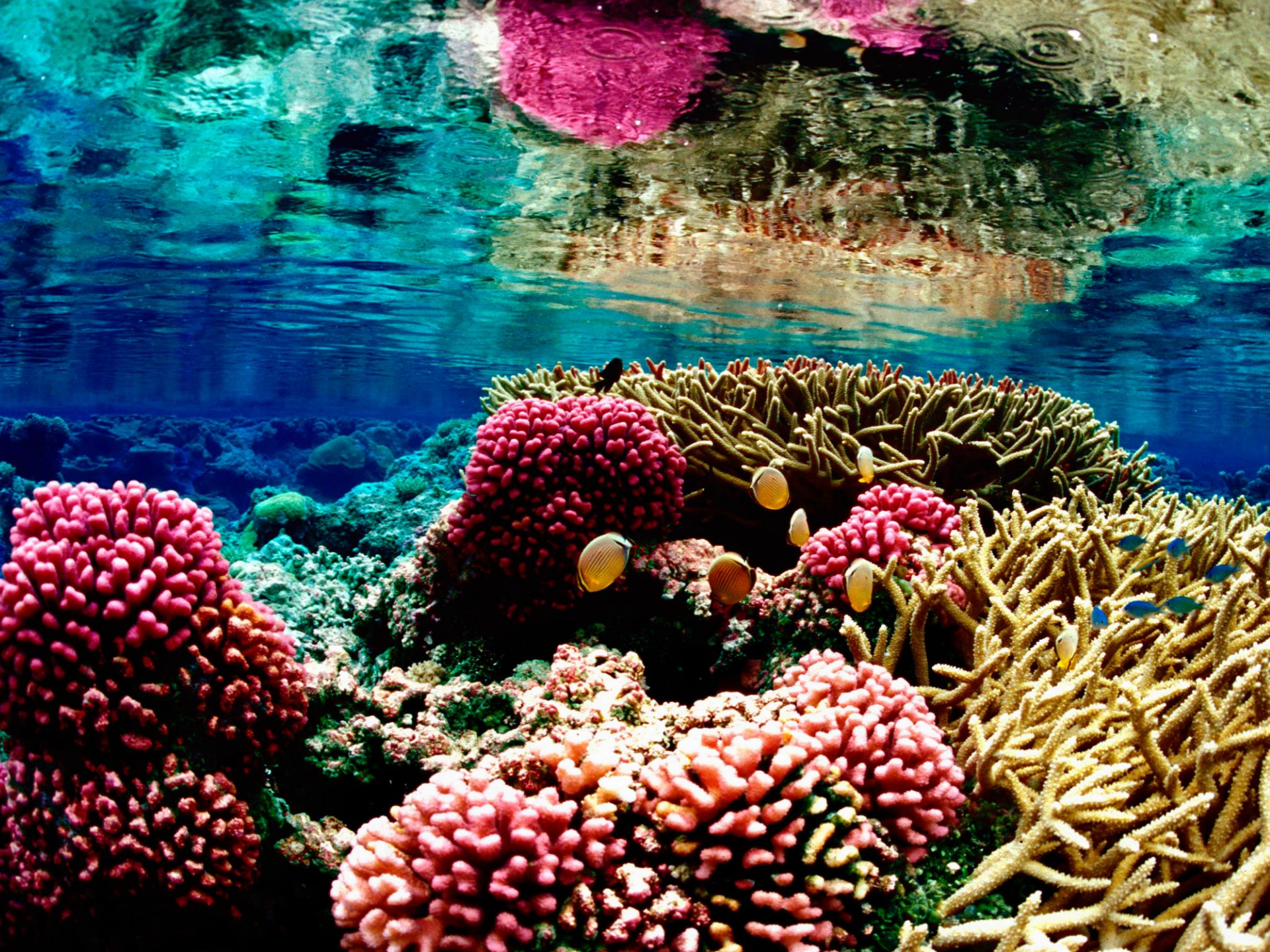
Ecological interactions and climate change:
a test case of pollinators and flowers

