Title: **The Philly Bee's Stake in Pollination: The Bees of Philadelphia**

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Abstract:

This study is part of a larger United States Geological Survey of the bees in the United States as part of a monitoring program of the flora and fauna of North America. While bees have been studied across Pennsylvania, in New York City and Baltimore, this is the first documented survey of the bees of Philadelphia. I sampled bees by netting once in July, August, and September. A total of 280 bees, representing 58 species were captured. This is the first record of several bee species for Pennsylvania, including the recently introduced *Hylaeus hyalinatus* Smith and *Coelioxys coturnix* Perez. I also document the presence of *Bombus pensylvanicus* Perez, a bumble bee that may be in decline. This study can be used to guide monitoring and conservation efforts.

INTRODUCTION

Wild bees are necessary and sufficient for the pollination of crops and the perpetuation of gardens. Garibaldi *et al.* (2013) suggested that wild insect pollination resulted in twice as much fruit set as honey bee pollination in crop fields across all continents, excluding Antarctica. Winfree et al. (2008) reported that wild bees sufficiently pollinated the watermelon crop on the majority of farms sampled in Pennsylvania and New Jersey.

The majority (95%) of bee species that have been documented for eastern North America have been captured at least once since 1990. This suggests that bee richness is not in decline in

the eastern United States (Colla et al., 2012). However, populations of at least two species of bumble bees, *Bombus affinis* Cresson and *Bombus pensylvanicus* Perez, may be in decline (Colla et al., 2012). The United States Geological Survey is now conducting surveys across the country to analyze that status of bee populations in the United States.

Bees occur in high abundance is urban settings, but no papers on bee populations outside of New York City, NY and Baltimore, MD have been published for cities in the Northeastern United States (Droege & Shapiro 2011 and Matteson et al. 2008). Specifically, there are no published studies of the wild bees of Philadelphia, despite the city's size, location mid-way between New York and Baltimore, and its status as an active port located on the East Coast Fall Line.

According to Cane (2005) in *Bees' Needs Challenged by Urbanization*, urban bee populations are different from rural and wild bee populations because of several characteristics. First, they are smaller because there is less habitat. Second, there are fewer ground nesting bees because of the prevalence of pavement and turf. Third, since there are less floral resources over all, there are fewer oligolectic bee species, defined as bees that collect from three families of plants or less (Wilmer, 2011). Fourth, there are fewer cleptoparasitic bees because of smaller populations of bees. Cleptoparastic bees represent the apex of bee communities and are only present where there are large enough populations of host bees to support parasitism (Sheffield, Pindar, Packer, & Kevan, 2013). Fifth, in large port cities, like Philadelphia, there are more likely to be exotic species, introduced from shipments.

The purpose of this study is to provide information on the richness of bees within the city and to create a record of bees in Philadelphia for future monitoring.

MATERIALS AND METHODS

I net collected once in 10 community gardens and multiple times in the Morris Arboretum in Philadelphia County from late June (6/25/2012) to October (10/16/2012) (Table 1). The Morris Arboretum is ecologically different from the gardens, but is still within the city boundary. This is a time independent survey since my purpose was only to document what bees

are present. If I could identify the bee in the field and its presence was documented for the area, I did not capture it (eg. *Xylocopa virginica* Linnaeus and *Bombus impatiens* Cresson). I used a BioQuip Products 38.1 -centimeter (15-inch) diameter model net. The bees were suffocated in ethyl acetate kill jars or frozen.

I pinned and labeled the bees and then identified them using the Discover Life Random Access Key (The Polistes Foundation, 2013). S. Droege confirmed my identifications. I used literature searches to determine whether the presence of each bee had been documented in Pennsylvania and Philadelphia (Donovall & vanEngelsdorp 2010; Tonietto & Ashcer, 2002; Vickruck, and Rehan, Sheffield, & Richards 2011) and whether or not the bee fell within the following categories: native, cleptoparasitic, oligolectic, and ground nesting (Table 2).

RESULTS

A total of 280 bee specimens (including two unidentified male *Lasioglossum*) were netted in the summer of 2012 in Philadelphia County, representing 58 species. Five species (9%) had

not been documented for Pennsylvania and 18 species (31%) had not been documented in Philadelphia. Five species (9%) were introduced taxa. Seven (12%) were cleptoparasites. Fourteen (24%) were oligolectic species and thirty-four (59%) were ground nesting (Table 2).

