Host-plant Specialist Bees – Biology, Biodiversity, and Conserving Them in Your Backyard

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Outline:

1. Meet the specialist bees
2. Specialist bees as a group of conservation concern
3. The lexicon of host-plant specialization
4. Specialization across bee phylogeny
5. Specialization across habitats
6. Which came first, generalization of specialization?
7. Which host-plant families do bees most often specialize upon?
8. Rapid evolution and host-plant specialization
9. Specialization and diversification
10. Why do bees specialize?
11. Conserving specialists in your backyard

1. Meet the specialist bees

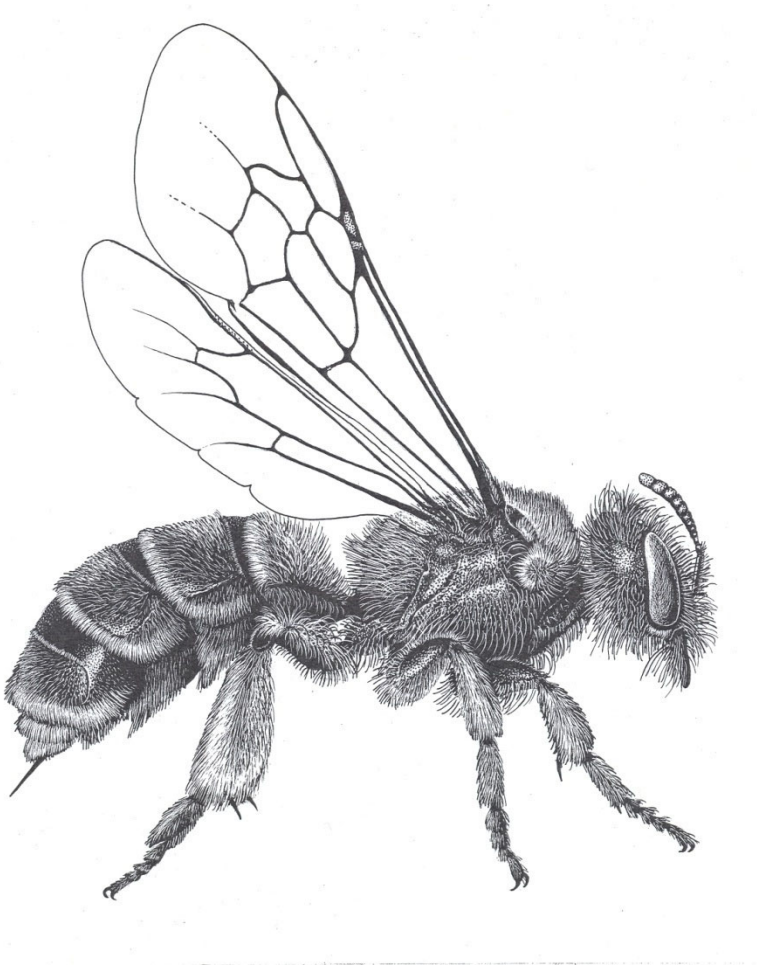
Scabiosa
(Dipsacaceae)

Dasypoda argentata
(Melittidae)

1. Meet the specialist bees

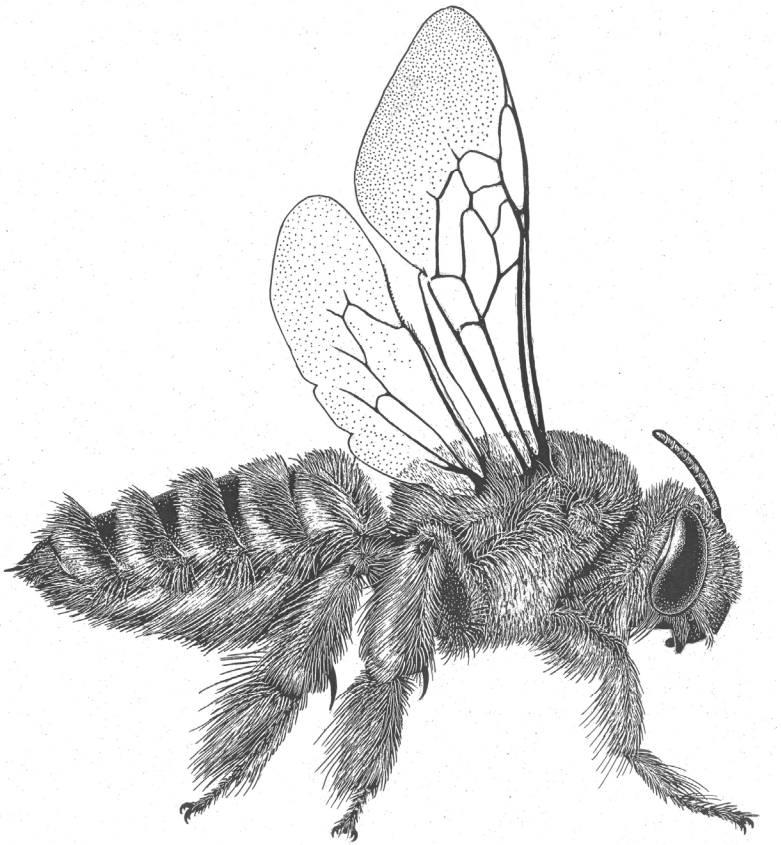
*Stachys (*Lamiaceae)

Rophites (Halictidae)



1. Meet the specialist bees

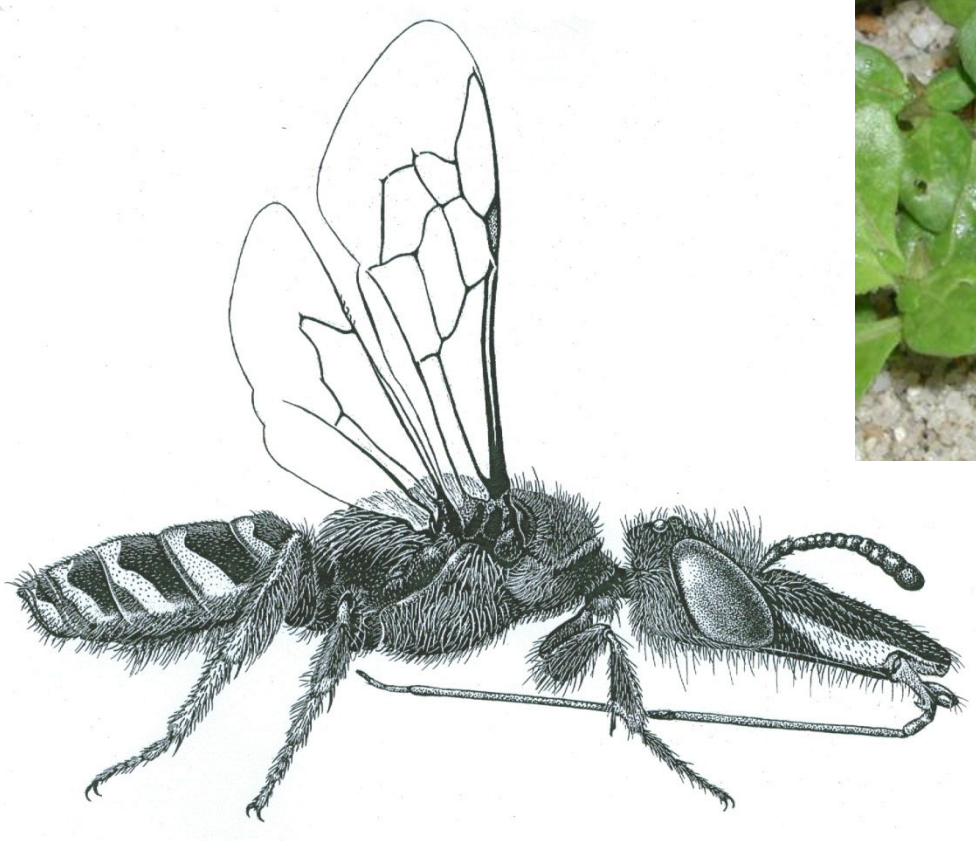
Fidelia villosa
(Megachilidae)



Mesembryanthemum
*(*Aizoaceae)

1. Meet the specialist bees

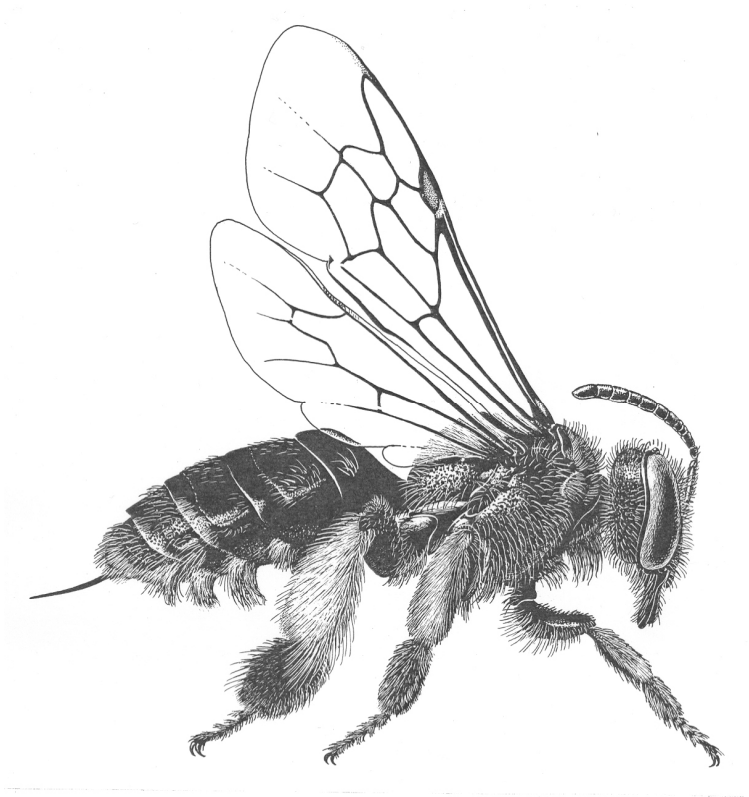
Chilimelissa rozeni
(Colletidae)



Nolana alba
(Solanaceae)

1. Meet the specialist bees

Lysimachia ciliata (Primulaceae)



Macropis nuda (Melittidae)

2. Specialist bees as a group of conservation concern

"By studying bee (and hoverfly) assemblages in Britain and the Netherlands, we found evidence of declines (pre- versus post-1980) in local bee diversity in both countries... Depending on the assemblage and location, pollinator *declines were most frequent in habitat and flower specialists*, in univoltine species, and/or in nonmigrants"

Biesmeijer JC, Roberts SPM, Reemer M, Ohlemüller R, Edwards M, et al. 2006. Parallel declines in pollinators and insect-pollinated plants in Britain and the Netherlands. Science. 313(5785):351–54

2. Specialist bees as a group of conservation concern

"Of the species included in the Red List of bees of Czechia, *oligoleges are proportionally more strongly represented than polyleges*. Most of these red-listed oligoleges are associated with specific and regionally endangered habitats, i.e. steppes or wetlands"

Bogusch P, Bláhová E, Horák J. 2020. Pollen specialists are more endangered than non-specialised bees even though they collect pollen on flowers of non-endangered plants. Arthropod-Plant Interactions. 14(6):759–69

2. Specialist bees as a group of conservation concern

"… the loss of bees was nonrandom, such that *bees that were specialists, parasites, cavity-nesters and/or those that participated in weak historic interactions were more likely to be extirpated… Specialists were lost more than generalists* (even after correcting for potential observation bias), despite the fact that their host-plants were still present"

Burkle LA, Marlin JC, Knight TM. 2013. Plant-pollinator interactions over 120 years: loss of species, co-occurrence, and function. Science. 339(6127):1611–15

3. The lexicon of host-plant specialization

Monolecty – specialization on a single plant species

Narrow oligolecty -- specialization on a single plant genus

Oligolecty -- specialization on a few, closely related plant genera (usually within a discrete taxonomic category, such as a tribe, subfamily, or family)

Mesolecty – collect pollen from multiple (1-3) plant families

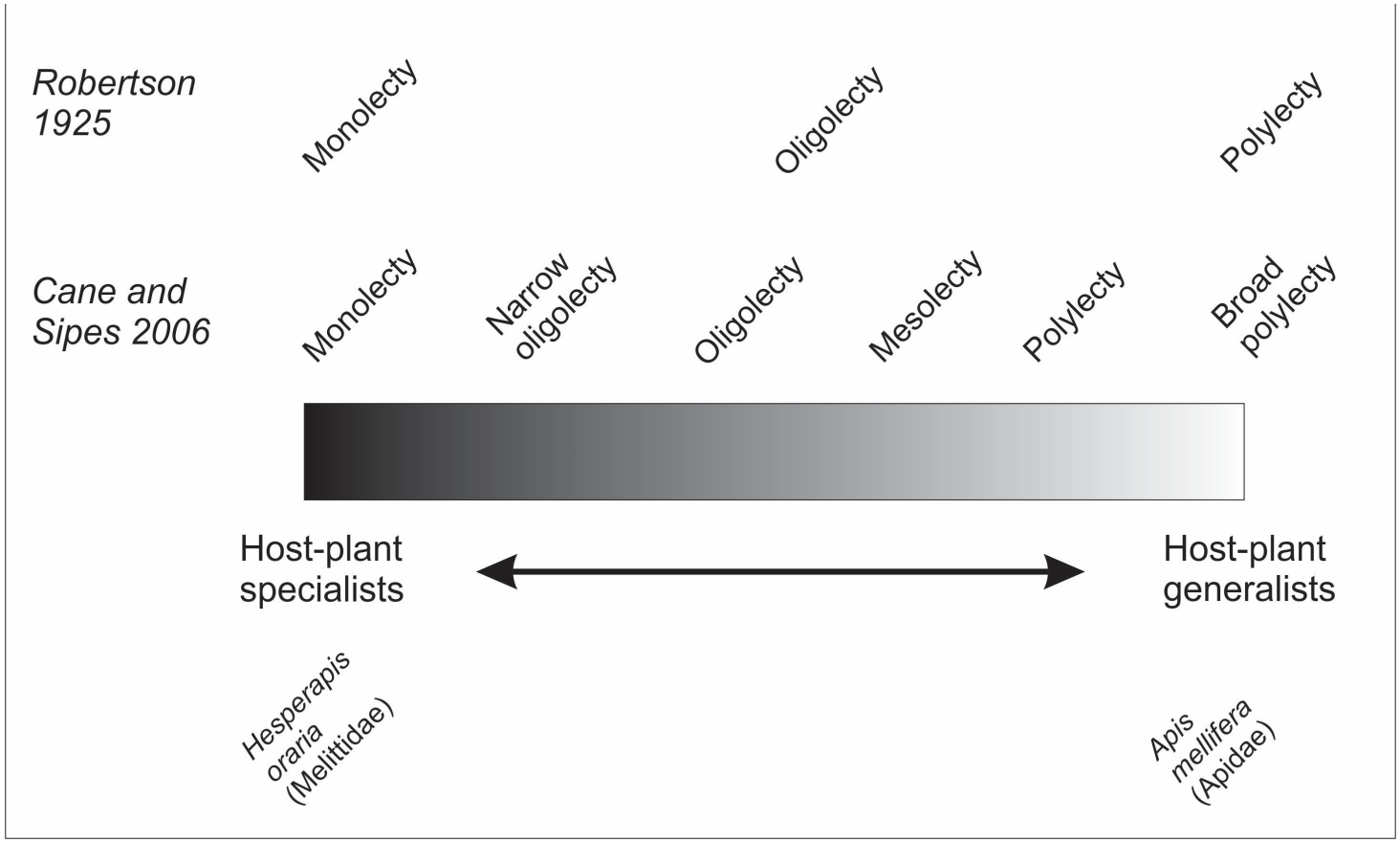
Polylecty – collect pollen from diverse (>4) plant families