Rachael Winfree

Dept of Ecology, Evolution and Natural Resources, Rutgers University

Mutualistic
interactions
underlie life on
earth







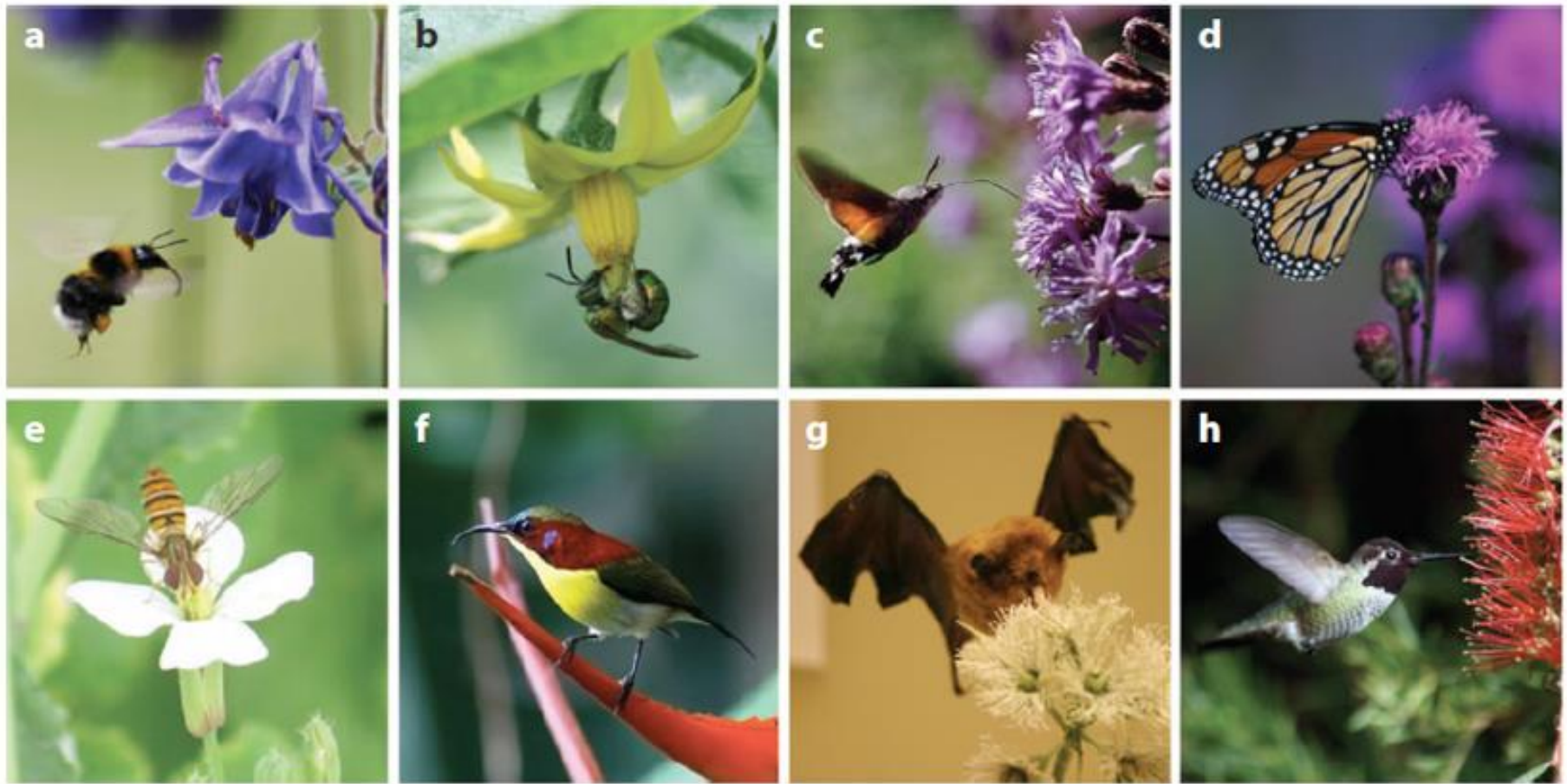


Figure 1

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

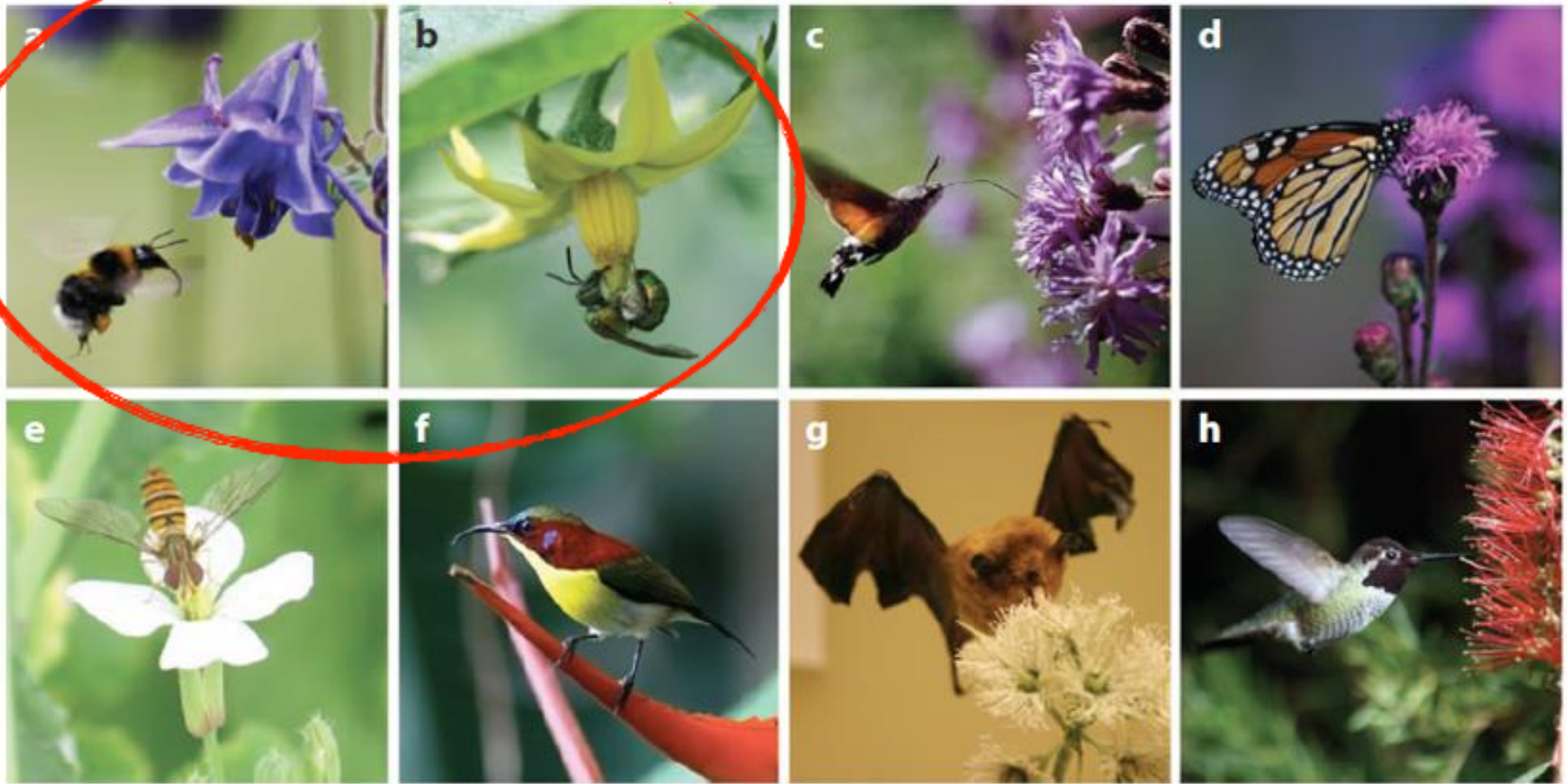


Figure 1

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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^a, John S. Ascher^b, David Wagner^c, Bryan N. Danforth^d, Sheila Colla^e, Sarah Kornbluth^b, and ~~Richard~~ Winfree^a

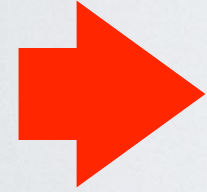
^aDepartment of Entomology, Rutgers University, New Brunswick, NJ 08901; ^bDivision of Invertebrate Zoology, American Museum of Natural History, New York, NY 10024; ^cDepartment of Ecology and Evolutionary Biology, University of Connecticut, Storrs, CT 06269; ^dDepartment of Entomology, Cornell University, Ithaca, NY 14853; and ^eDepartment of Biology, York University, Toronto, ON, Canada M3J 1P3

Edited by F. Stuart Chapin, University of Alaska, Fairbanks, AK, and approved November 7, 2011 (received for review September 21, 2011)