DISCCUSSION

The majority of bees that had not been documented in Pennsylvania were in the genus *Lasioglossum* (all but one). This result is not surprising since researchers are still constructing this group's taxonomy. For example, the species *Lasioglossum gotham* Gibbs has not been recorded in Pennsylvania, but the classification of the species itself is recent (2011) (The Polistes Foundation, 2013).

Ceratina mikmaqi Rehan & Sheffield, which I netted at Benjamin Rush State Park, is an uncommon oligolectic species (The Polistes Foundation, 2013). I netted the uncommon bee *Lasioglossum taylorae* Gibbs as it was foraging on *Datura stramonium* L. at the Morris Arboretum. No floral hosts have been recorded for this species until now (The Polistes Foundation, 2013). Other oligolectic species include *Melissodes* sp. that were foraging on *Helianthus* in many of the community gardens, as well as males of the squash bee, *Peponapis pruinosa* Say, that were collected in squash flowers in Warrington Community Garden in West Philadelphia.

The exotic bee species that I captured included *Anthidium manicatum* L. and *Anthidium oblongatum* Illiger, both of which have spread from Europe and whose presence in North America is well known (The Polistes Foundation, 2002). I collected *Megachile apicalis* Spinosa from *Cirsium* in Pennypack State Park. This European bee has been documented in New York and Baltimore but not in Philadelphia (The Polistes Foundation, 2013). *Hylaeus hyalinatus* Smith is a recently introduced species from Europe. This is the first record of it in Philadelphia.

I netted the cleptoparasitic bee, *Coelioxys coturnix* Perez in Southwark Community Garden in South Philadelphia. This bee was recently introduced from Europe (The Polistes Foundation, 2013). Interestingly enough, its host species, *Megachile minutissima* Radoszkowski has not been documented as present in North America. (Figure 1). It is believed to be parasitic on *Megachile rotundata* Fabricius, an introduced bee species from Europe (Droege & Shapiro, 2011).

I netted a single *Bombus pensylvanicus* Perez at Maple Acres Farm (40° 7' 6", 75° 16' 23"). This farm is not in Philadelphia County, but this specimen is worth noting because *Bombus pensylvanicus* populations may be in decline (Colla et al., 2012).

SIGNIFICANCE AND BROADER IMPACT

This study reports the presence of several bees that were undocumented for this area and provides information about the diversity of bee species in Philadelphia. The presence of the *Coelioxys coturnix* suggests that bee populations within the city are at least large enough to support cleptoparasitic bees, though it warrants further research and documentation of its specific hosts here in North America. The single capture of *Bombus pensylvanicus* indicates that this bumble bee is still present in the area, but not in abundance.

Using this research, I have presented information about native bees at several events in the Philadelphia community, including at the Philadelphia Honey Festival, a volunteer workshop at the Morris Arboretum, and an event at the Franklin Institute. I will deposit the specimens at the Academy of Natural Sciences of Drexel University in Philadelphia, PA for future reference.

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APPENDIX

Table 1. Gardens in Philadelphia where I collected specimens.

Garden	Address	Location	Latitude	Longitude
Bartram's Garden	54th Street and Lindbergh Boulevard	West	39° 55' 57"	75° 12' 44"

Bel Arbor Community Garden	1018 Kimball Street	South	39° 56' 16''	75° 9' 38
Benjamin Rush State Park	Roosevelt Blvd & Southhampton Rd.	North East	40° 7' 10"	74° 58' 36"
The Morris Arboretum	100 Northwestern Avenue	North West	40° 5' 30''	75° 13' 29''
Pennypack Park	7979 State Rd.	North East	40° 3' 55"	75° 2' 20"
South Street Community Garden	837 South St.	South	39° 56' 34"	75° 9' 23"
Southwark / Queen Village Community Garden	311 Christian St.	South	39° 56' 13''	75° 8' 57"
Warrington Community Garden	4731 Warrington Ave.	West	39° 56' 53	75° 13' 4"
St. Bernard Community Garden	1010 S. St. Bernard St.	West	39° 56' 39	75° 13' 5"
Kingsessing and 47th	1128 South 47th Street	West	39° 56' 43''	75° 12' 46

