

Building a Better Bee Garden With Ornamental Horticulture Research Bee-ing a Better Bee Gardener Davis, CA, September 23, 2017

Christine Casey, Ph.D. UC Davis Department of Entomology and Nematology Häagen-Dazs Honey Bee Haven

The Häagen-Dazs Honey Bee Haven

- Planted Fall 2009 with major funding from Häagen-Dazs
- Information and inspiration for the urban bee gardener
- Undergraduate classes and internships
- K-12 school groups and youth outreach
- Research projects and forage for research facility bees





Bees 101

Diverse

- -Worldwide: 20,000 species
- -North America: 4000 species
- California: 1600 species
- Unlike the honey bee, most are solitary
 - -70% nest under ground
 - 30% nest above ground, i.e. "cavity
 - nesting"



Pollen = protein source. Pollen varies in the amino acids it provides. A mix of pollen is needed for complete nutrition.



- Protein (i.e. pollen) is essential for bee reproduction. Bees learn to associate flower traits with pollen rewards and can remember these associations longer than for those associated with nectar. (Animal Behavior 111:93-100)
- Honey bees will forage over a large area, regardless of close resources. Foraging is driven by pollen needs. (Functional Ecol. 26:1186-1196)



Scopa – pollen is carried dry



Corbicula – pollen is carried moist

Nectar = carbohydrate source in the field and used to make honey in the hive. Contains a mix of amino acids, sugars, and phytochemicals that impact bee health.







Bees in urban gardens

Bees can be diverse and abundant in urban settings, especially if floral diversity is present.

Carper et al. 2014 Fortel et al. 2014 Everaars et al. 2011 Wojcik and McBride 2011 Fetridge et al. 2008 Matteson et al. 2008 Wojcik et al. 2007 Frankie et al. 2005 Goulson et al. 2001

Bees at the Haven (since 2008):

- 85 species
- 26 genera
- 5 families





US turf area = 163,812 km² (40.5 million acres) CA turf area = 11,159 km² (2.8 million acres) Common bees in urban gardens Family Apidae: Honey bees









Common bees in urban gardens Apidae: Carpenter bees



Common bees in urban gardens Apidae: Bumble bees









Common bees in urban gardens Halictidae: Sweat bees



Common bees in urban gardens Megachilidae: Leafcutter bees

What do bees need in gardens?FoodWaterShelter













Aren't all flowers the same?









California



California is one of the most focustually drivers regions in the world, with a high number of endemic species and many unique plant communities such as cossial parity and gatar sequity access. Californian attavity plants support a corresponding diversity of pollitations, with an estimated frankality and western bandhe less, and over 200 and a group, there are beneficial focus and over 200 at 1,000 attavity of pollitations, with an estimated frankality and western bandhe less, and over 200 at a group, there and other pollations matanta hashity, productive plant communities, provide food that santation wildlife, and plays are sensitial to fit or exposed band.

Providing wildlow-resch. Inhten is the most influent attenty one units the support pollimone, maintain the support pollimone, and the support pollimone, text as their primary fixed source, and finanks are then pollimone to be and the support of t

and humilinging and some set boost for butterly and other carefully according to a set boost for butterly and be dealing various monarch population. With hey statistic the set of the set of the set of the set transmission of the set of the set of the set of the transmission. They will be ablatible to growing conditions of the set of the set of the set of the set of the transmission. They will be ablatible to growing conditions of the set of the set of the set of the set of the transmission. They will be ablatible to growing conditions of the set of the the set of the the set of the the set of the the set of the the set of the the set of the the set of the the set of the set

climates, are nof on attree wers, shrube, a diversity of tag biological a diversity of the come werdyand registering your habitat on our n of pollinator controlos.



Numerous bee plant lists have been developed

- Scientific basis of the lists is not always clear
- Lists vary greatly, even for the same region
 (Garvuzov and Ratnieks, Functional Ecology 28: 364-374)

Does native matter?

 Important for bees that specialize on one group of flowers, such as *Diadasia* spp. and *Sphaeralcea* spp.