days from 1 January

100 150 200 250



days from 1 January

100 150 200 250



days from 1 January

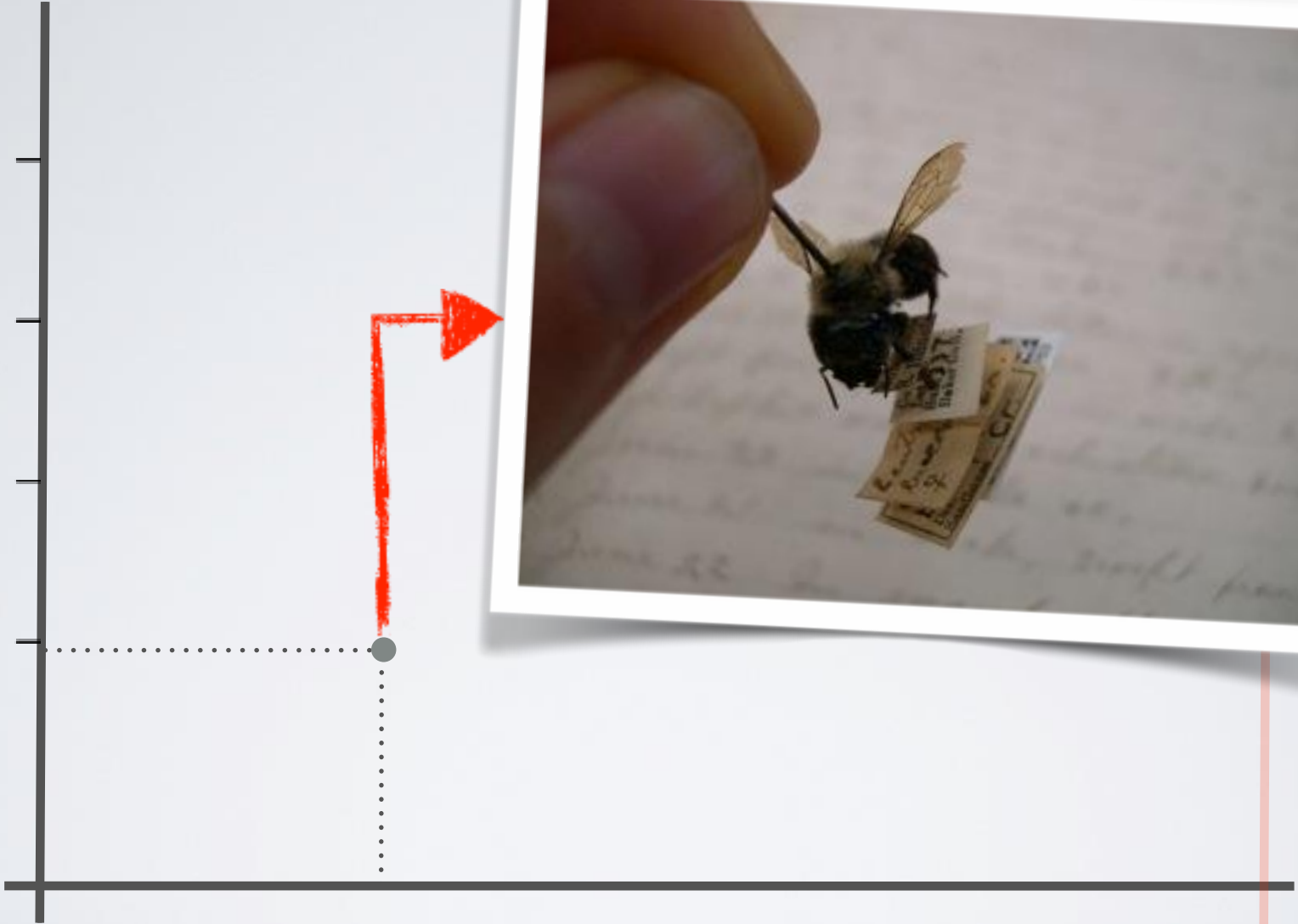
100 150 200 250



days from 1 January

100 150 200 250

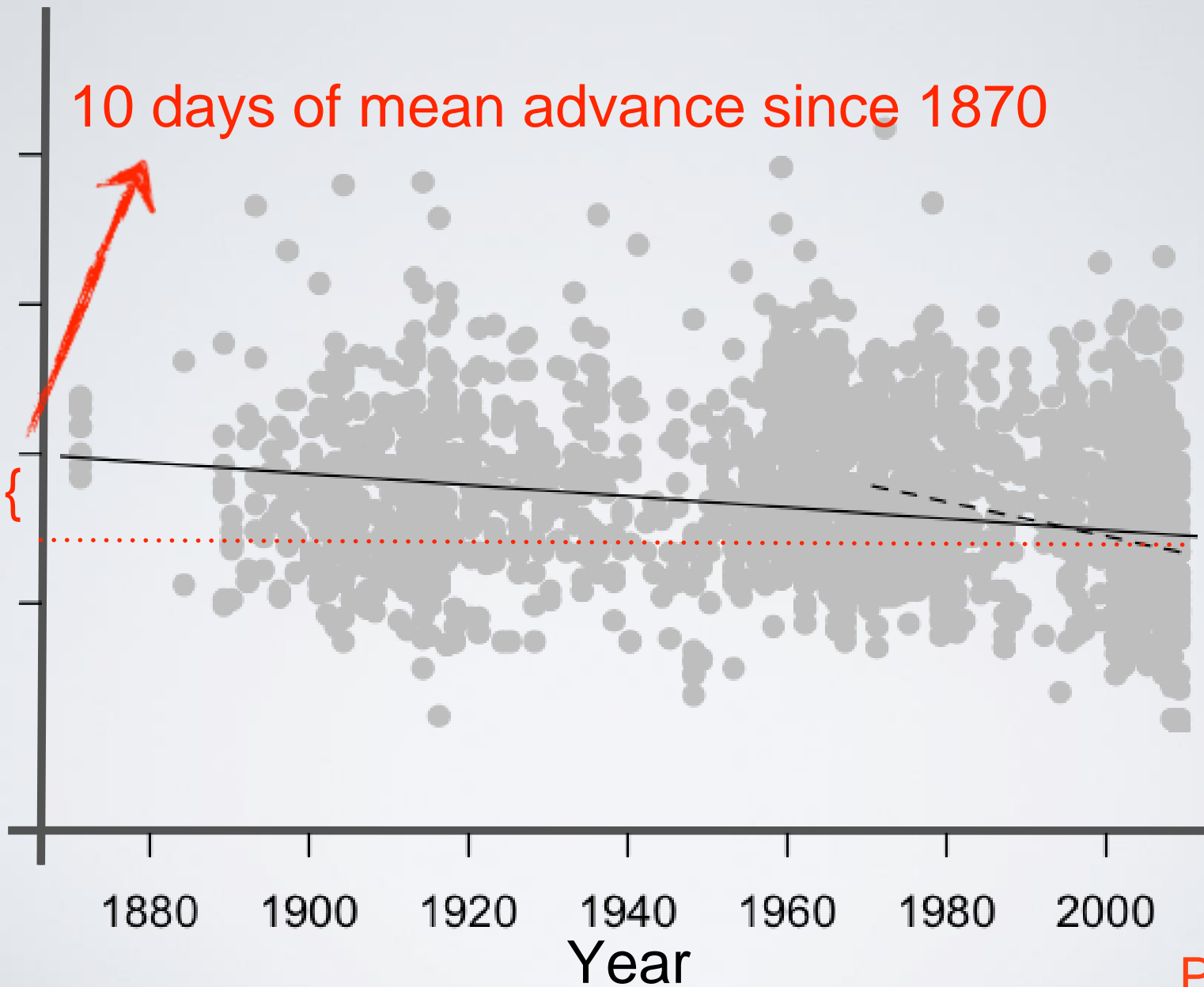
Year



days from 1 January

250
200
150
100

10 days of mean advance since 1870



$P < 0.001$

days from 1 January

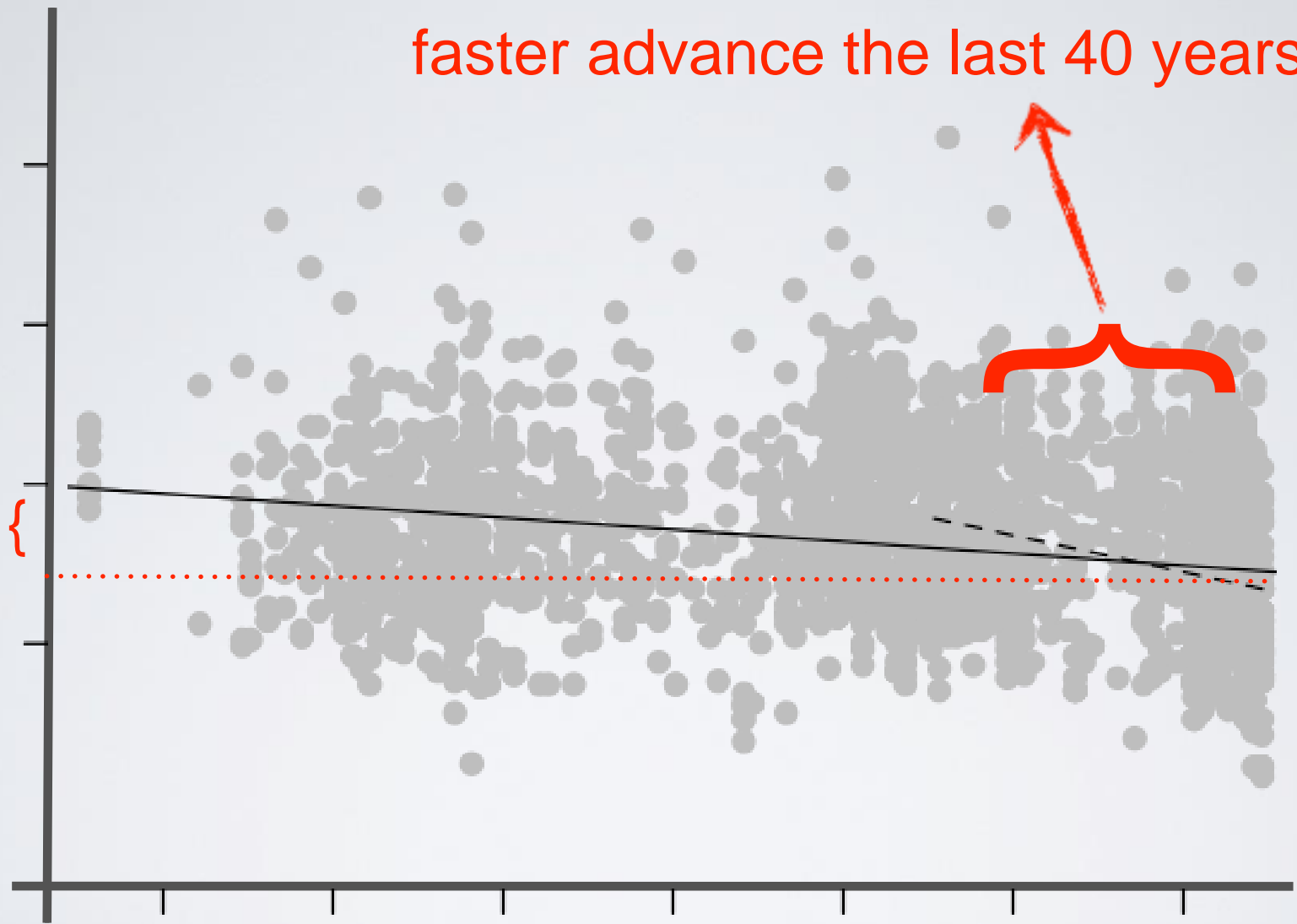