Broad polylecty – collect pollen from numerous plant families present in the area (>25% of available families)

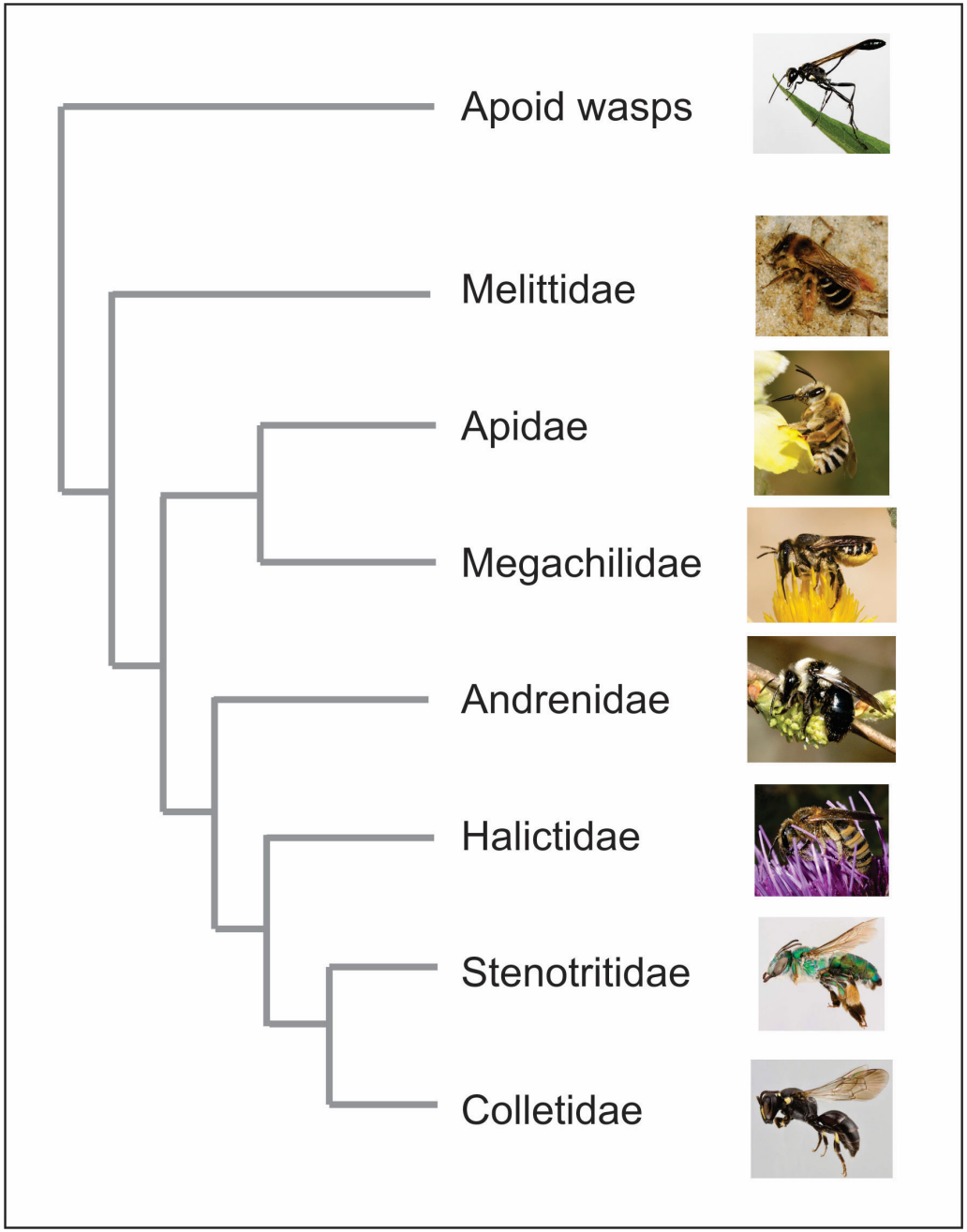
"Eclectic" oligolecty – specialize on two (or more) discrete plant genera from unrelated plant families (e.g., *Osmia ribifloris*)

Cane & Sipes (2006)

3. The lexicon of host-plant specialization

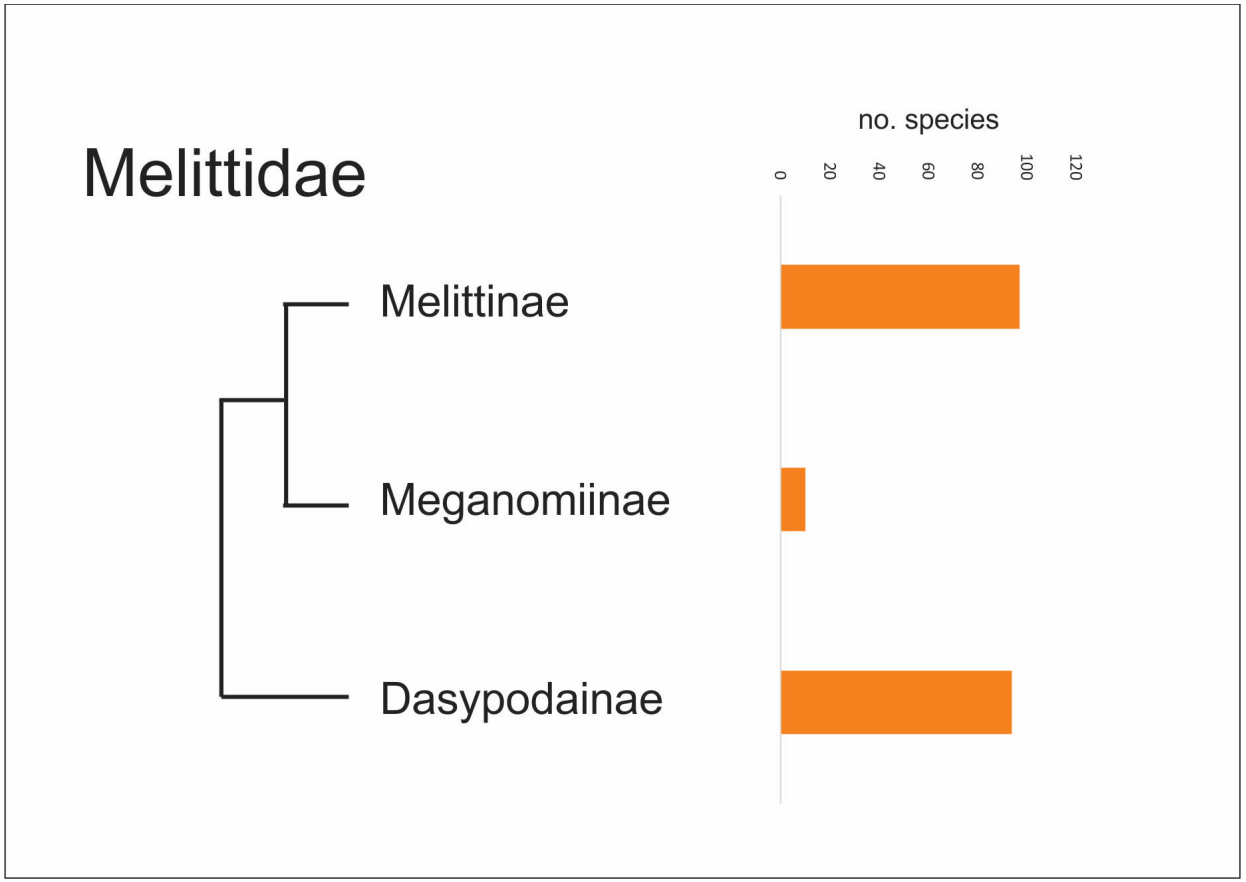


Danforth et al. (2019)



4. Specialization across bee phylogeny

Danforth et al. (2013)