 Results are mixed in disturbed habitats (i.e. gardens and farms)

(For example: Matteson et al., Insect Conservation and Diversity 4:89-98; Williams et al. Basic and Applied Ecology 12:332-341)



- Honey bees with access to natural forage have fewer diseases than those fed protein supplements (Apidologie 47: 186-196)
- Plant secondary metabolites can reduce bumble bee parasite infections (Richardson et al., Proc. Royal Soc. London 282)

 Even within an attractive group of plants (Lamiaceae), there are differences in attractiveness. A comparison in Spain found that catmint and hyssop were the most attractive within this group. There is variation year-to-year and within bee **Species.** (J. Econ. Ent. 109(2):529-536)

Garden factors that affect bee abundance and richness

- Floral abundance (+)
- Mulch (-)
- Bare ground (+)









Bees and plants UC Berkeley-UC Davis studies in California gardens







Two-year study in replicated plots in Great Britain

- Honey bees and bumble bees made up the majority of bees observed
- No correlation between the plants preferred by the two groups of bees
- 100-fold difference in flower attractiveness; Lamiaceae were the most attractive

(Garbuzov and Ratnieks, Functional Ecology 28:364-374)

USDA: Protecting Pollinators With Economically Feasible And Environmentally Sound Ornamental Horticulture



Major questions

- Which commonly-sold plants do bees prefer?
- Are systemic pesticides found in nectar and pollen of horticultural plants at levels of concern?
- Can IPM practices that are compatible with bee pollinators be developed and accepted by growers?
- Is "pollinator friendly" labeling of interest to consumers?

USDA: Protecting Pollinators With Economically Feasible And Environmentally Sound Ornamental Horticulture

- California: UCD (Casey and Niño); UCCE San Diego (Bethke)
- 5 year study; our objective is to quantify bee pollinator plant preference in the urban landscape
- Replicated plots of 15 commonly-sold plants will be evaluated weekly; 20 of the most bee-attractive plants in the Haven will be evaluated weekly

Bee use of common ornamental plants

- Sampling took place weekly from July 20 to September 11; work will continue for four years
- Five-minute timed counts were made and bees were counted as honey bees, bumble bees, carpenter bees, and other bees
- Weekly bee bowl sampling was also performed



			Flower	Flower	Flower
Plant genus	Plant species/cultivar	Plant family	color	shape	size
	millefolium				
Achillea	'Moonshine'	Asteraceae	Yellow	Flat	Small
	<i>purpurea</i> 'Pow Wow				
Echinacea	Wild Berry'	Asteraceae	Pink	Flat	Large
Erigeron	karvinskianus	Asteraceae	White	Flat	Small
Lavandula	'Goodwin Creek Grey'	Lamiaceae	Purple	Tubular	Small
Nepeta	x faasenii	Lamiaceae	Purple	Tubular	Small
	heterophyllus				
Penstemon	'Catherine de la Mare'	Scrophulariaceae	Purple	Tubular	Large
Perovskia	atriplicifolia	Lamiaceae	Purple	Tubular	Small
Salvia	nemorosa 'May Night'	Lamiaceae	Purple	Tubular	Small
Salvia	microphylla 'Hot Lips'	Lamiaceae	Red	Tubular	Large
Symphyotrichum	chilensis	Asteraceae	Purple	Flat	Small
Tagetes	erecta 'Alumia Flame'	Asteraceae	Yellow	Flat	Large
Teucrium	chamaedrys	Lamiaceae	Purple	Tubular	Small
Verbascum	nigrum	Scrophulariaceae	Yellow	Tubular	Large
Verbena	lilacina 'De la Mina'	Verbenaceae	Purple	Tubular	Small
	elegans 'California				
Zinnia	Giant'	Asteraceae	Varied	Flat	Large

Mean number of honey bees by plant genus

Plant genus	Mean no. of honey	SE
	bees	
Nepeta	1.18	0.22
Zinnia	1.18	0.09
Salvia	0.24	0.05
Verbascum	0.11	0.06
Symphyotrichum	0.08	0.03
Perovskia	0.05	0.03
Erigeron	0.04	0.03
Achillea	0.03	0.02
Echinacea	0.02	0.00
Lavandula	0.00	0.00
Penstemon	0.00	0.00
Tagetes	0.00	0.00
Teucrium	0.00	0.00
Verbena	0.00	0.00