faster advance the last 40 years

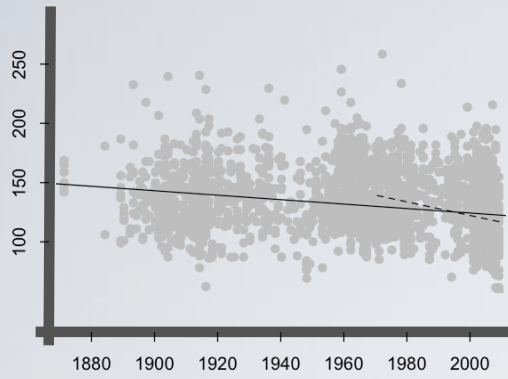
250
200
150
100

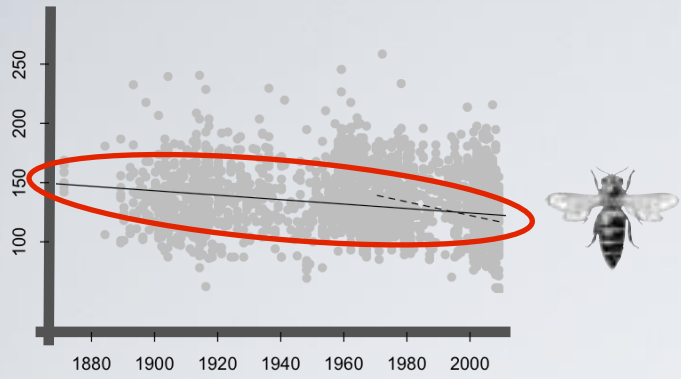
1880 1900 1920 1940 1960 1980 2000

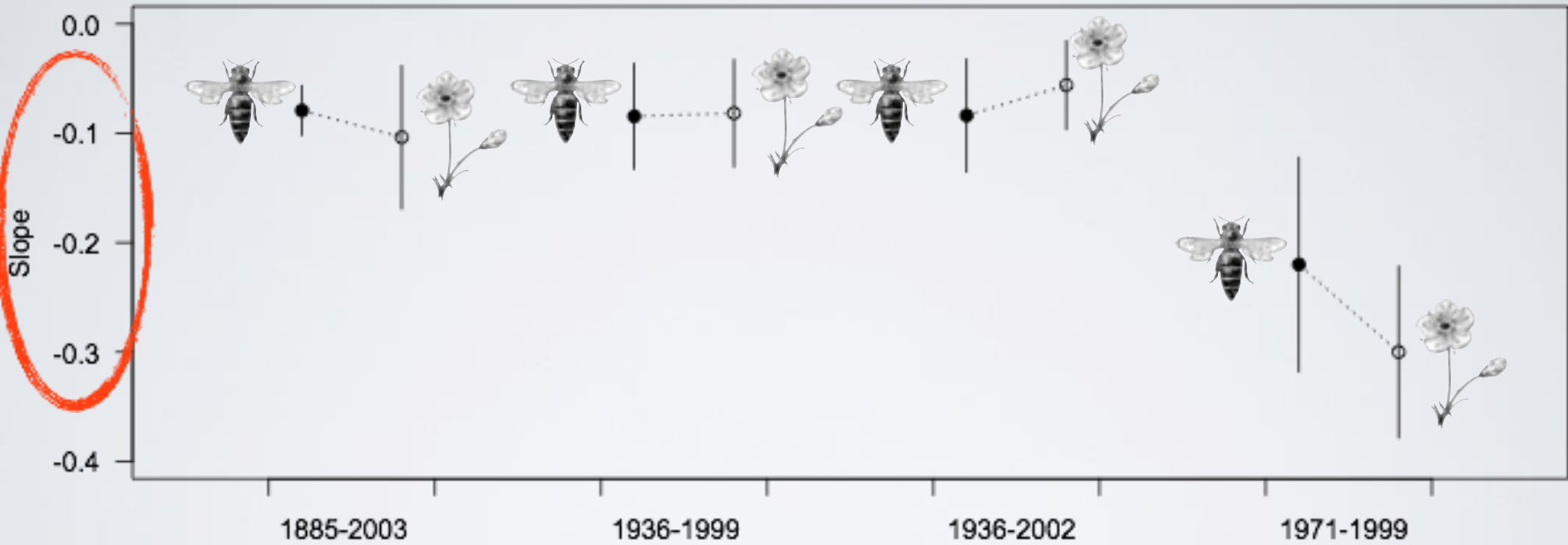
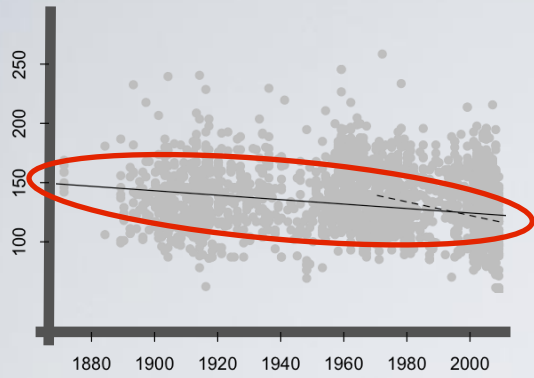
Year

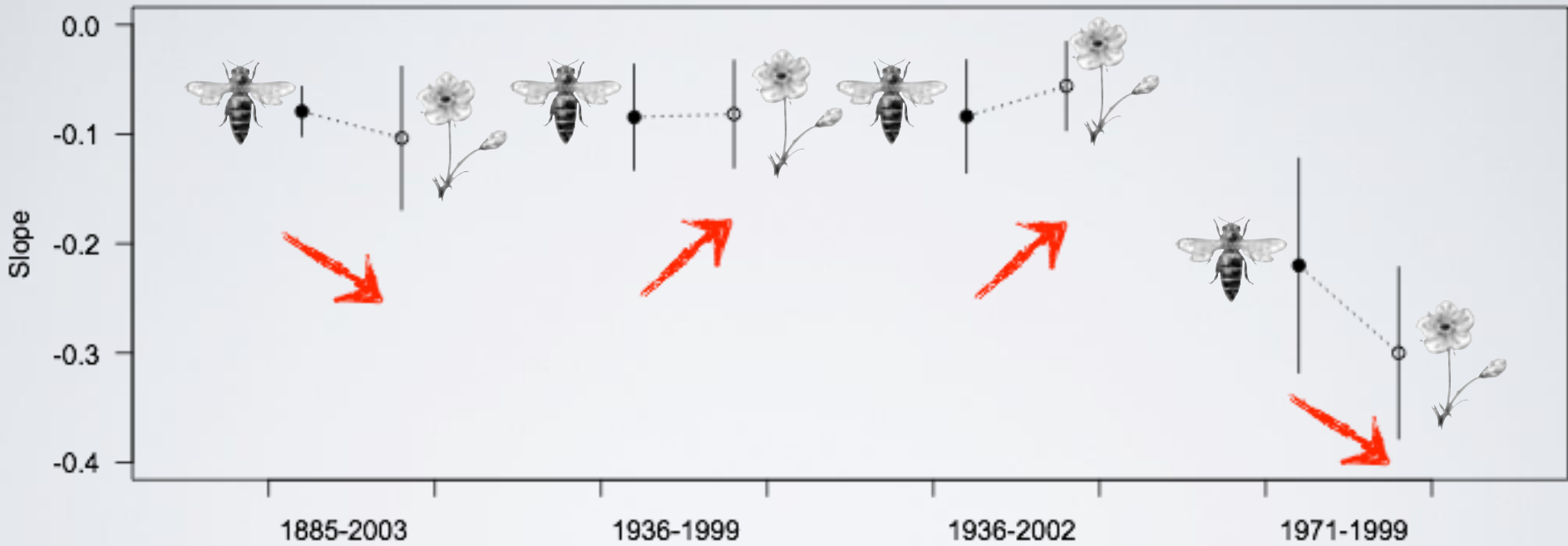
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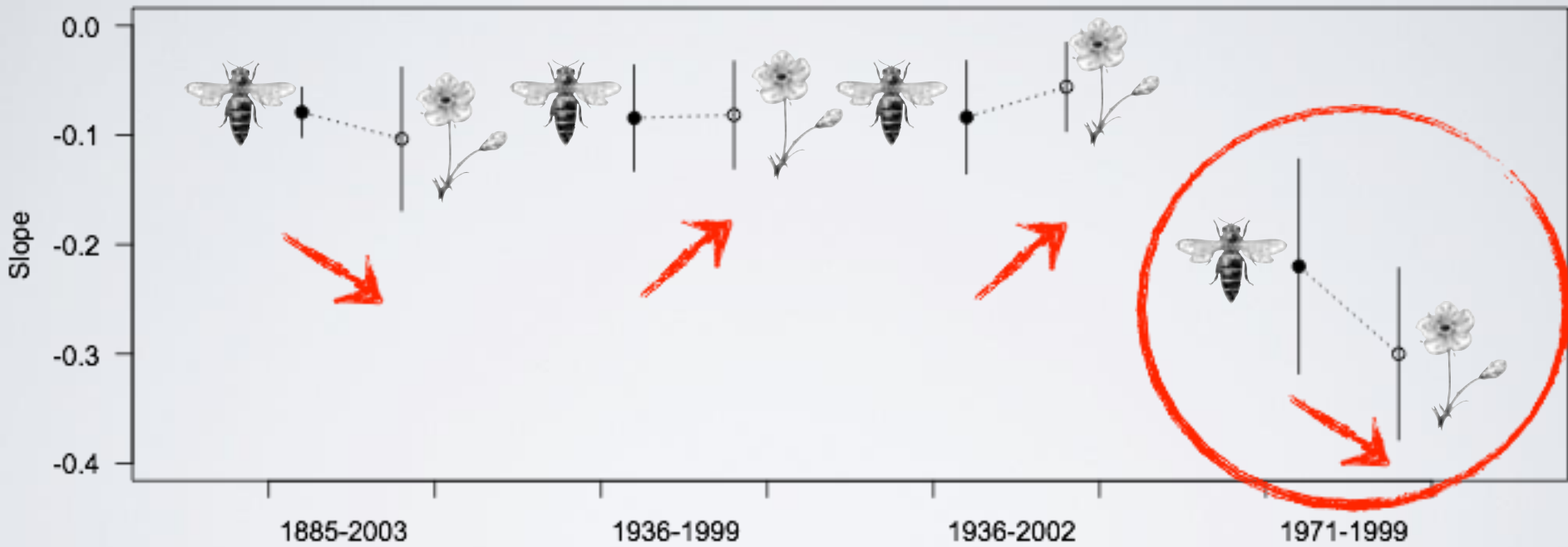