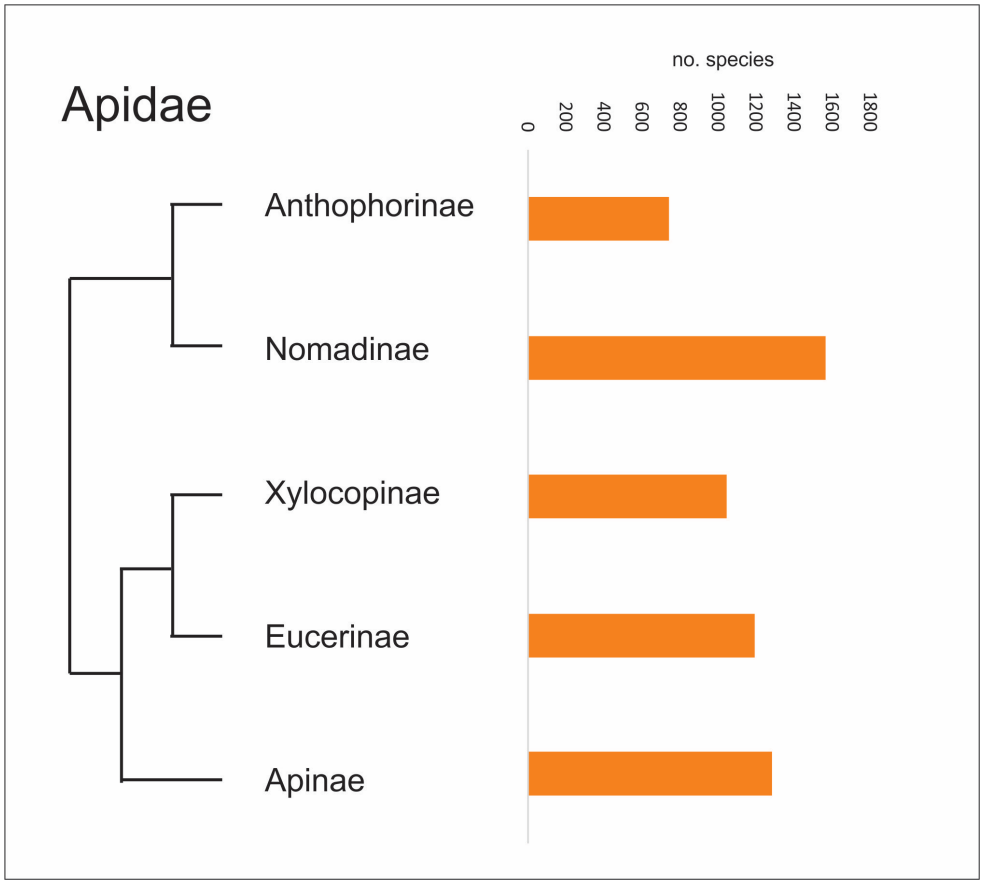
Melitta nigricans

Macropis nuda

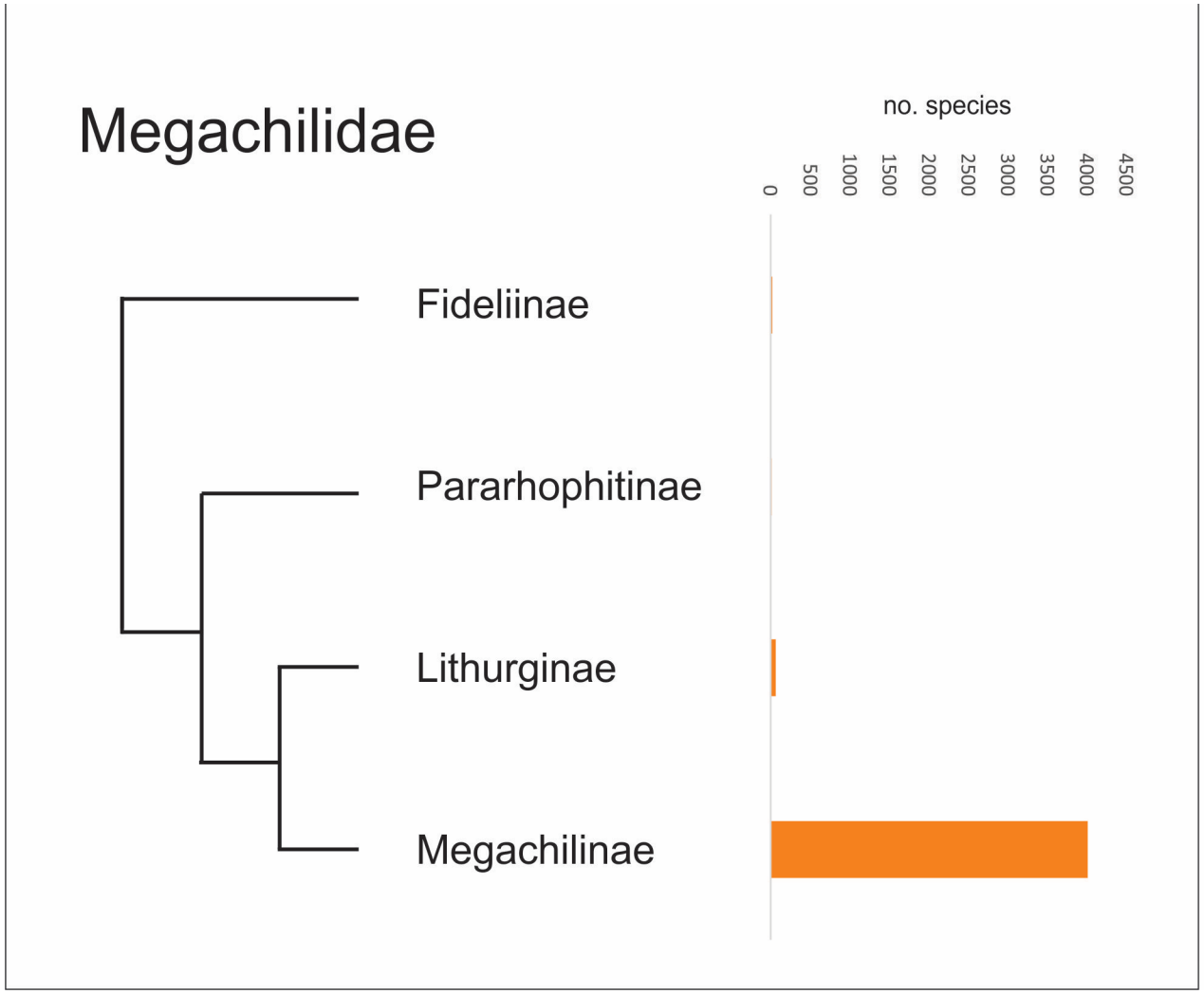
Dasypoda hirtipes

Synhalonia mediterranea

Ceratina sp.



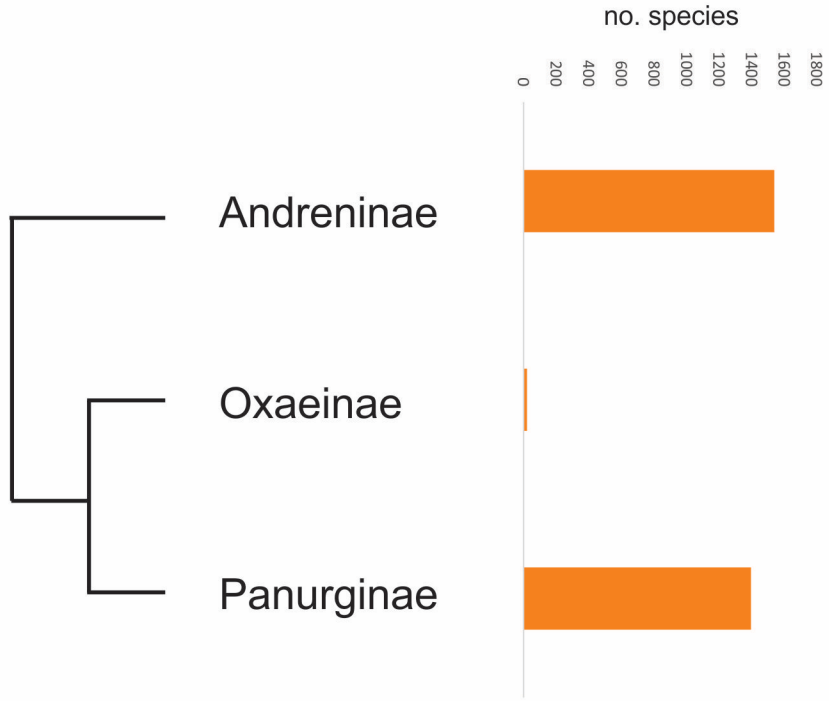
Nomada armata



Lithurgus chrysurus

Anthidium strigatum

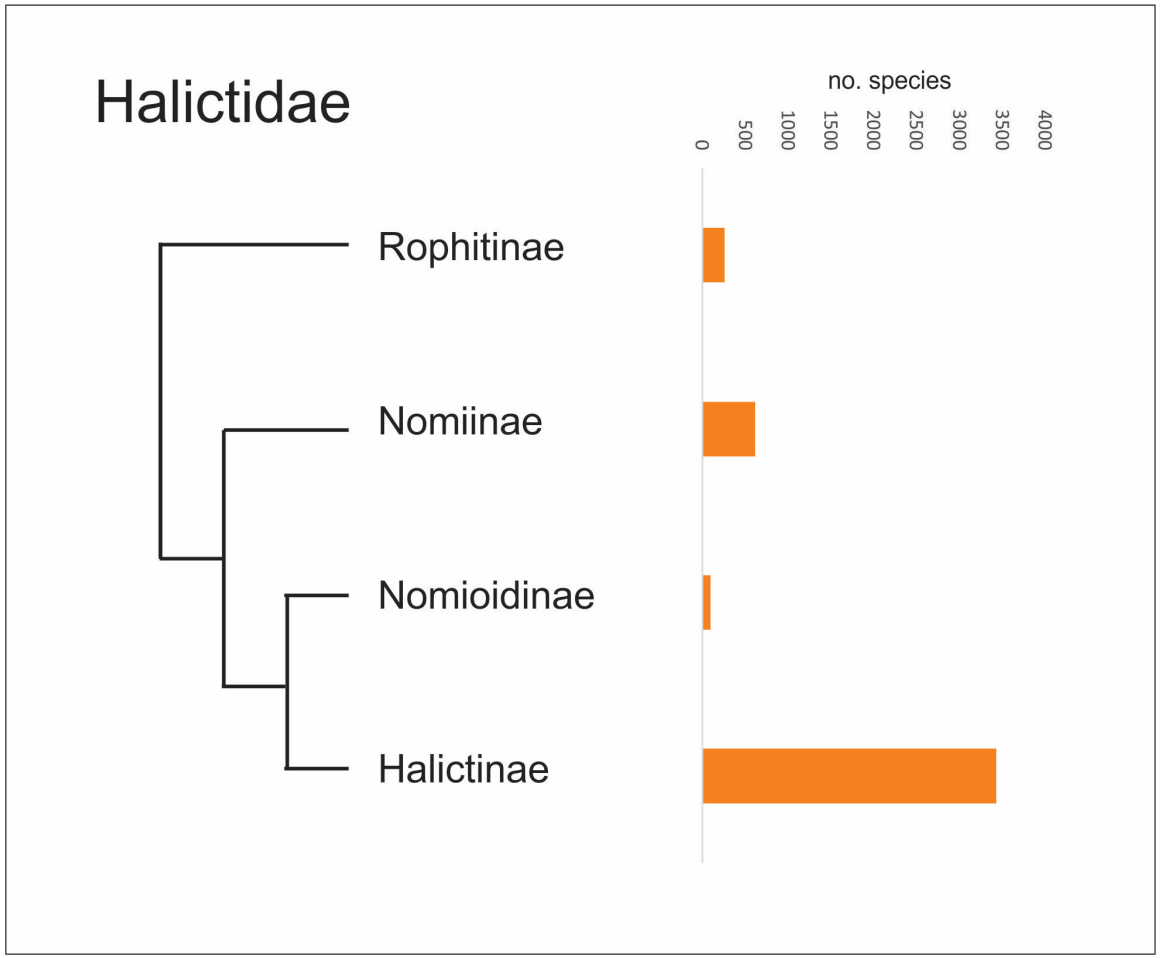
Andrenidae



Andrena crataegi

Oxaea flavescens

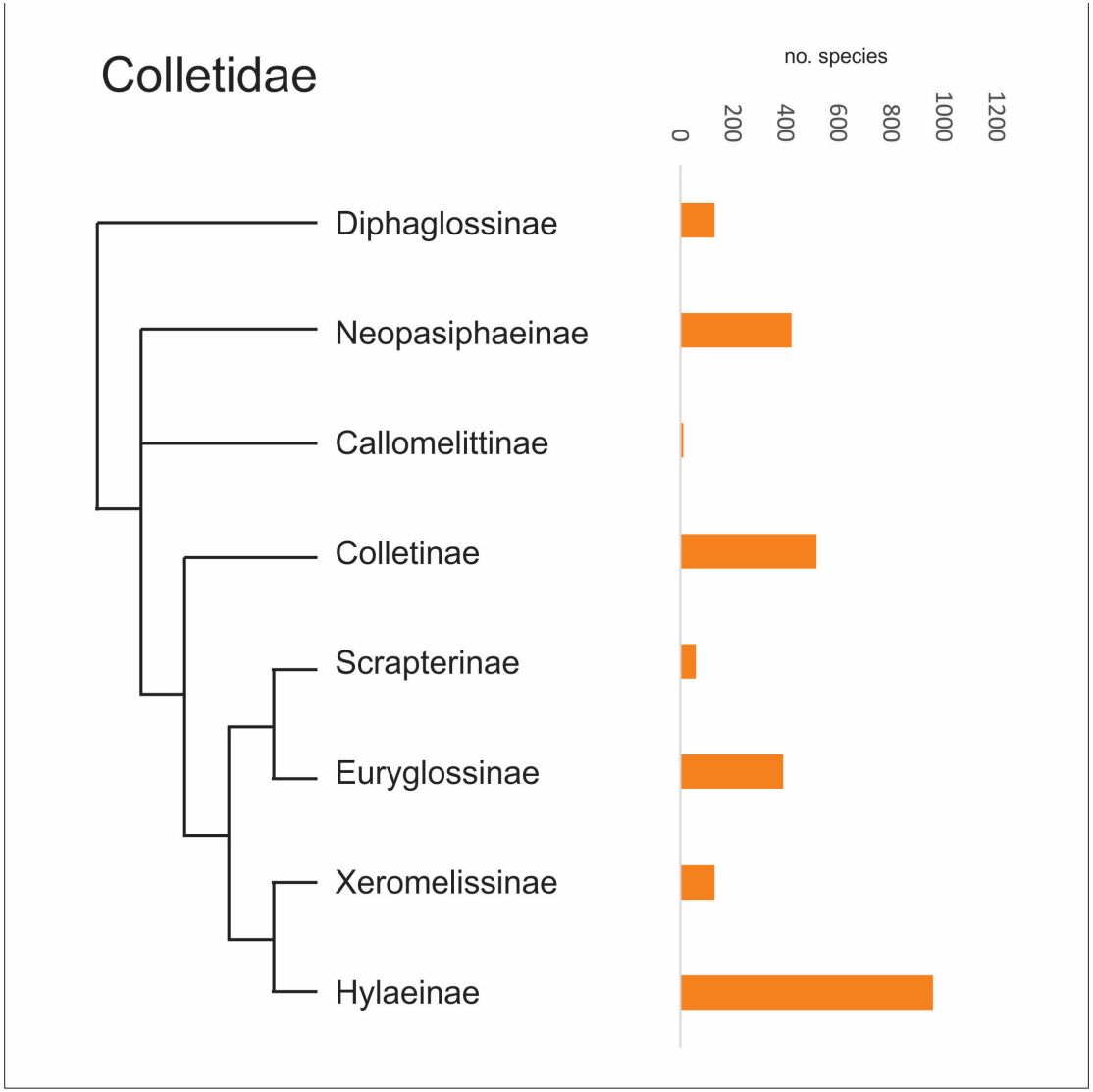
Macrotera portalis



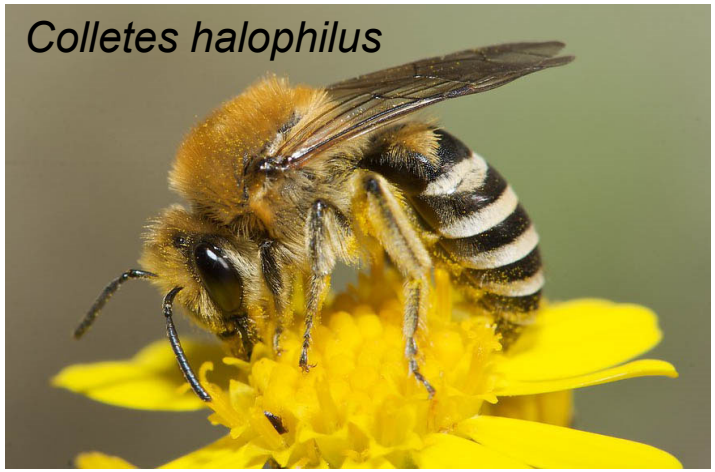
Systropha planidens

Pseudapis sp.

Halictus sp.