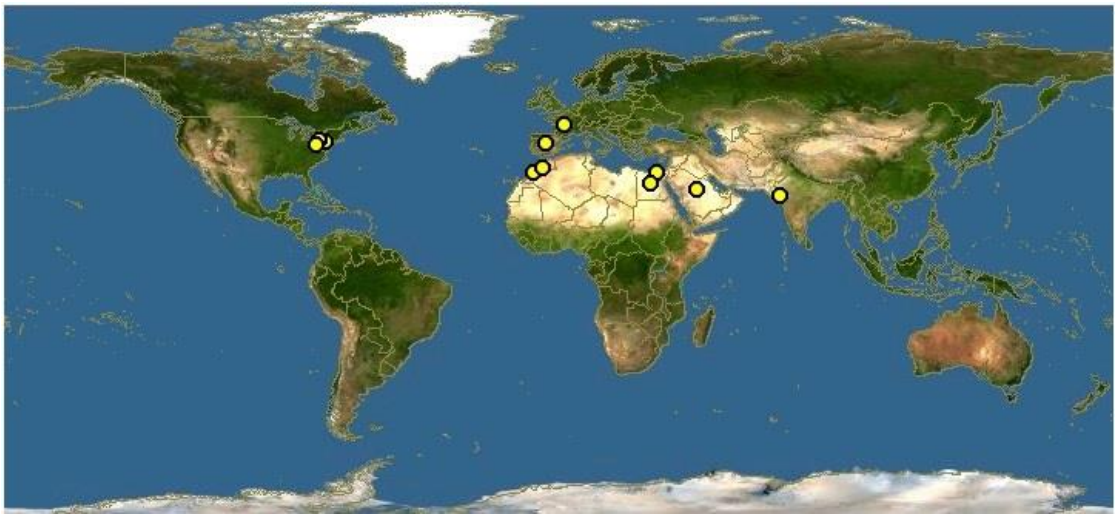
Table 2. Specimen data. 1 and 0 represent true and false, respectively, for each characteristic.

Genus species	Count	Richness	Documented PA?	Documented Phila?	Native?	Cleptoparasitic?	Oligolectic?	Ground nesting?
Agapostemon	**5**							
sericeus	1	1	1	1	1	0	0	1
texanus	1	1	1	1	1	0	0	1
virescens	3	1	1	1	1	0	0	1