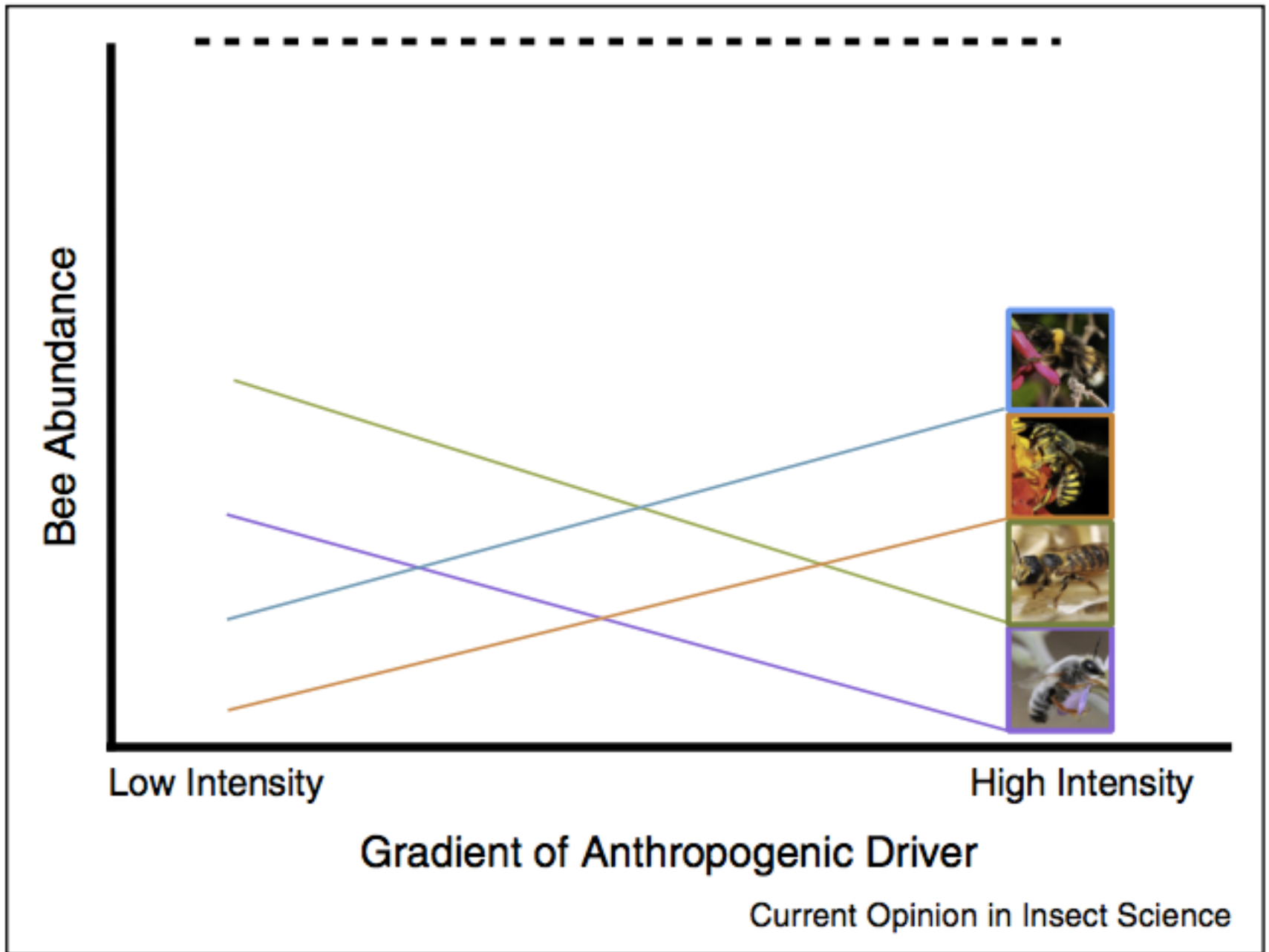








Can bee biodiversity buffer
pollination against climate change?





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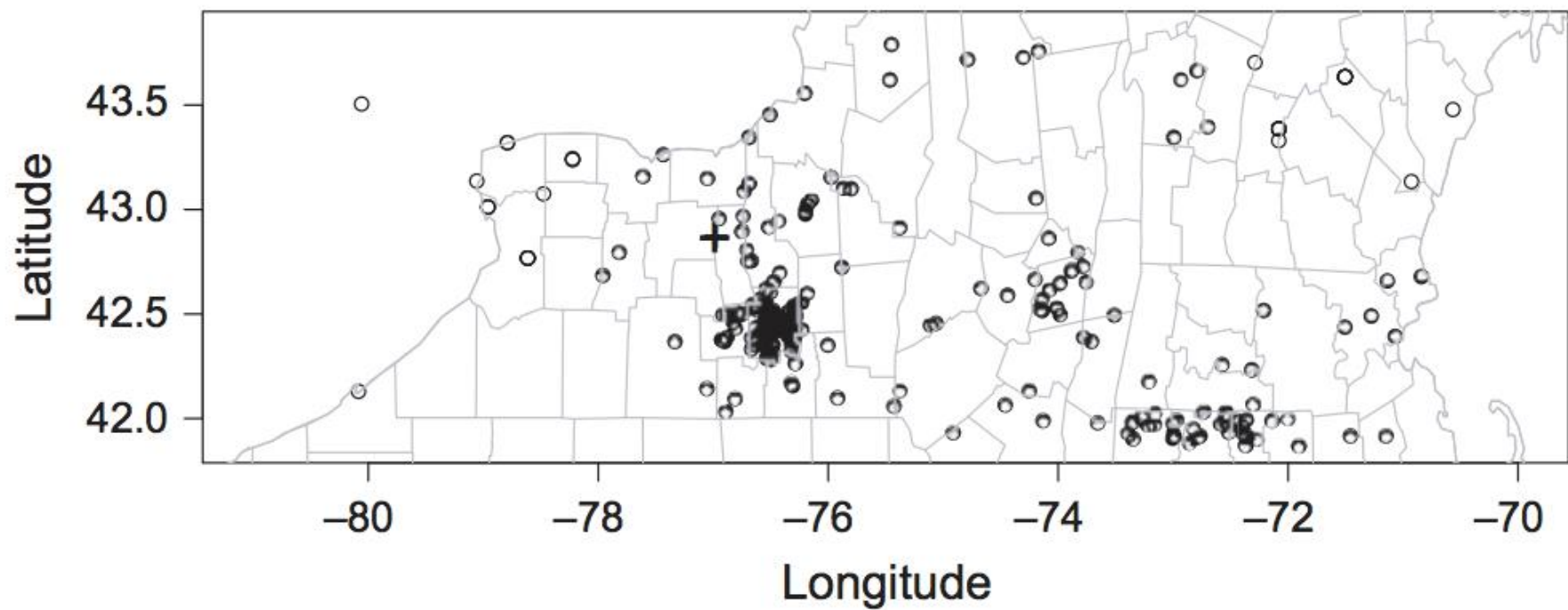
LETTER

Biodiversity ensures plant–pollinator phenological synchrony against climate change

Ignasi Bartomeus,^{1,2} Mia G. Park,³ Jason Gibbs,^{3,4} Bryan N. Danforth,³ Alan N. Lakso⁵ and Rachael Winfree^{1,6}