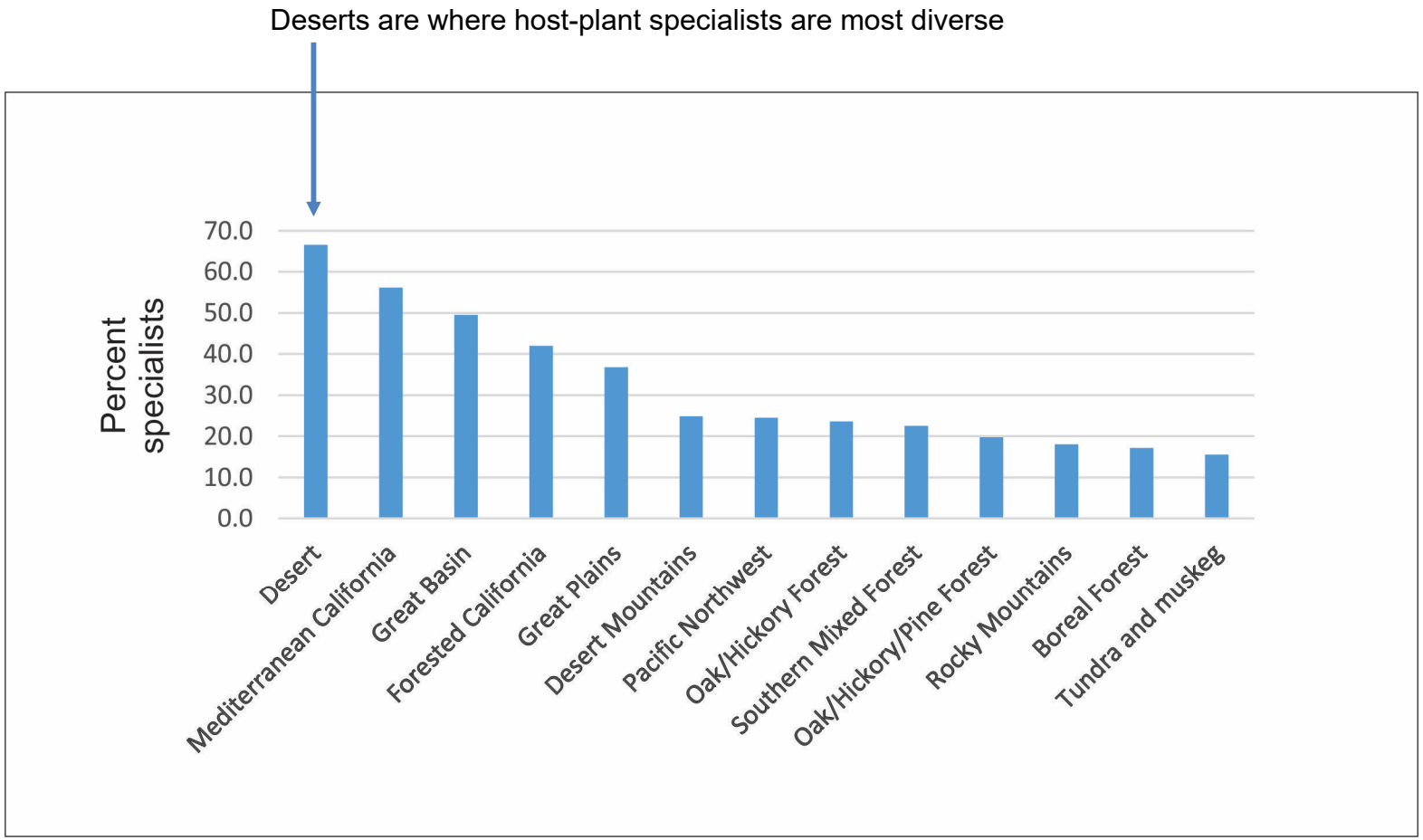

Colletidae
no. species
0
200
400
600
800
1000
1200
Diphaglossinae
Neopasiphaeinae
Callomelittinae
Colletinae
Scrapterinae
Euryglossinae
Xeromelissinae
Hylaeinae


Caupolicana fulvicollis

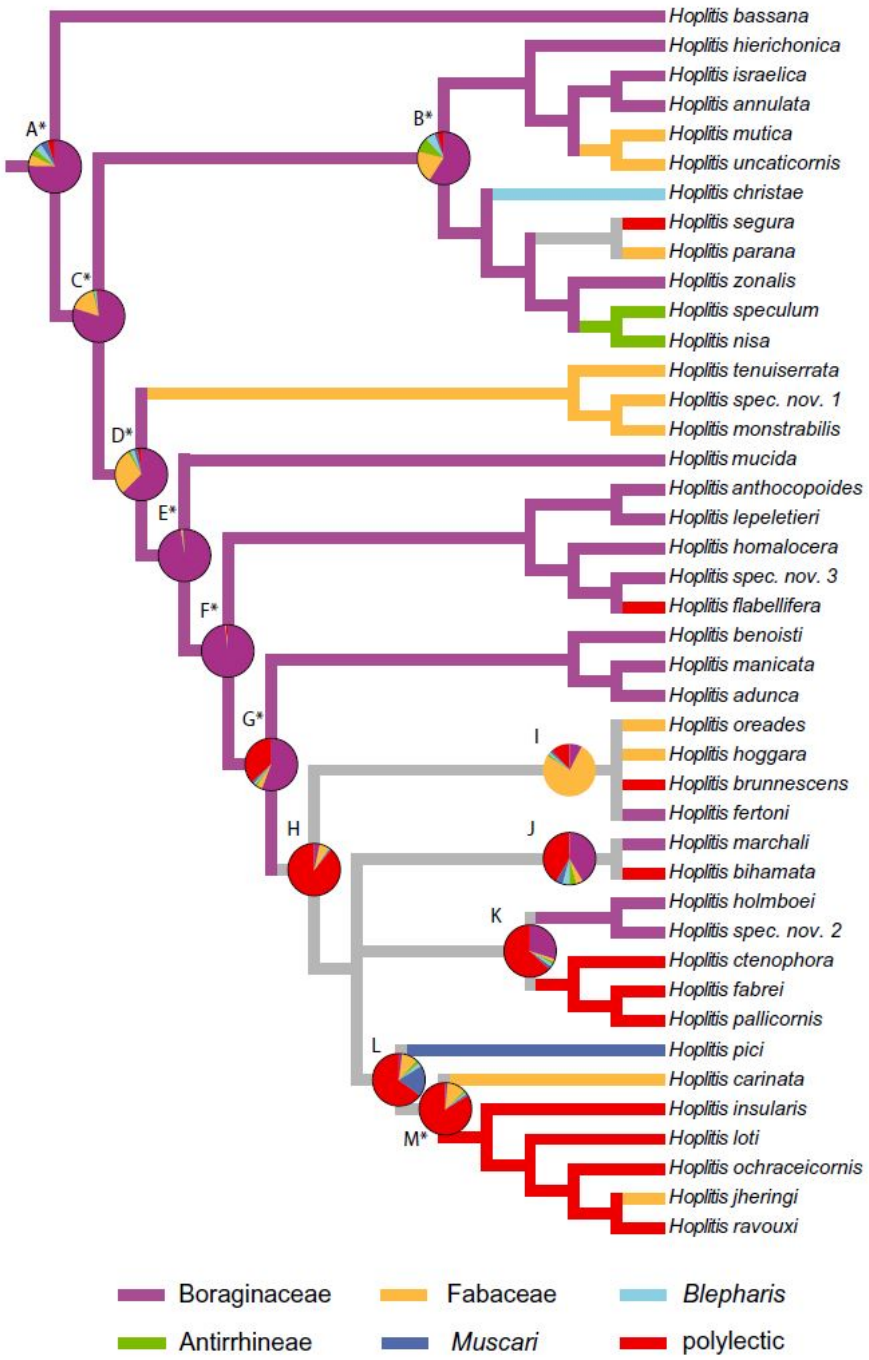

Colletes halophilus

Hylaeus sp.

5. Specialization across habitats



Moldenke (1979)

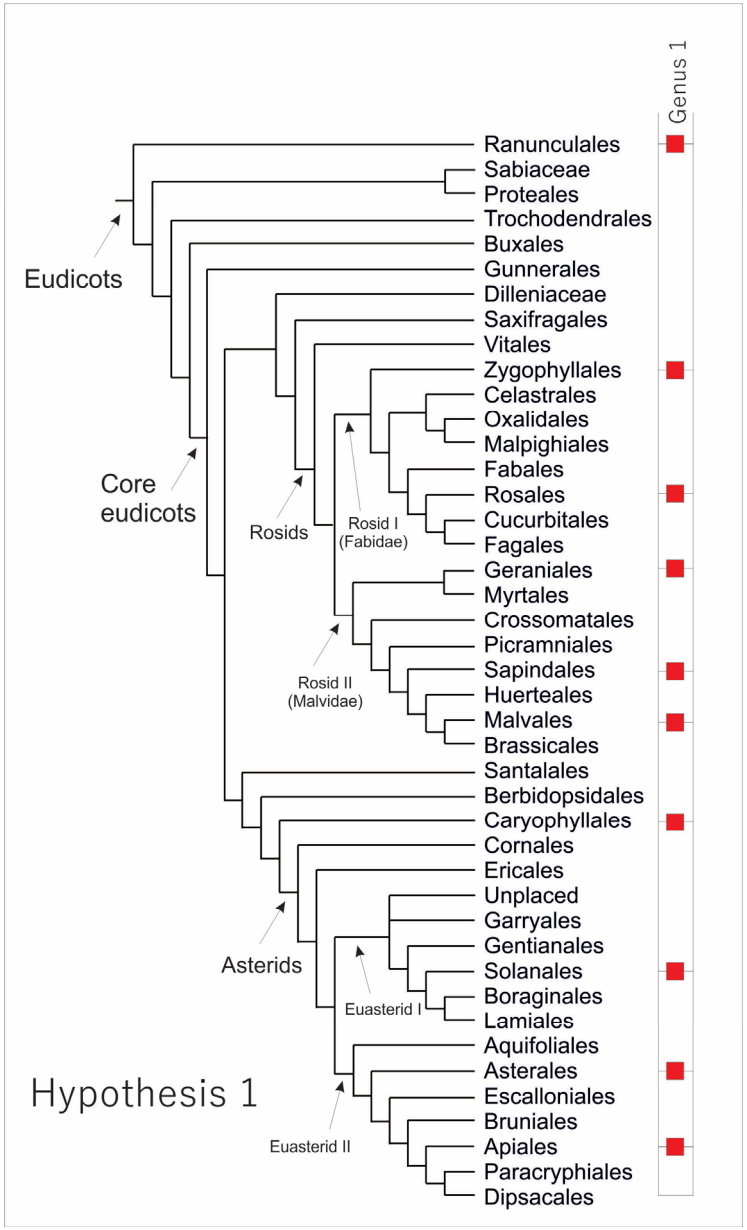


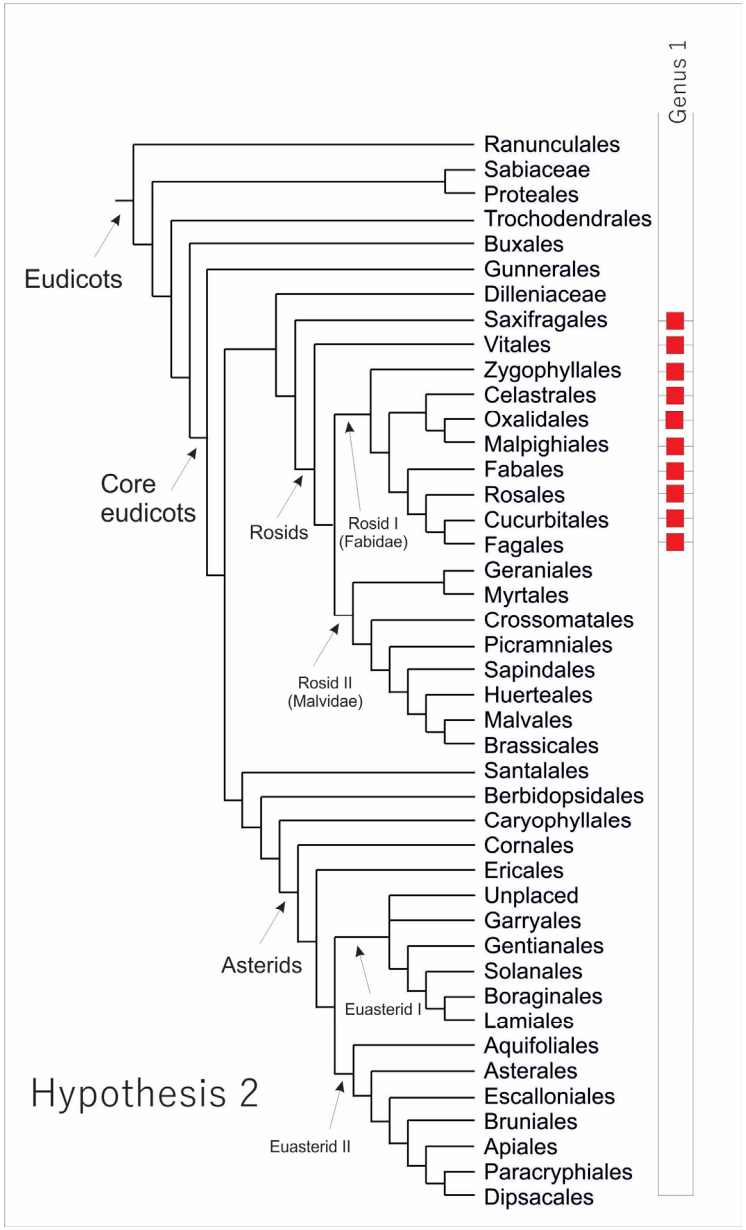
6. Which came first, generalization of specialization?