Mean number of 'other' bees by plant genus

Plant genus	Mean no. of 'other'	SE	
	bees		
Symphyotrichum	4.55	0.64	
Zinnia	3.98	0.38	
Nepeta	3.51	0.31	
Perovskia	3.18	0.41	
Erigeron	3.18	0.51	
Tagetes	2.22	0.25	
Salvia	1.94	0.27	
Achillea	1.17	0.18	
Echinacea	0.79	0.30	
Verbena	0.76	0.16	
Penstemon	0.63	0.26	
Verbascum	0.46	0.16	
Teucrium	0.30	0.13	
Lavandula	0.10	0.10	



Mean no. of bees per 5-minute count \pm SE

Bee use of common garden plants





Garden plant evaluation

Family	Genus	Species
Asteraceae	Bidens	ferulifolia
Asteraceae	Echinacea	'Cheyenne Spirit'
Onagraceae	Epilobium	canum 'Catalina'
Polygonaceae	Eriogonum	fasciculatum
Escalloniaceae	Escallonia	x exoniensis
Asteraceae	Gaillardia	'Arizona Sun'
Crassulaceae	Hylotelephium	spectabile
Lamiaceae	Lavandula	x intermedia
Scrophulariaceae	Leucophyllum	frutescens
Lamiaceae	Perovskia	atriplicifolia
Lamiaceae	Salvia	greggii 'Hot Lips'
Verbenaceae	Lantana	hybrid
Asteraceae	Solidago	californica
Malvaceae	Sphaeralcea	ambigua
Lamiaceae	Teucrium	chamaedrys

Garden plant evaluation



Mean no. of bees per 2-minute count \pm SE

Garden plant evaluation



Garden plant evaluation Proportion of samples with honey bees



Garden plant evaluation Proportion of samples with other bees



Effect of irrigation and plant cultivar on bee attractiveness

 UC Plant **Sciences** have ongoing trials to evaluate common landscape plant water needs



 We have partnered with them to begin bee evaluations of these plants

Effect of cultivar on bee attractiveness



Ш С Mean no. honey bees per 5-minute count ±

- Many plant families
- Continuous bloom
- Different flower shapes, sizes, and colors
- Plant in patches





Bees and plants: simple vs. doubled flowers



Echinacea purpurea



Echinacea 'Hot Papaya'



Bees and plants: patch size Aim for 10 ft² patches of one species





Shelter– ground level

- Bare ground
- Rock and stone crevices
- Stumps and logs





Shelter– ground level

Halictus rubicundus prefers to nest in pebblecovered soil rather than bare ground, possibly due to pebbles warming the soil. (Apidologie 46:728-734)



Year and Surface Treatment

Shelter – above ground

- Cavity-nesting bees use abandoned beetle galleries in the wild
- Bee houses mimic that habitat in gardens
- Bees are central-place foragers and will utilize resources in the nest area
- Bees tend to nest in the same area each year
- Size matters: a bee will use a diameter cavity that corresponds to her body size







Figure 1. Different nest boxes and materials used to construct them. **a**, **b** Bamboo reeds (**a** photo credit: Stephen Humphreys), **c**, **d** Drilled holes in wood blocks. **e**, **f** Wood cartridges. **g** Cardboard paper tubes. **h** Extruded plastic tubes.

(Apidologie 48: 311-327)



Water

- Honey bees prefer "dirty" water
- Honey bees will change their water source over the year depending on its mineral content (Bonoan et al., Ecological Entomology 42:195-201)

Furrow versus drip irrigation did not affect wild bee abundance or richness in sunflower (Sardinas et al., California Agriculture 71:35-40)



Acknowledgements USDA-NIFA-SCRI CA Department of Food and Agriculture CA Department of Pesticide Regulation Häagen-Dazs UC Davis College of Agriculture and **Environmental Sciences** Wells Fargo **Daughters of the American Revolution California State Chapter** Whole Foods Palm Bay International **Individual donors** Volunteers!

Questions? http://hhbhgarden.ucdavis.edu http://ucanr.edu/blogs/TheBeeGardener/