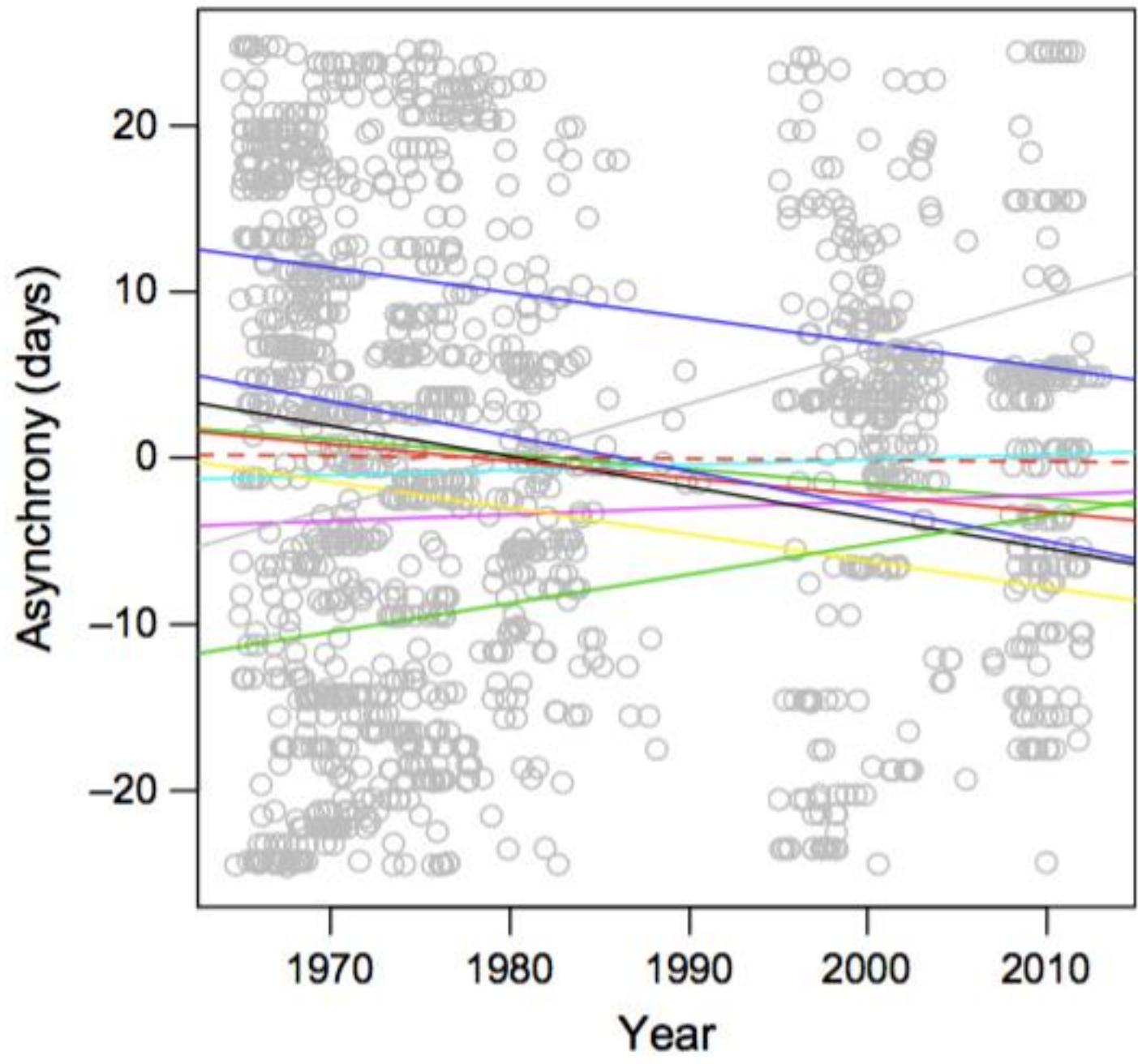
Abstract

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*†

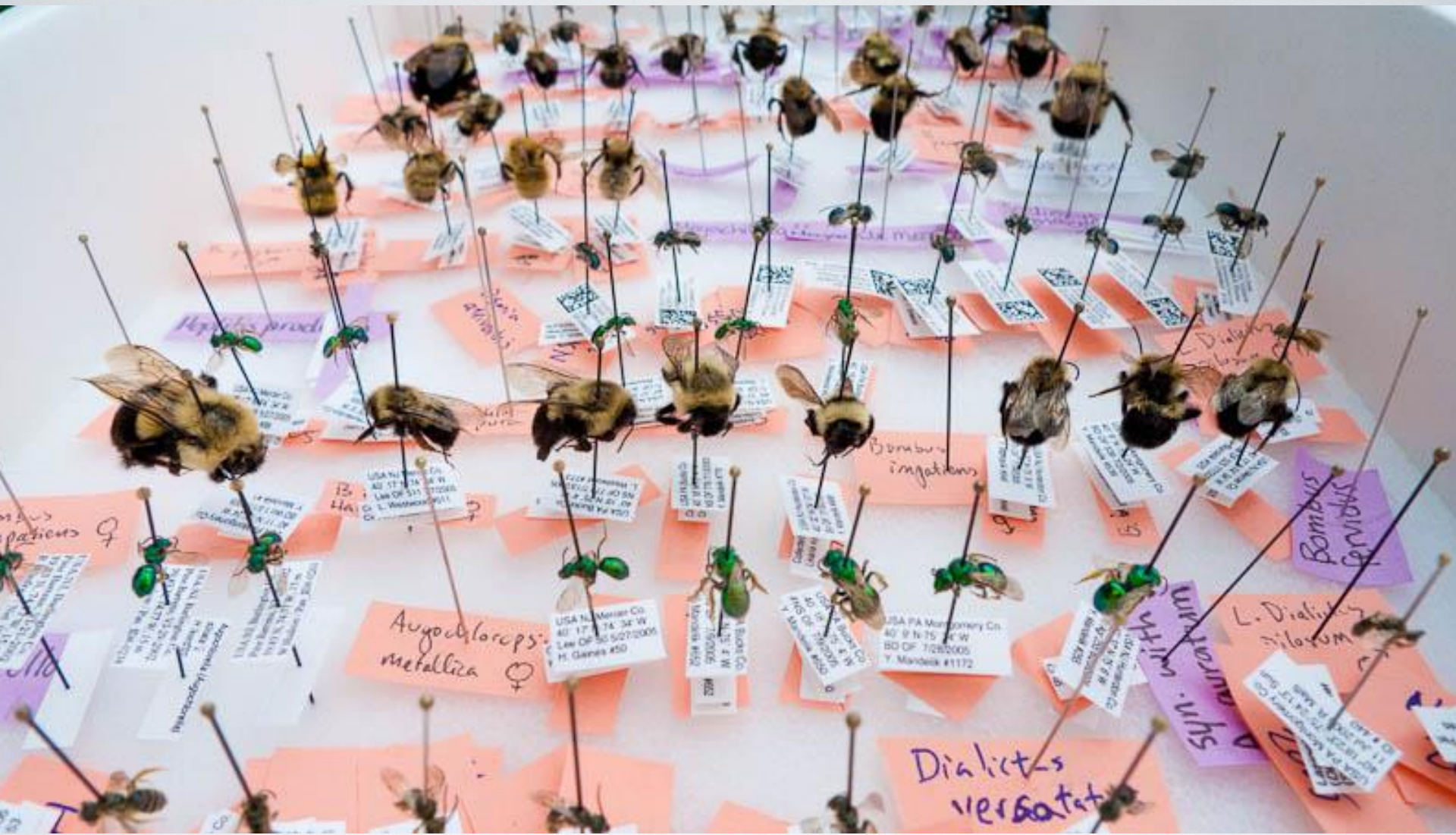
*Department of Entomology, Rutgers, The State University of New Jersey, 93 Lipman Drive, New Brunswick, NJ 08901, USA,

†Department of Ecology, Evolution and Natural Resources, Rutgers, The State University of New Jersey, 93 Lipman Drive, New Brunswick, NJ 08901, USA