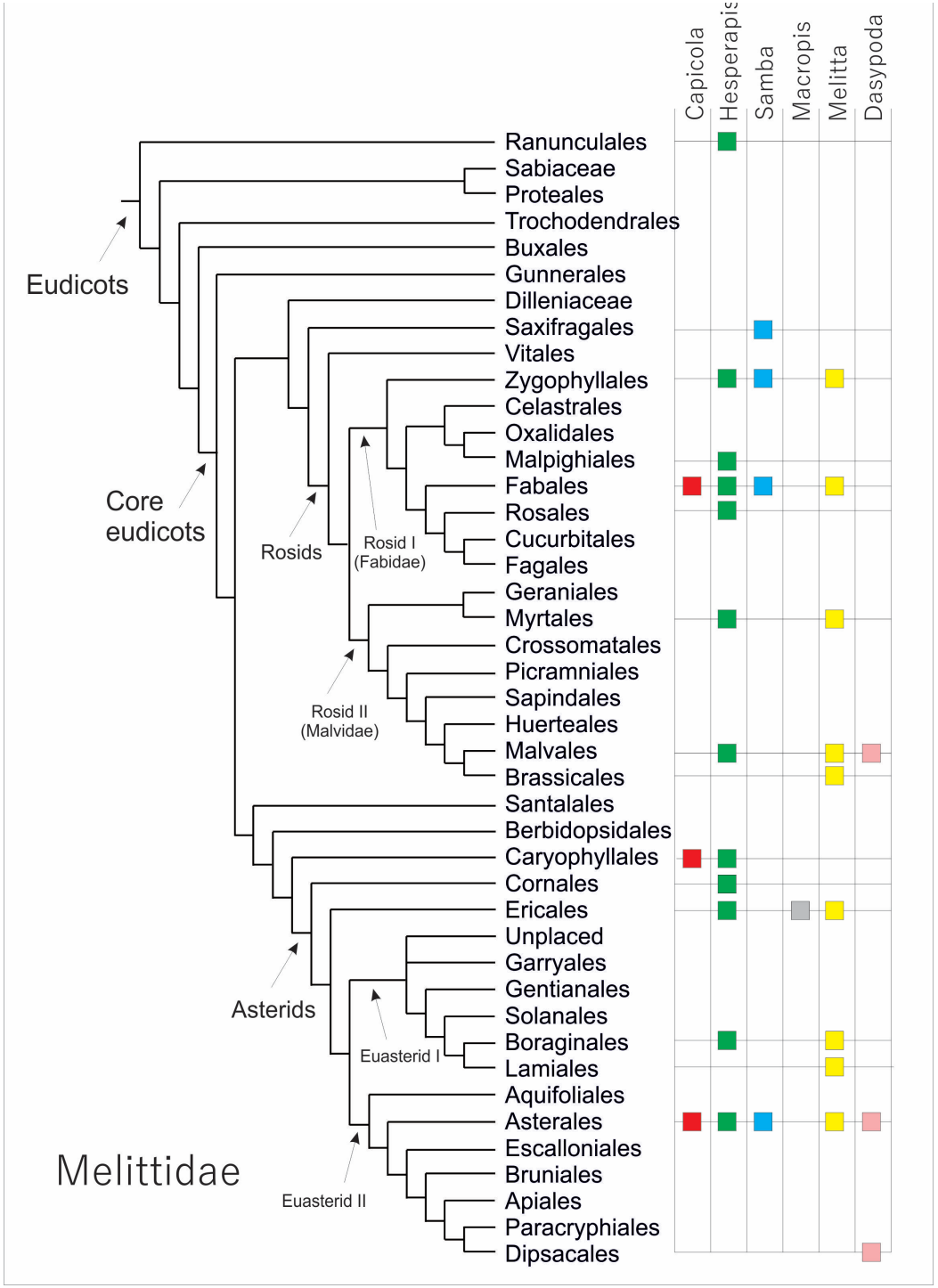
Hoplitis anthocopoides

Sedivy et al. (2013)

7. Which host-plant families do bees most often specialize upon?







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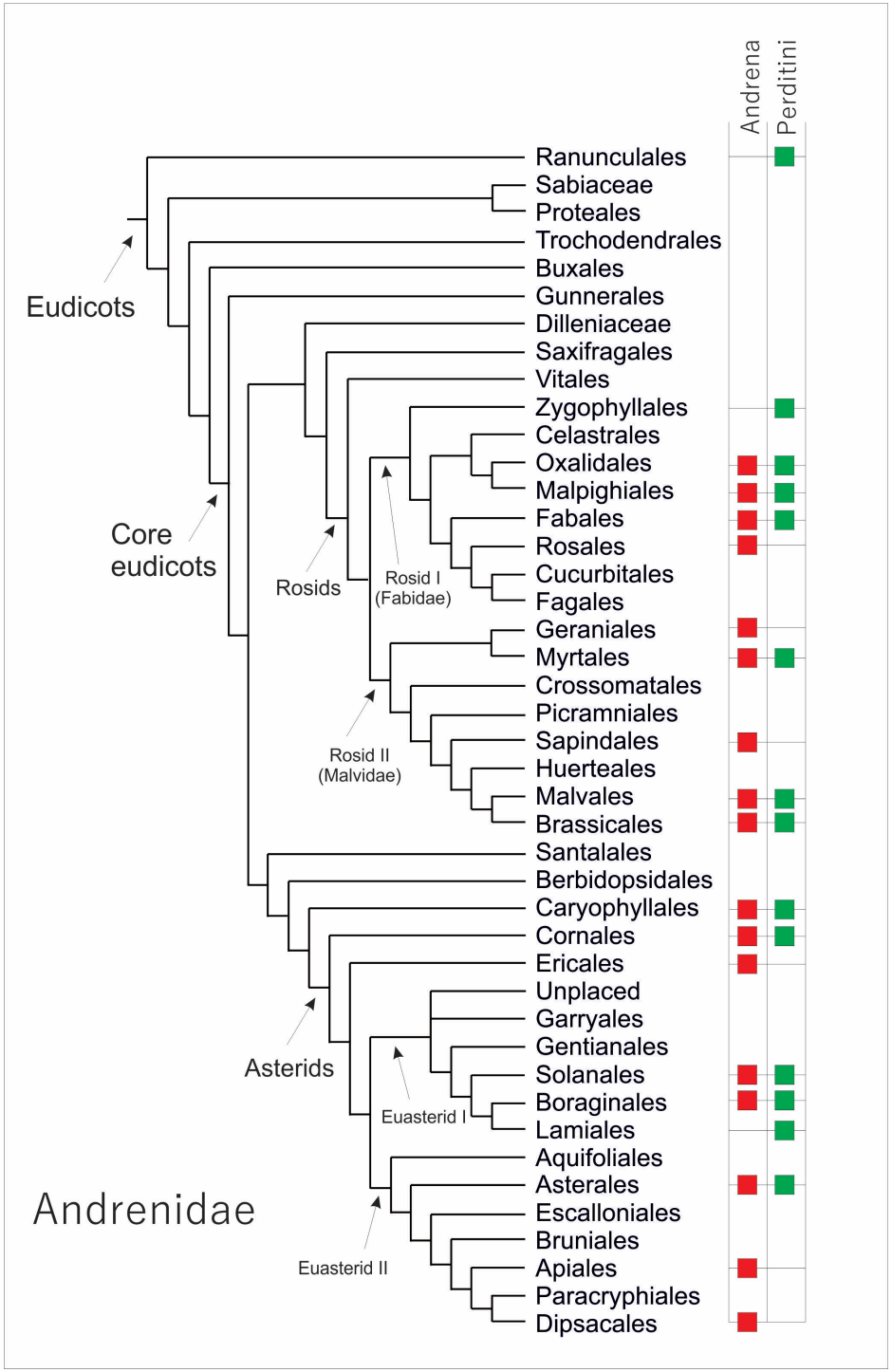

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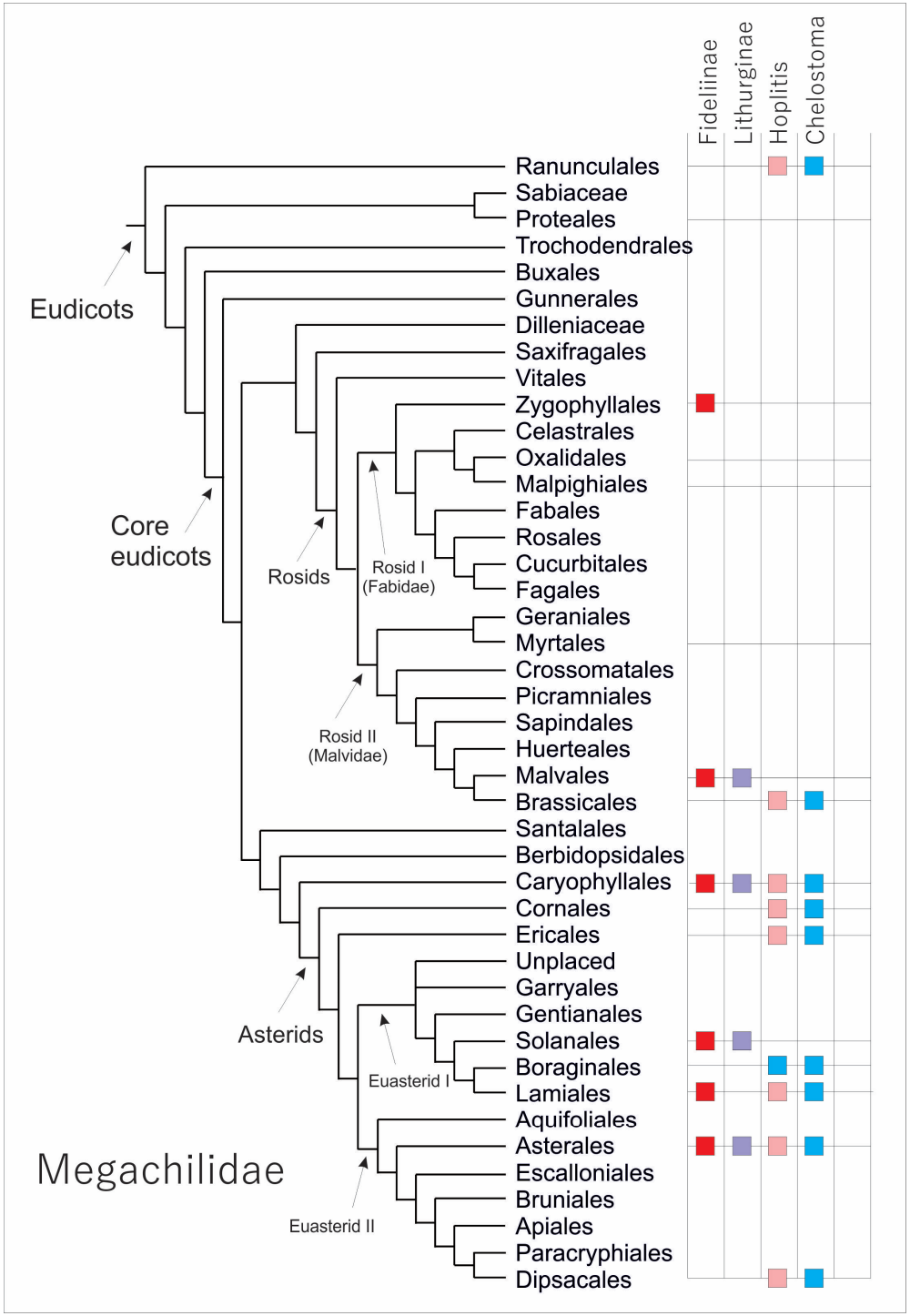


7. Which host-plant families do bees most often specialize upon?

8. Rapid evolution and host-plant specialization

Larrea tridentata (Zygophyllaceae) = creosote bush

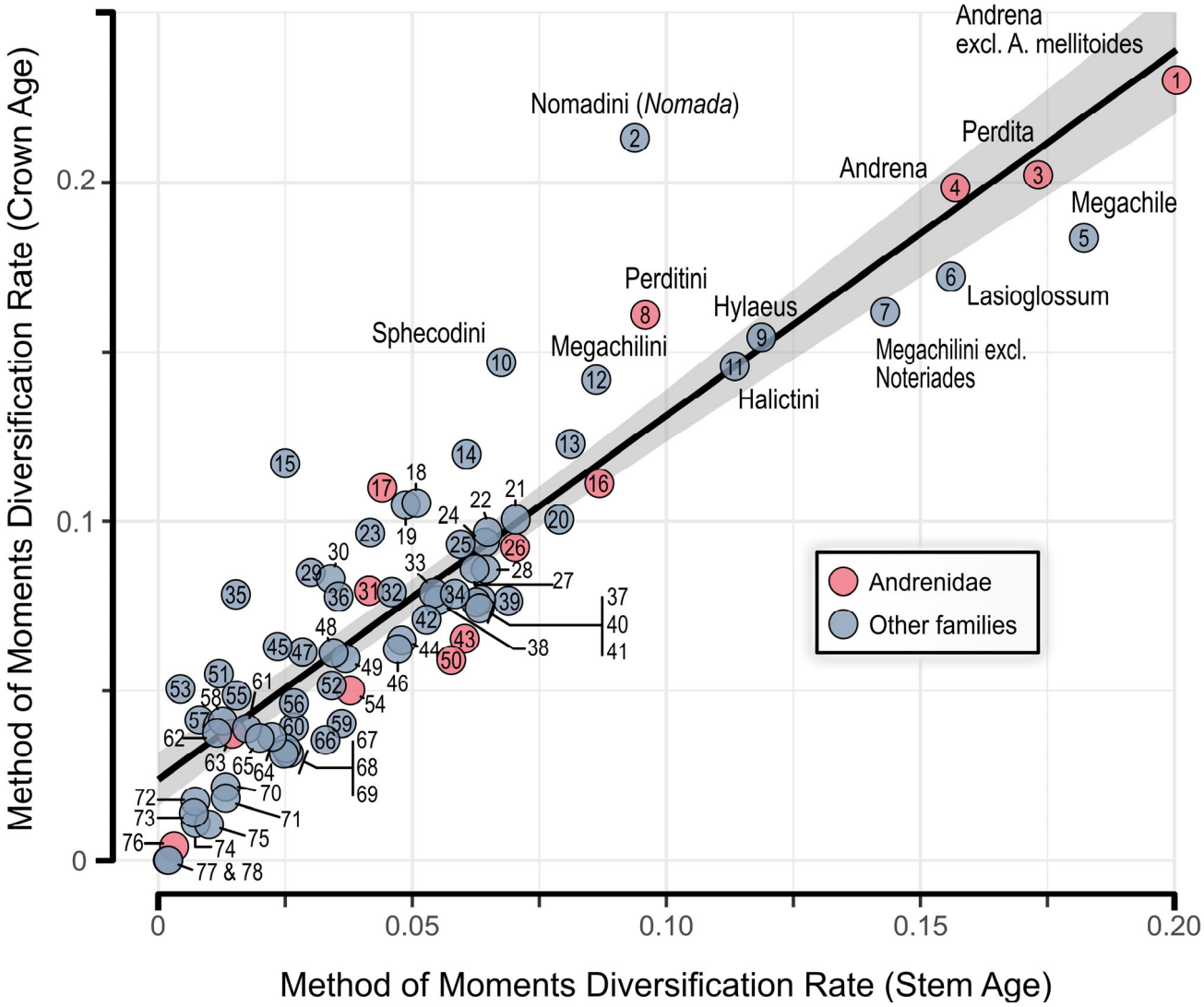
8. Rapid evolution and host-plant specialization