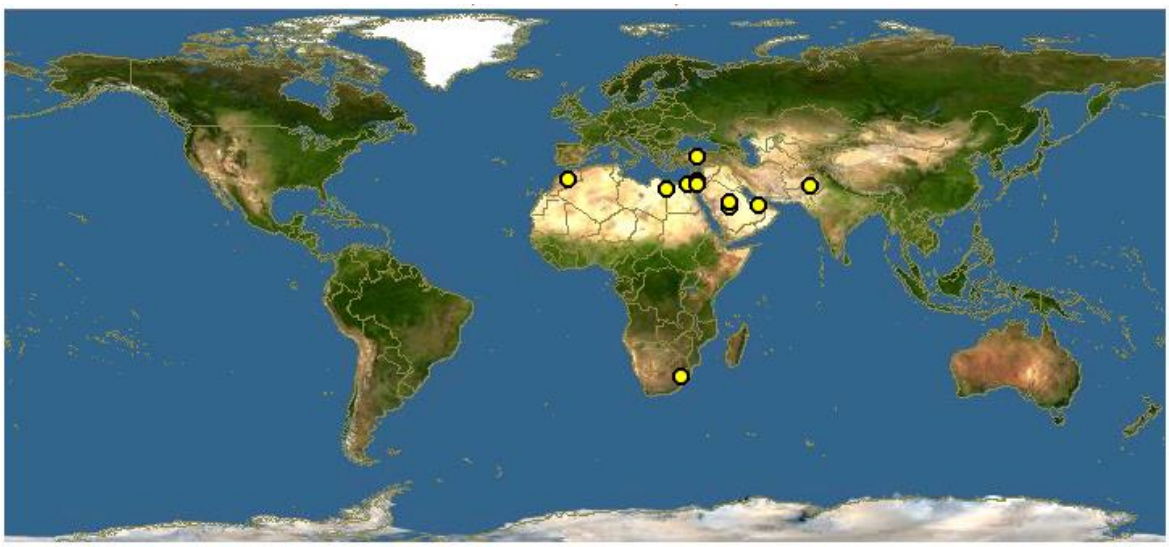
Anthidium	**7**							
manicatum	4	1	1	1	0	0	0	0
oblongatum	3	1	1	1	0	0	0	0
Augochlora	**8**							
pura	8	1	1	1	1	0	0	1
Augochlorella	**4**							
aurata	4	1	1	1	1	0	0	1
Augochloropsis	**3**							
metallica	3	1	1	1	1	0	0	1
Bombus	**42**							
auricormis	1	1	1	1	1	0	0	0
bimaculatus	7	1	1	1	1	0	0	0
fervidus	8	1	1	1	1	0	0	0
griseocollis	13	1	1	1	1	0	0	0
impatiens	10	1	1	1	1	0	0	0
pennsylvanicus	1	1	1	1	1	0	0	0
Ceratina	**20**							
calcarata	14	1	1	1	1	0	0	0
dupla	4	1	1	1	1	0	0	0
mikmagi	1	1	1	0	1	0	1	0
strenua	1	1	1	1	1	0	0	0
Coelioxys	**3**							
coturnix	2	1	0	0	0	1	0	0
sayi (octodentata)	1	1	1	1	1	1	0	0
Epeolus	**1**							
bifasciatus	1	1	1	1	1	1	1	1
Halictus	**60**							
confusus	5	1	1	1	1	0	0	1
ligatus	44	1	1	1	1	0	0	1
parallelus	1	1	1	1	1	0	0	1
rubicundus	10	1	1	1	1	0	0	1
Holocopasites	**1**							
calliopsidis	1	1	1	1	1	1	1	1
Hylaeus	**10**							
hyalinatus	3	1	1	0	0	0	1	1
mesillae	2	1	1	0	1	0	0	1
modestus	5	1	1	1	1	0	0	1
Lasioglossum	**39**							
bruneri	2	1	1	1	1	0	0	1
callidum	2	1	0	0	1	0	0	1
coriaceum	2	1	1	0	1	0	0	1
gotham	1	1	0	0	1	0	0	1

illnoense	2	1	1	0	1	0	0	1
imitatum	17	1	1	1	1	0	0	1
pilosum	2	1	1	1	1	0	0	1
quebecense	1	1	1	0	1	0	0	1
taylorae	5	1	0	0	1	0	1	1
trigeminum	3	1	0	0	1	0	1	1
versatum	2	1	1	0	1	0	0	1
Megachile	**28**							
apicalis	1	1	1	0	0	0	1	0
brevis	9	1	1	1	1	0	0	0
campanulae	1	1	1	1	1	0	0	0
centuncularis	4	1	1	1	1	0	0	0
exilis	1	1	1	1	1	0	0	0
mendica	4	1	1	1	1	0	0	0
pugnata	3	1	1	0	1	0	0	0
relativa	1	1	1	0	1	0	0	0
rotundata	4	1	1	1	1	0	0	0
Mellisodes	**39**							
agilis/trinodis	24	1	1	1	1	0	1	1
bimaculata	4	1	1	1	1	0	0	1
desponsa	11	1	1	1	1	0	1	1
Peponapis	**4**							
pruinosa	4	1	1	1	1	0	1	1
Pseudopanargus	**1**							
compositorum	1	1	1	0	1	0	1	1
Triepeolus	**4**							
helianthi	1	1	1	0	1	1	1	1
remigatus	2	1	1	1	1	1	1	1
simplex	1	1	1	0	1	1	1	1
Xylocopa	**1**							
virginica	1	1	1	1	1	0	0	0
Grand Total	**280**	**58**	**53**	**40**	**53**	**7**	**14**	**34**

Figure 1. Comparison of distribution of *Coelioxys coturnix* and *Megachile minutissima*.



Distribution of *Coelioxys coturnix*.



Distribution of *Megachile minutissima.*