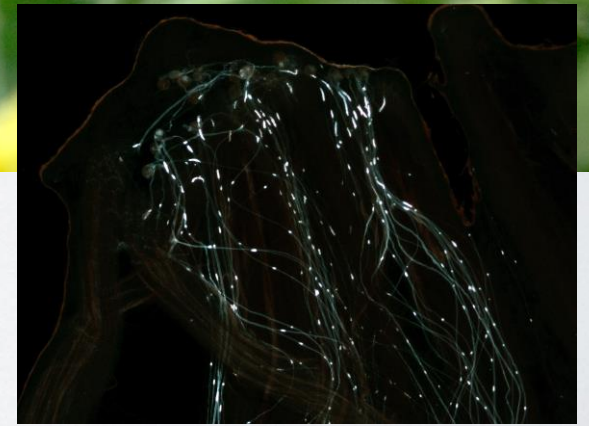
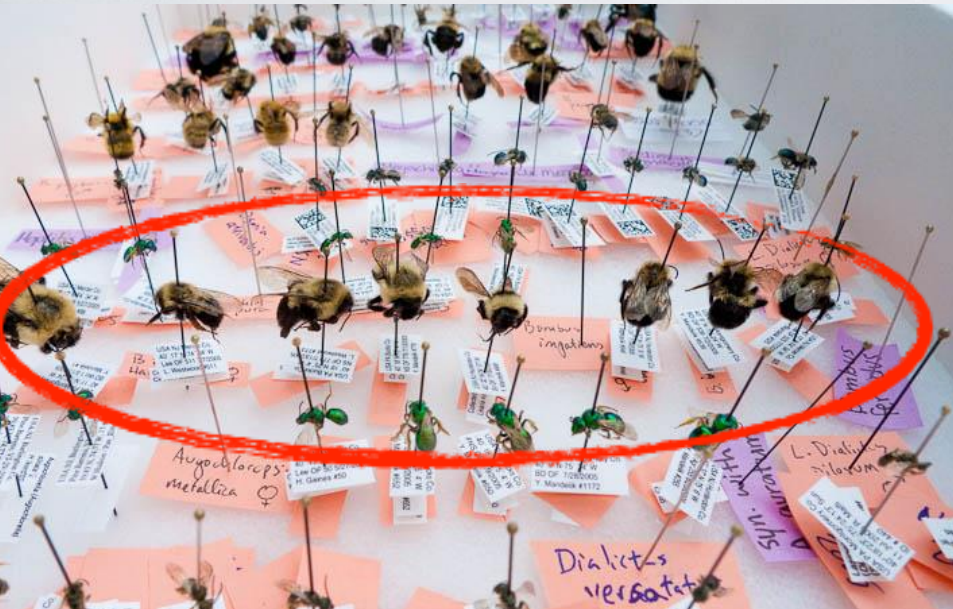
4 years of data from 18 farms
>16,000 bee visits to >46,000 flowers
471 pollen deposition experiments







estimate pollination provided per bee species group





Bumble bees
(98% *Bombus impatiens*)



Honey bee
(*Apis mellifera*)



Melissodes bimaculata



Peponapis pruinosa



Green bees
(89%
Augochlora pura)



Ceratina
(3 species)

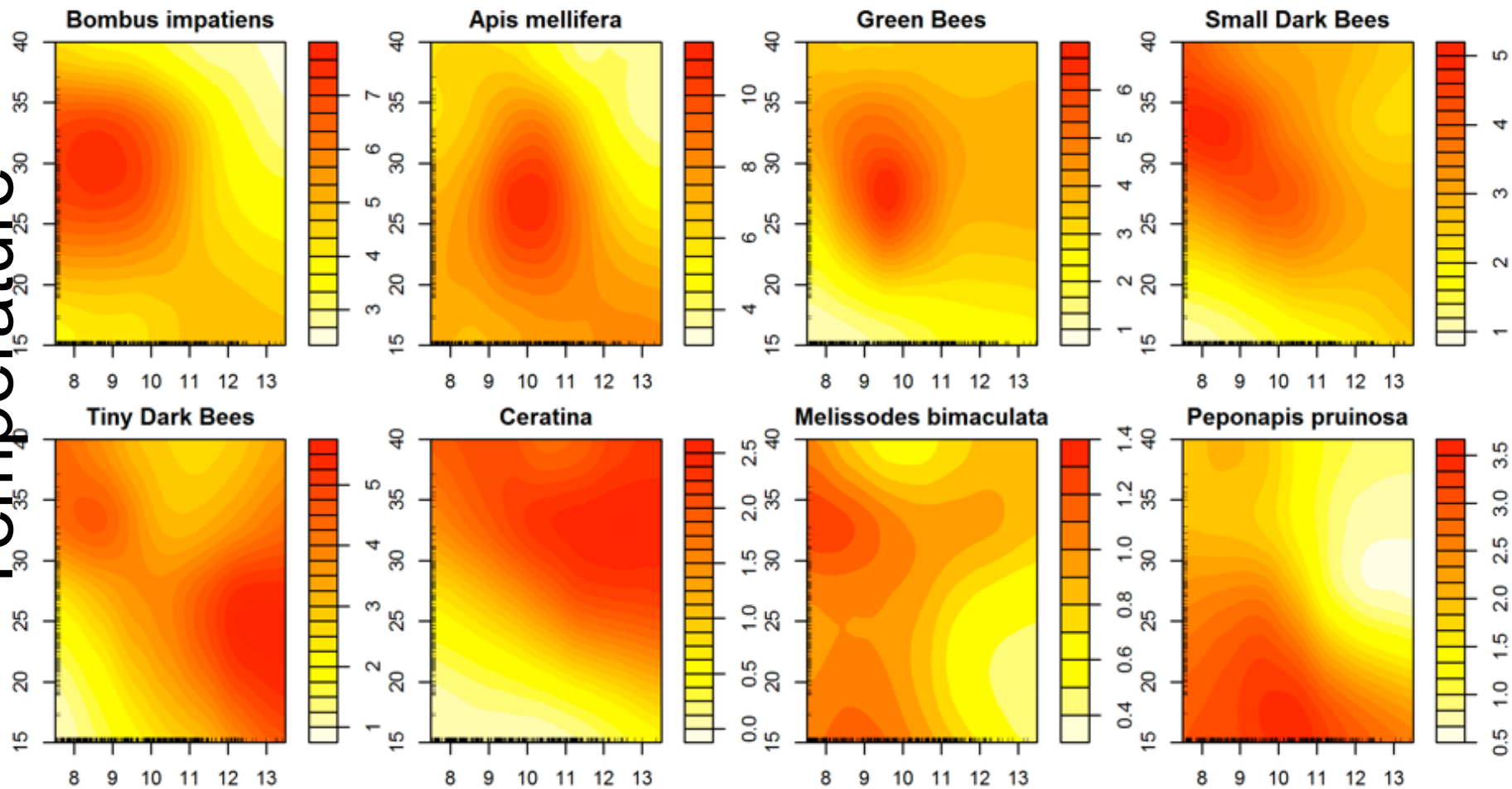


Small dark
(15
species)



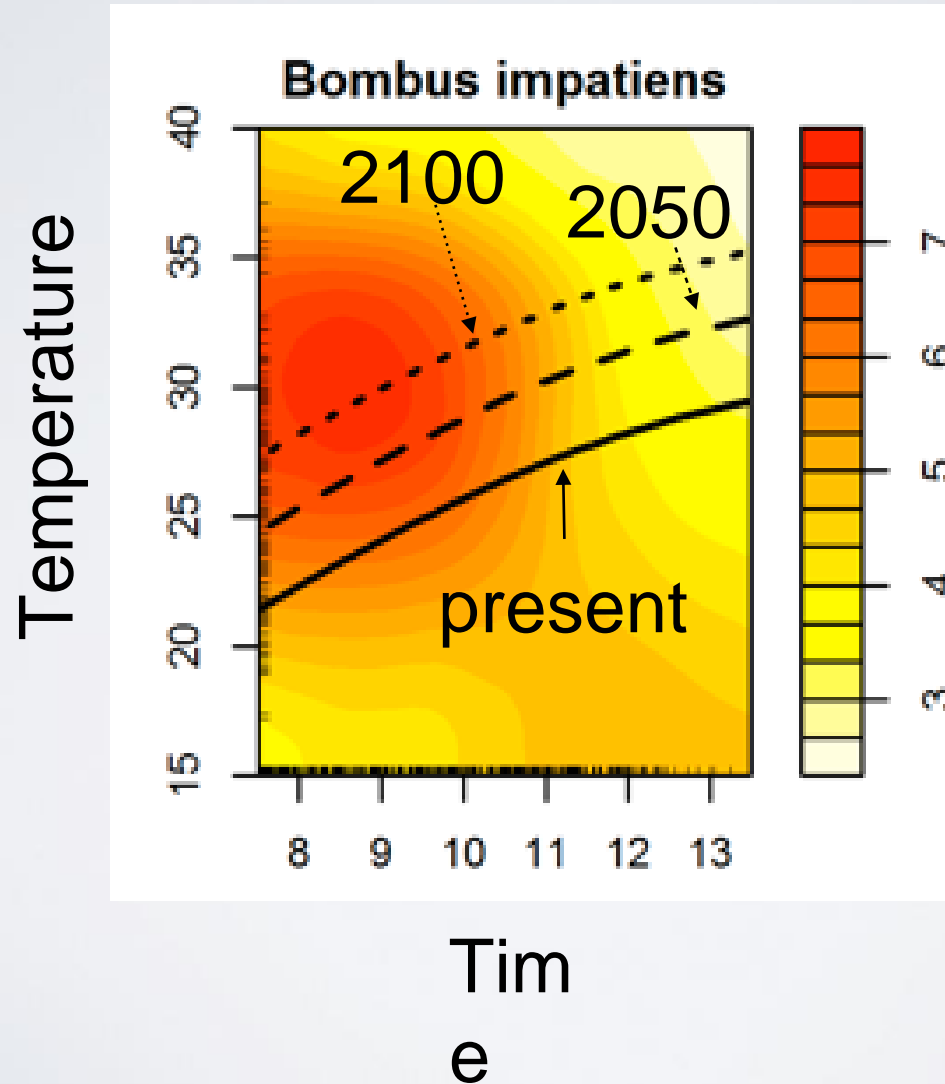
Tiny dark
(7
species)