Species	Family
Ancylandrena larreae	Andrenidae
Colletes clypeonitens	Colletidae
Colletes covilleae	Colletidae
Colletes larreae	Colletidae
Habropoda pallida	Apidae
Hesperapis arida	Melittidae
Hesperapis larreae	Melittidae
Trachusa larreae	Megachilidae
Hoplitis biscutellae	Megachilidae
Megandrena enceliae	Andrenidae
Calliopsis (Nomadopsis) foleyi	Andrenidae
Calliopsis (Nomadopsis) larreae	Andrenidae
Perdita covilleae	Andrenidae
Perdita eremica	Andrenidae
Perdita flavipes	Andrenidae
Perdita larreae	Andrenidae
Perdita lateralis lateralis	Andrenidae
Perdita punctulata	Andrenidae
Perdita semicaerulea	Andrenidae

19 specialist bee species in just 1.5 million years

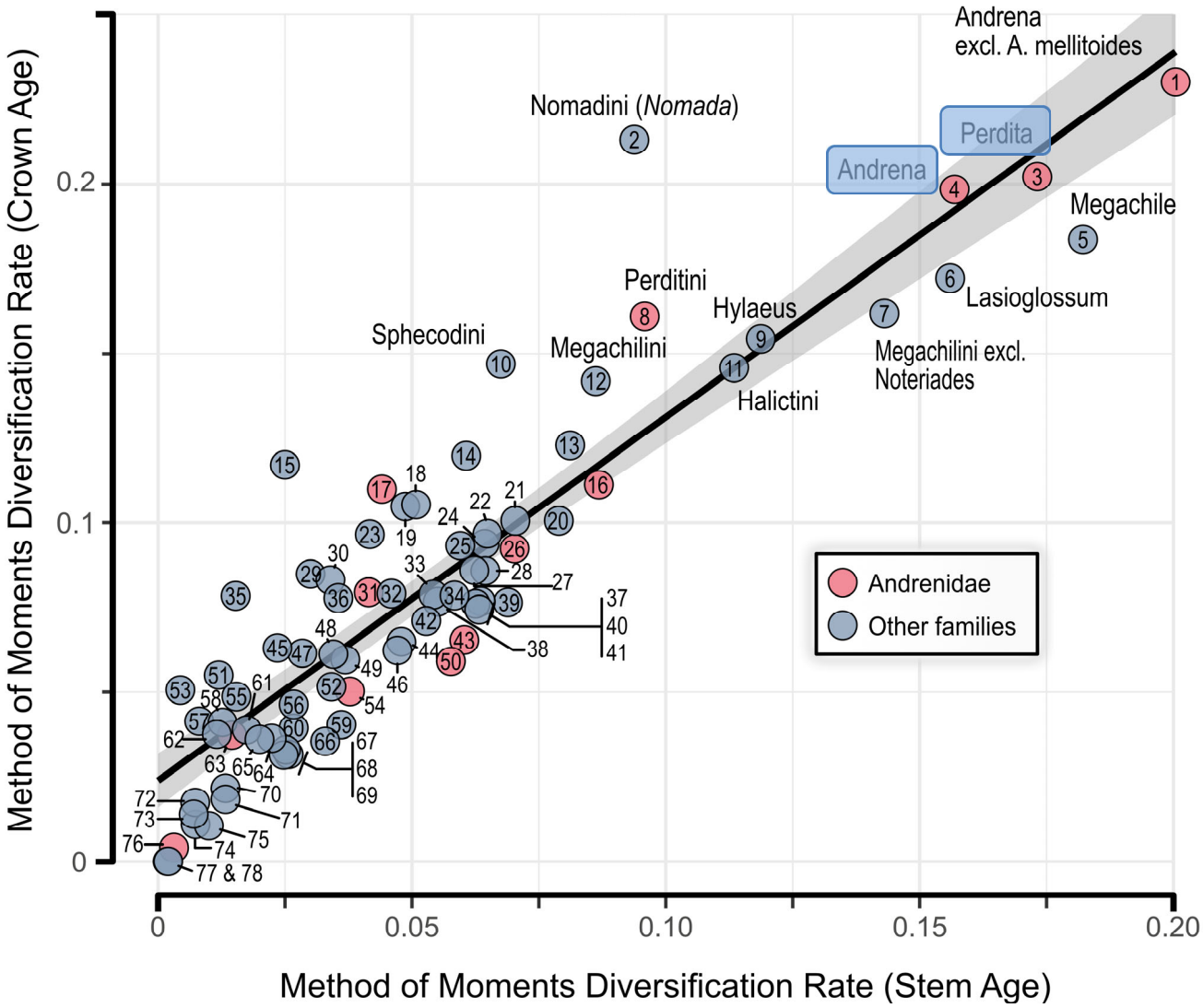
Creosote bush specialists

9. Specialization and diversification



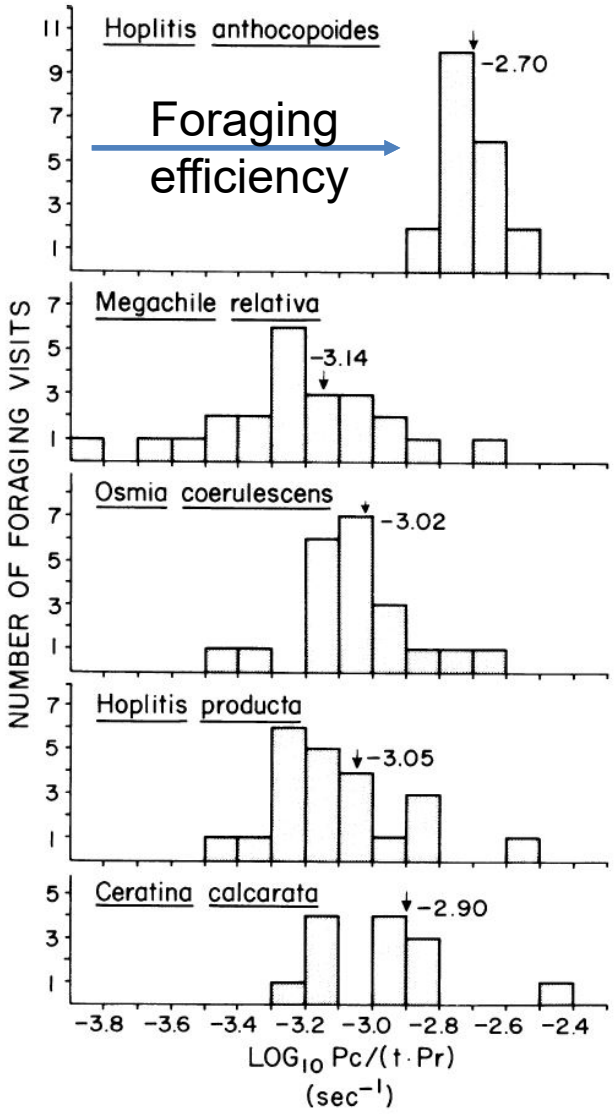
Bossert et al. (2021)

9. Specialization and diversification



Bossert et al. (2021)

10. Why do bees specialize?



Strickler et al. (1979)

Hypothesis 1:
specialists are more efficient foragers

Hoplitis anthocopoides
(Megachilidae)

Echium vulgare
(Boraginaceae)

10. Why do bees specialize?

Hypothesis 2: Specialist bees choose host-plants with the greatest nutritional value

Ecological Monographs, 70(4), 2000, pp. 617–643

WHAT GOVERNS PROTEIN CONTENT OF POLLEN: POLLINATOR PREFERENCES, POLLEN–PISTIL INTERACTIONS, OR PHYLOGENY?

T'AI H. ROULSTON,[1,4] JAMES H. CANE,[2,5] AND STEPHEN L. BUCHMANN[3]

[1]*Department of Entomology, 301 Funchess Hall, Auburn University, Alabama 36849 USA*
[2]*USDA-ARS Bee Biology and Systematics Laboratory, Utah State University, Logan, Utah 84322 USA*
[3]*USDA-ARS Hayden Honey Bee Research Laboratory, 2000 E. Allen Road, Tucson, Arizona 85719 USA*

"Plant genera hosting specialist pollen-collecting bees did not have particularly protein-rich pollen"

Roulston et al. (2000)

10. Why do bees specialize?

Hypothesis 3: Specialist bees choose super-abundance resources

Larrea (Zygphyllaceae) = creosote bush

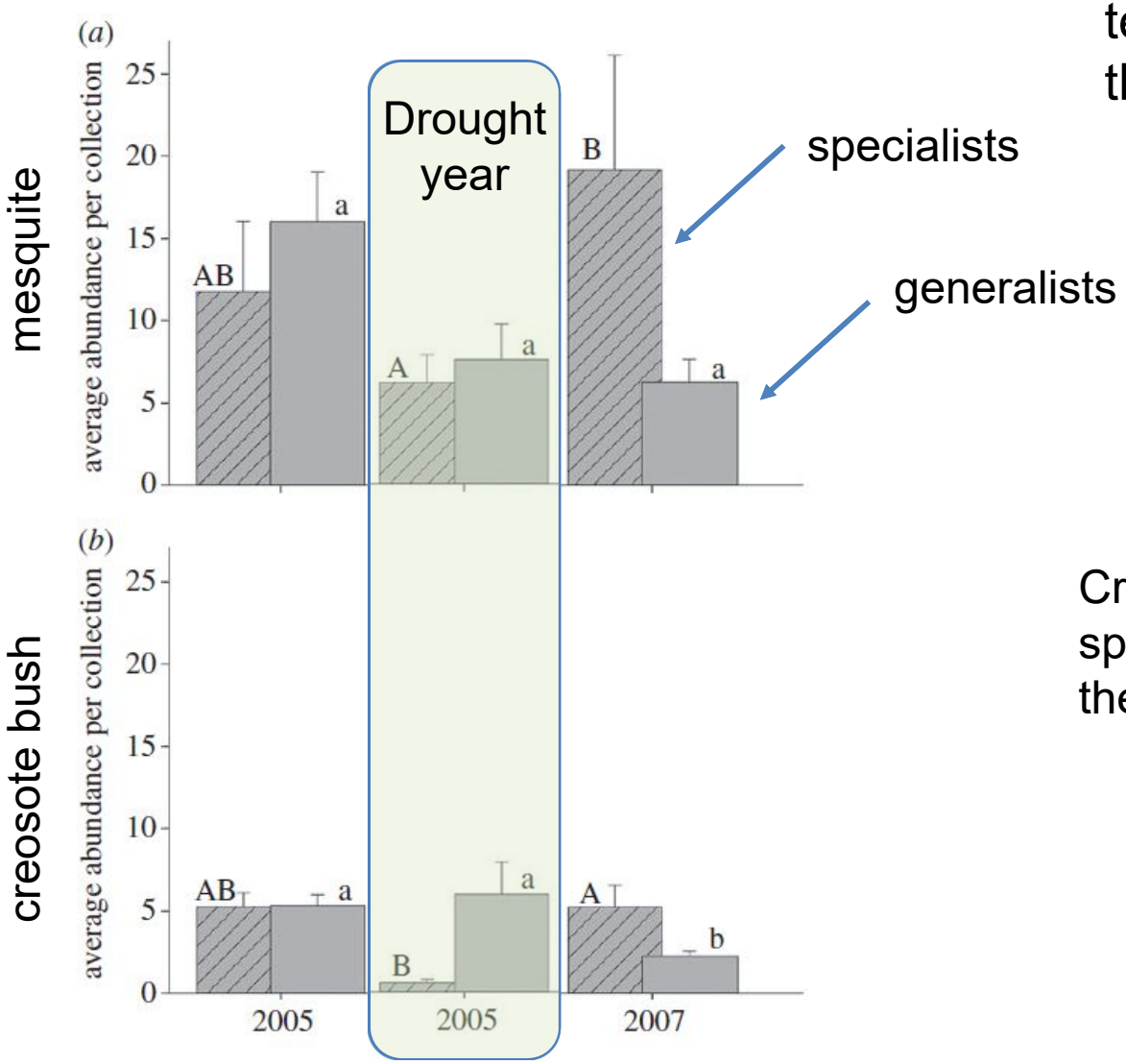
Helianthus (Asteraceae) = sunflower

Salix (Salicaceae) = willow

Minckley et al. (1994)

10. Why do bees specialize?

Hypothesis 4: Specialist bees benefit by being in temporal synchrony with their host-plants

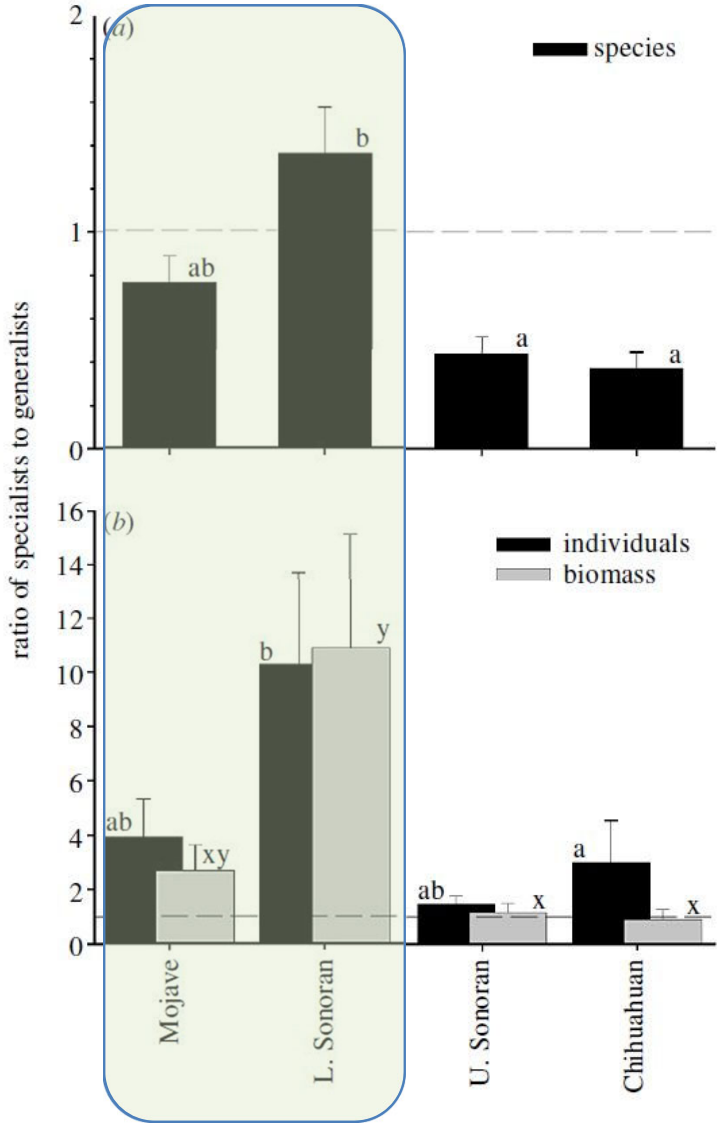


Creosote bush specialists drop out in the drought year

Minckley et al. (2013)

10. Why do bees specialize?

Hypothesis 4: Specialist bees benefit by being in temporal synchrony with their host-plants



In the driest deserts, specialist bees are most diverse and most abundant!

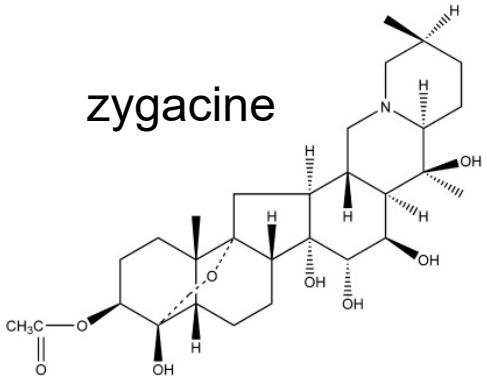
Minckley et al. (2000)

10. Why do bees specialize?

Hypothesis 5: Specialist bees have overcome plant defensive chemicals, leaving the generalists behind

Toxicoscordion paniculatum (Melanthiaceae) -- deathcamas

zygacine

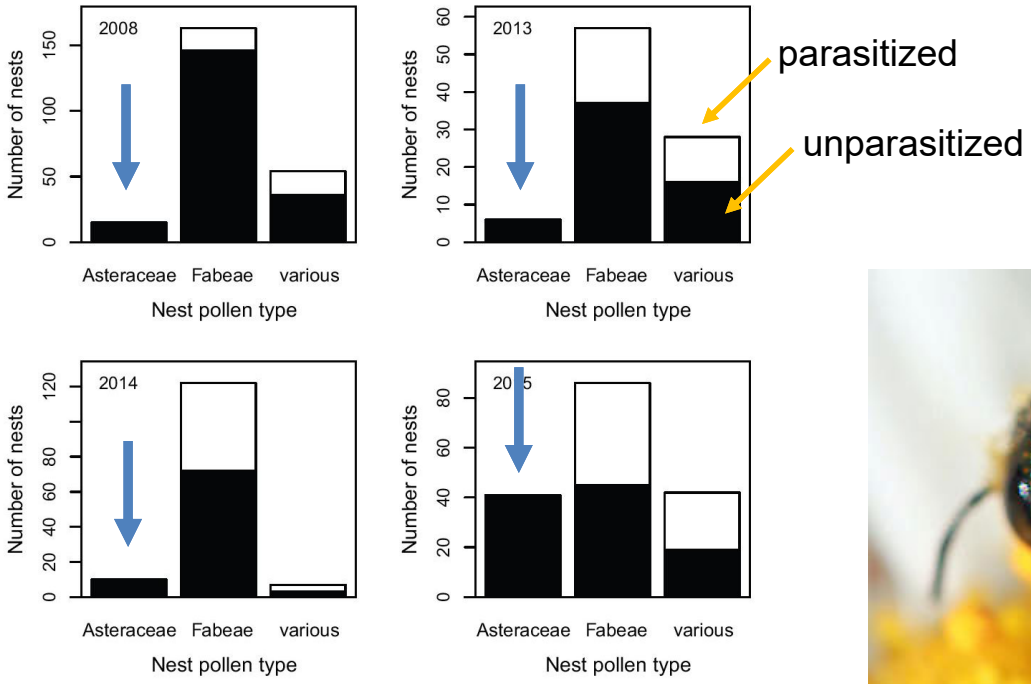


Andrena astragali (Andrenidae)

Cane (2018)

10. Why do bee specialize?

Hypothesis 6: Specialist bees are self-medicating to deter pathogens and parasites



Osmia coloradensis

Fabaceae specialists (*Osmia iridis*)

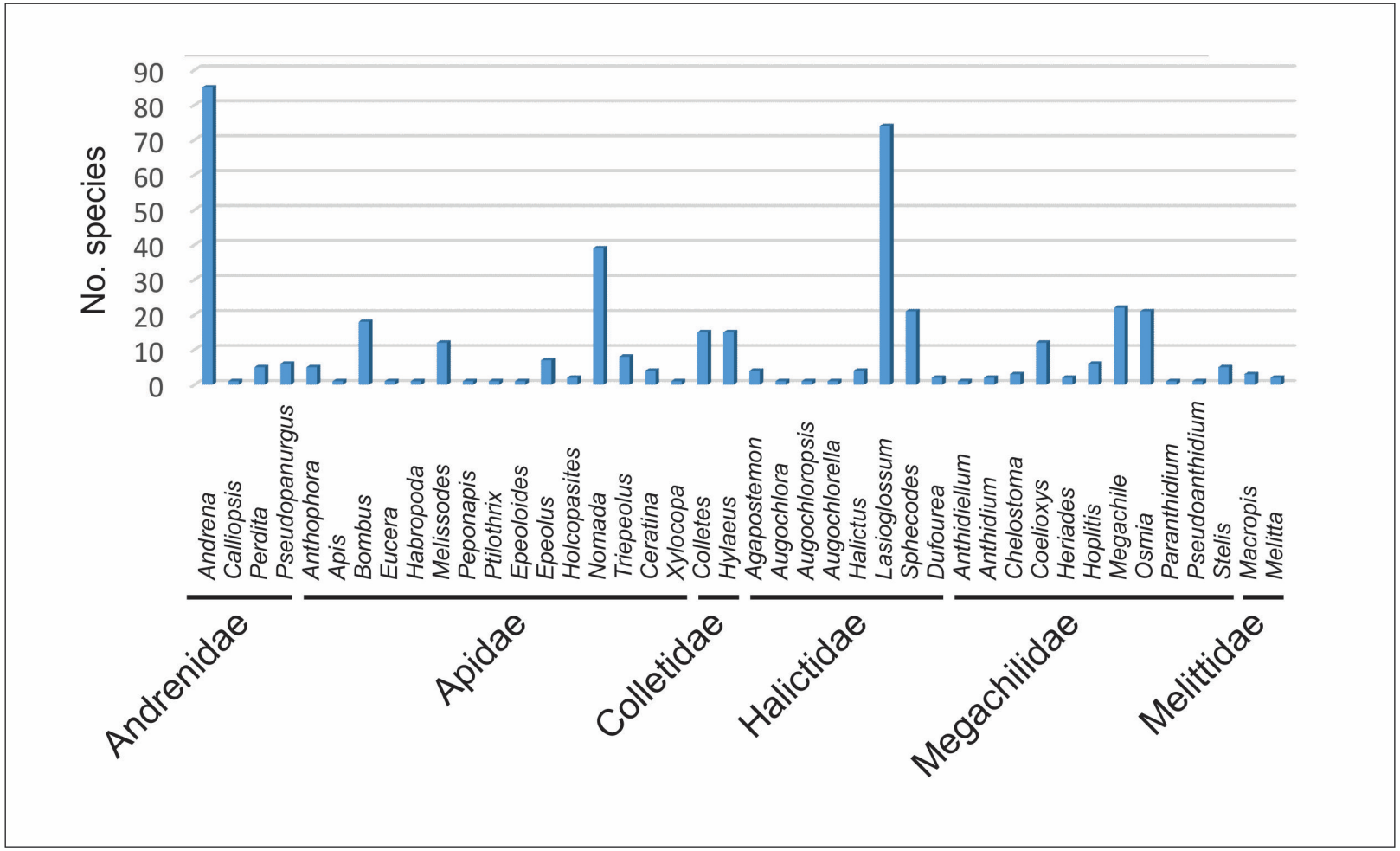
Asteraceae specialists (*Osmia coloradensis, O. montana, and O. subaustralis*)

Generalists (*Osmia tristella and O. tersula*)

Spear et al. (2016)

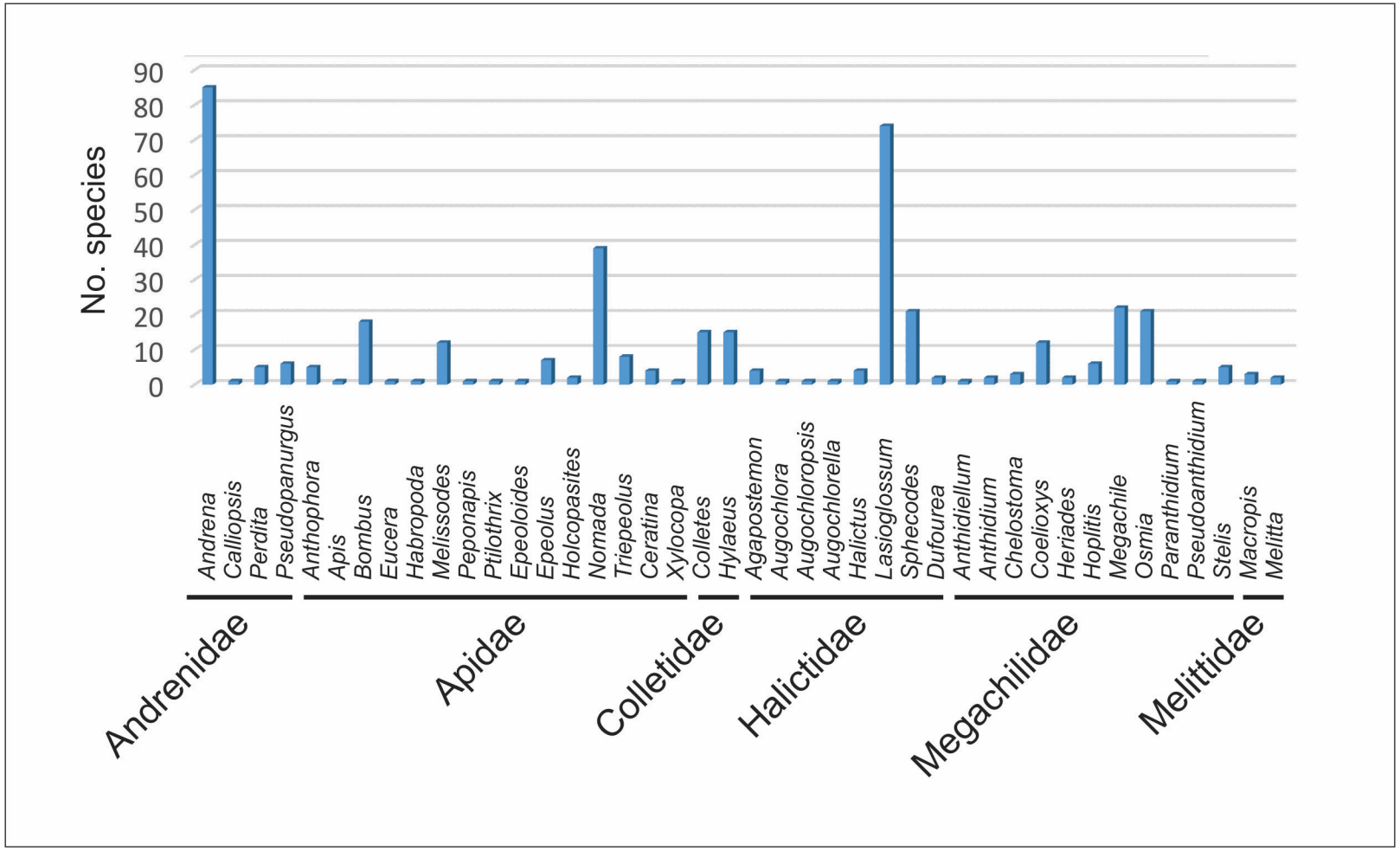
11. Conserving specialists in your backyard