Temperature





Time of day

Future climate scenario IPCC A1






Biodiversity buffers crop pollination against climate 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%

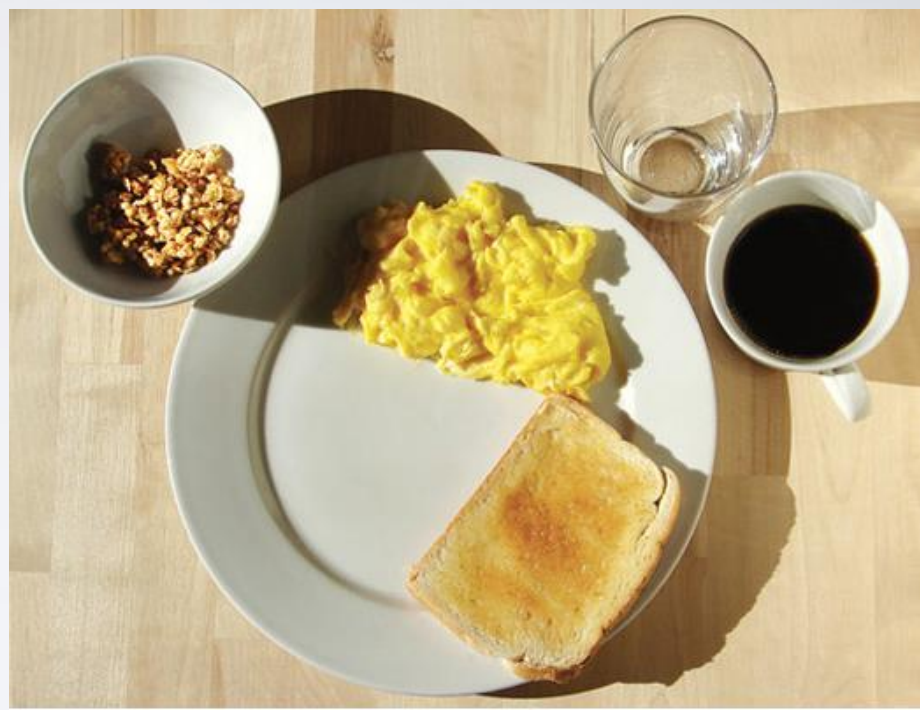
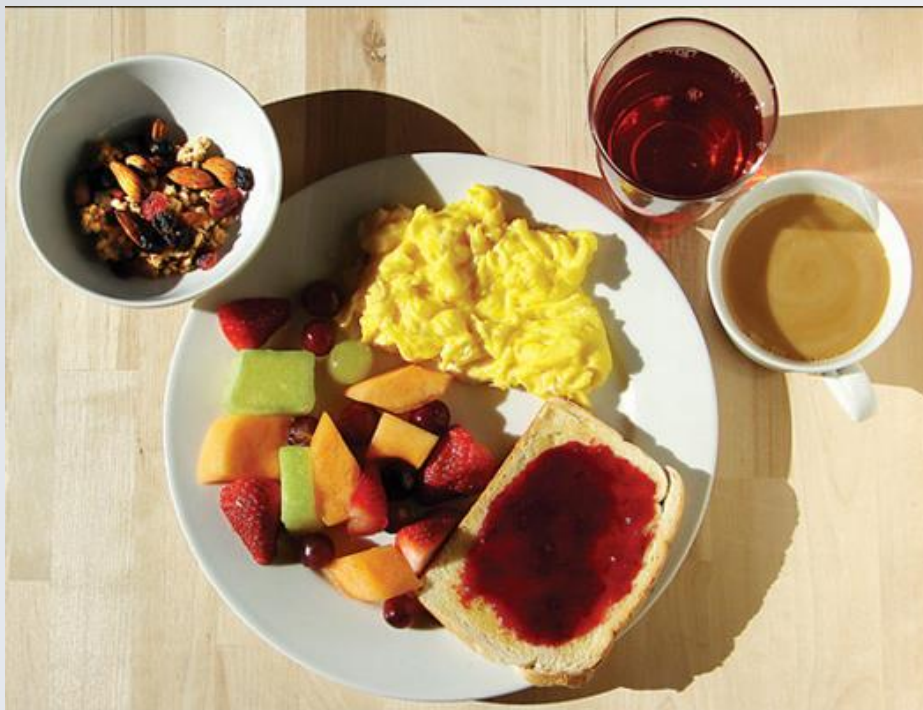


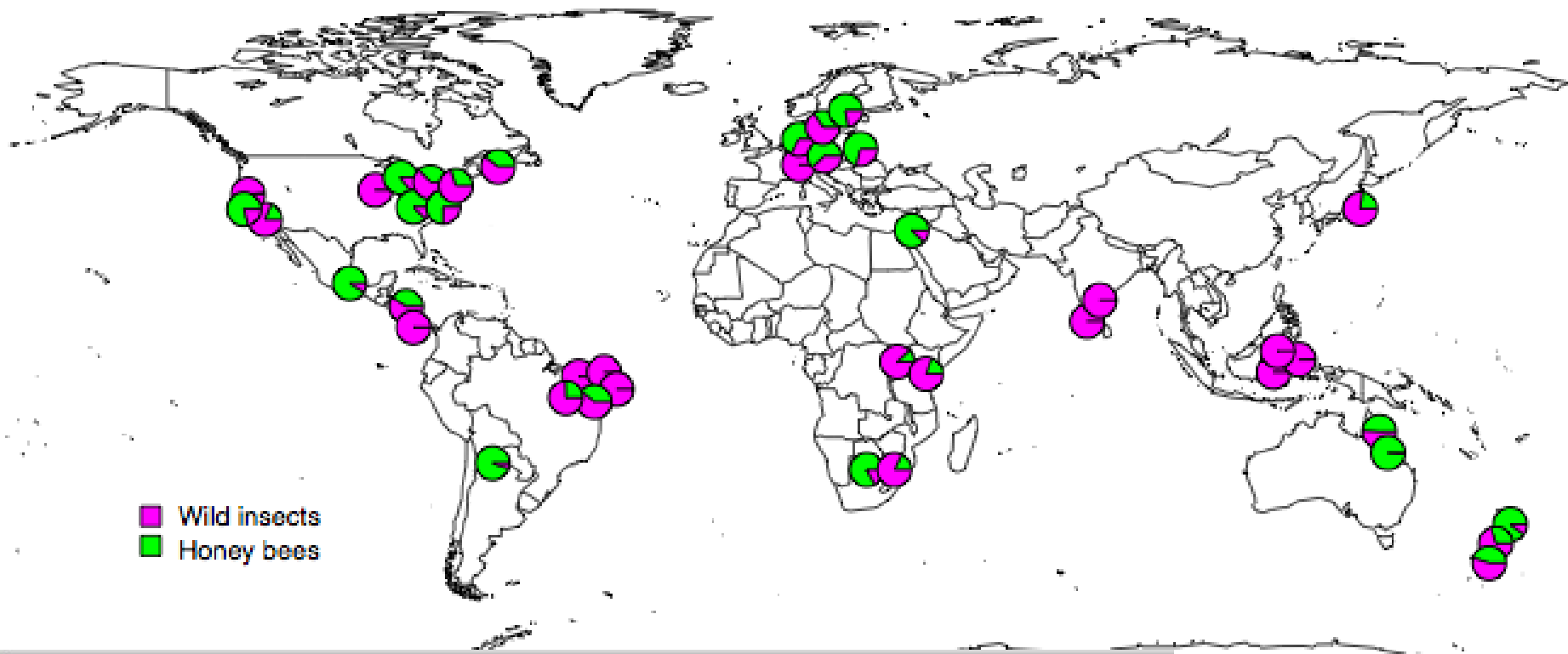
Pollinators and climate change: the link to human health



75% of crops

breakfast without pollinators





REPORTS

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SCIENCE

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Wild Pollinators Enhance Fruit Set of Crops Regardless of Honey Bee Abundance

Lucas A. Garibaldi,^{1*} Ingolf Steffan-Dewenter,² Rachael Winfree,³ Marcelo A. Aizen,⁴ Riccardo Bommarco,⁵ Saul A. Cunningham,⁶ Claire Kremen,⁷ Luísa G. Carvalheiro,^{8,9}



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Thank you