New York bee diversity



11. Conserving specialists in your backyard

20% of New York bees are host-plant specialists



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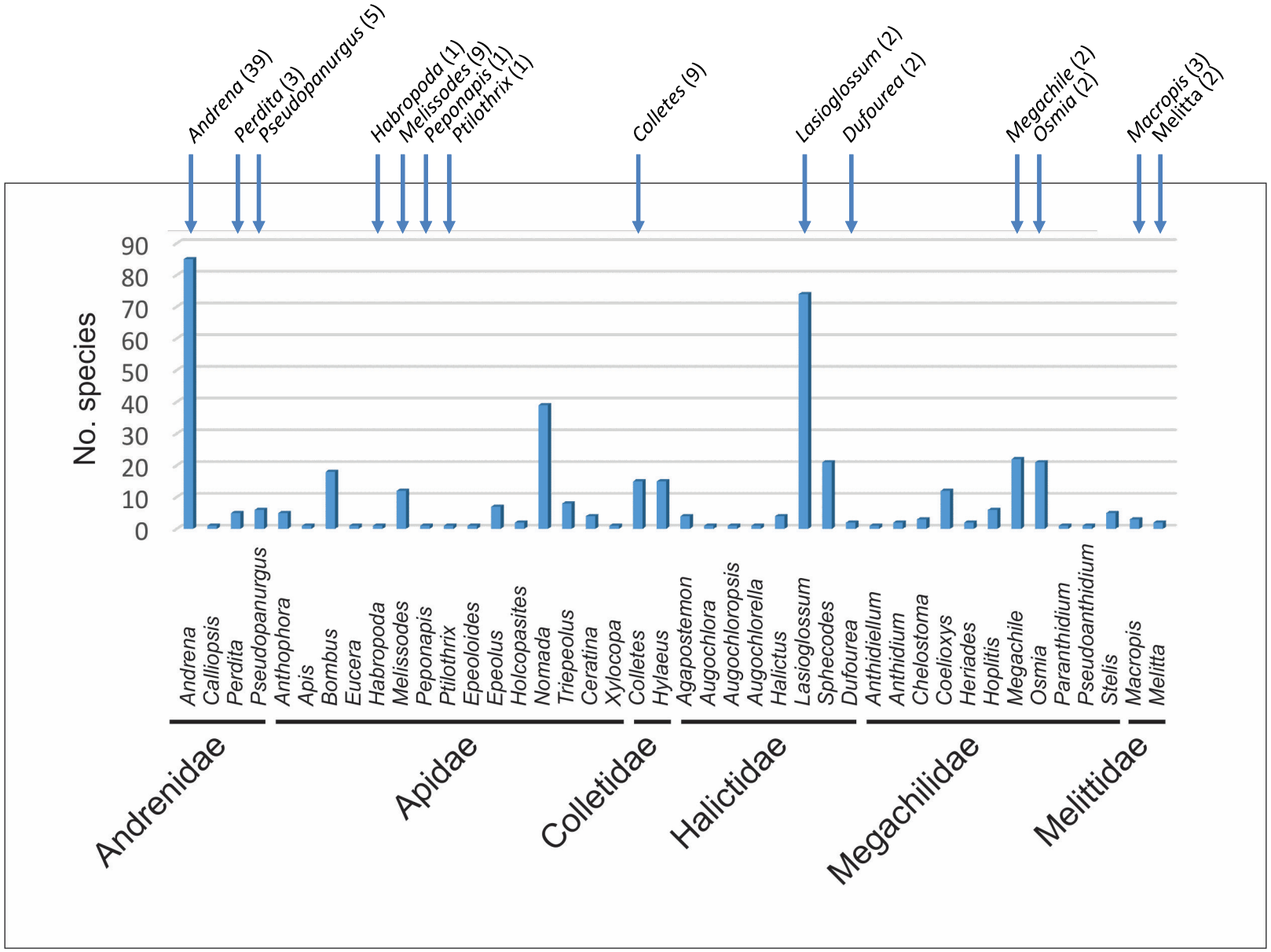


11. Conserving specialists in your backyard

Melissodes druriellus (Apidae)

Solidago (Asteraceae)

11. Conserving specialists in your backyard

Dufourea monardae (Halictidae)

Monarda didyma (Fabaceae)

11. Conserving specialists in your backyard

Ptilothrix bombiformis (Apidae)

Hibiscus moscheutos (Malvaceae)

11. Conserving specialists in your backyard

Colletes validus (Apidae)

Vaccinium angustifolium
(Ericaceae)

11. Conserving specialists in your backyard

Colletes latitarsis (Colletidae)

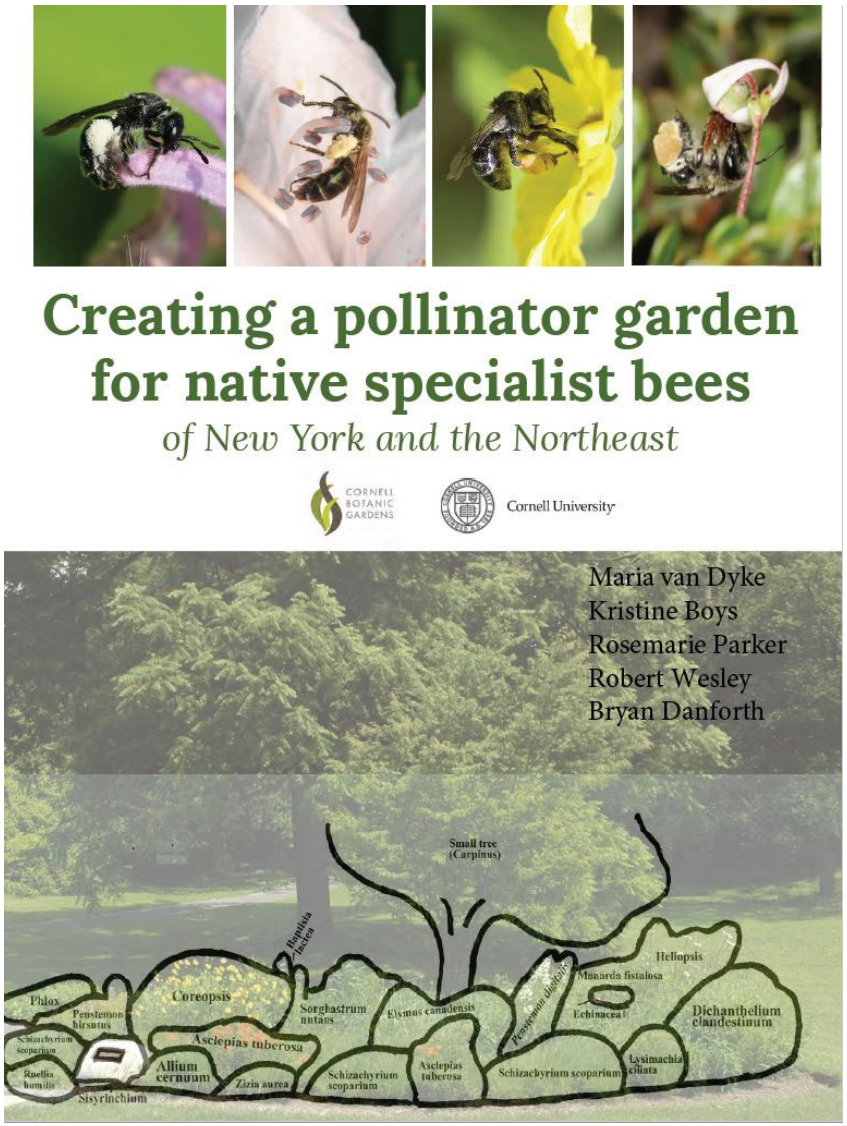
Physalis heterophylla (Solanaceae)

11. Conserving specialists in your backyard

Andrena erigeniae (Andrenidae)

Claytonia virginica (Monteaceae)

11. Conserving specialists in your backyard



[Creating a pollinator garden for native specialist bees of New York and the Northeast]

Also available at the [Pollinator network @ Cornell]

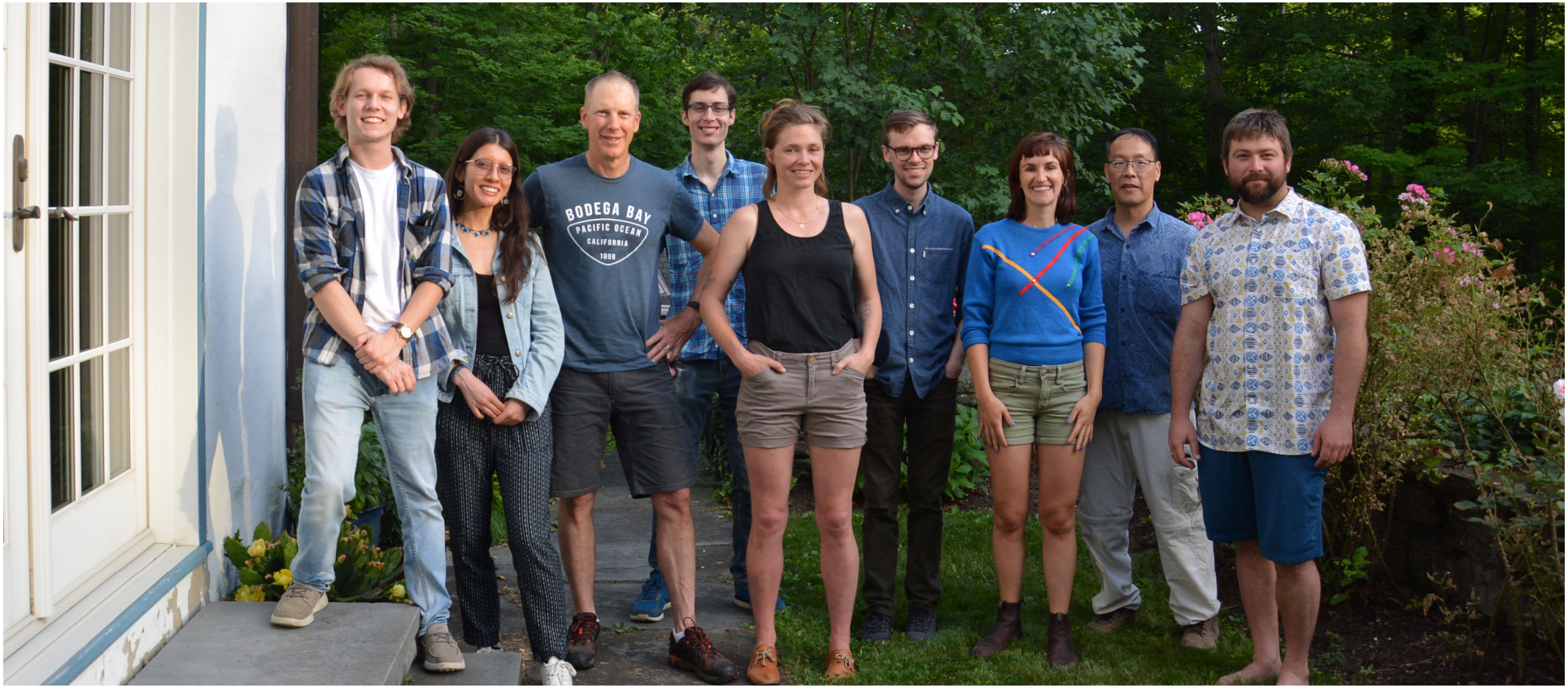
Jarrod Fowler's website on specialist bees of the US:

https://jarrodfowler.com/bees_pollen.html

Acknowledgements

Maria Van Dyke

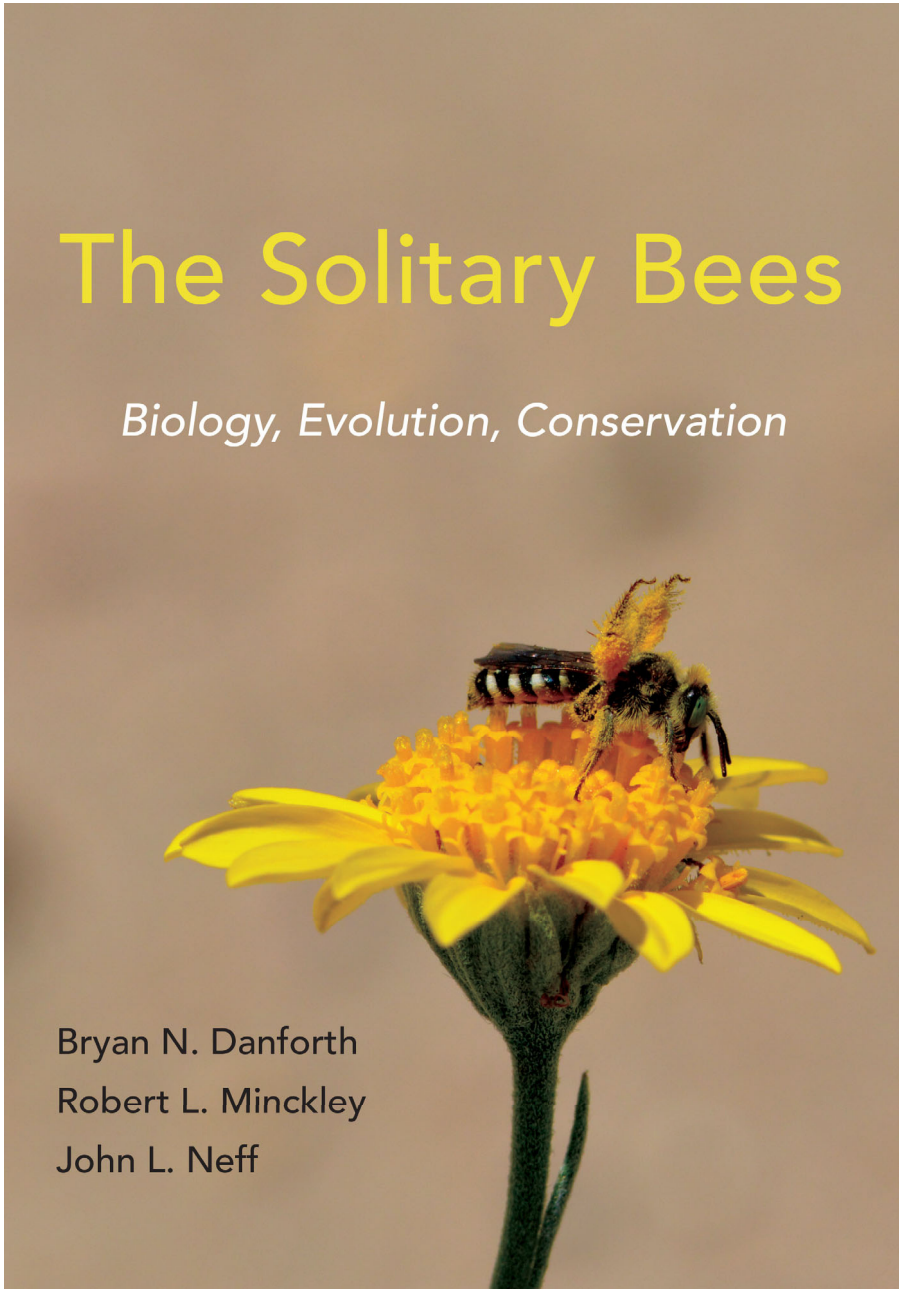
Acknowledgements



Undergraduates, graduates and post-docs in my lab

Acknowledgements

My family (Marina Caillaud, Nicholas and Isabelle Danforth)



American Publishers Award for Single Volume Reference in the Biological Sciences (2020)

Princeton University Press
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https://press.princeton.edu/titles/13525.html

Questions?

Anthophora atriceps (Apidae) approaching flower of *Trifolium stellatum* (Fabaceae) with mouthparts extended. Photo courtesy of Nico Vereecken.

END