The Wild Bees of New York: Our Insurance Policy Against Honey Bee Decline

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Pollination is a valuable service provided by both managed bees (primarily honey bees, *Apis mellifera*) and wild, native bees. Bee pollination is essential for the production of fruits, nuts, vegetables, spices, stimulants (such as coffee), and edible oils (such as sunflower and canola). Estimates of the economic contribution of pollination vary widely, but two recent studies give us a sense of the magnitude of the contribution pollinators make to the global and national economy. Gallai et al. (2009) estimated that the contribution of pollination to the global economy was approximately $170 billion annually, and Calderone (2012), based on data for the US alone, estimated that pollination contributes over $15 billion/year to the US economy. In New York, important pollinator-dependent crops include apple ($250 million/year), squash and pumpkin ($74 million/year), tomatoes ($47 million/year), strawberries ($7 million/year), cherries ($3 million/year), and pears ($2.5 million/year) (economic data from New York State Department of Agriculture and Markets; www.agriculture.ny.gov). Many of New York’s most high value fruits are entirely dependent on pollinators for successful production.

Based on our research on apples over the past seven years, there is a surprisingly diverse fauna of wild bees that contribute to apple pollination in NY. We have documented over 118 wild bee species visiting apple blossoms in surveys of NY apple orchards from Lake Ontario to the Hudson Valley (Russo et al. 2015). We have shown that wild bees are numerically abundant across orchards varying in size and management (Russo et al. 2015), that wild bees are highly effective pollinators on a per-visit basis (Park et al. 2015), and that wild bee diversity and abundance are correlated with apple fruit and seed set (Blitzer et al., in prep.). Apples are not the only crop that benefits from wild pollinators. Strawberries, pears, cherries, tomatoes and cucurbit crops are benefitting from a diverse wild pollinator fauna as well.

In April, 2015, Governor Cuomo announced that New York State will establish a taskforce to develop a Pollinator Protection Plan to promote the health and stability of pollinator populations in New York State. A first step toward developing a comprehensive Pollinator Protection Plan is to accurately document the diversity of wild bees in New York. To that end, we have been developing a complete list of New York’s wild bees. Our goal is to accurately document what species occur in New York, which bee species are native and which are non-native, and as much information about the natural history, nesting biology, floral preferences, social behaviors as possible. This is essential baseline data for developing a comprehensive Pollinator Protection Plan for NY.

We assembled our list of New York bee species using the American Museum of Natural History’s “Arthropod Easy Capture” database (Schuh et al. 2010, Schuh 2012). These data were originally gathered as part of an NSF-funded research grant to John Ascher, Jerome Rozen, Jr., and Douglas Yanega entitled “Collaborative Databasing of North American Bee

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Figure 1. Histogram showing the distribution of the number of species across the 42 bee genera known from New York. Our largest genera are *Andrena* and *Lasioglossum*, followed by *Nomada*, *Megachile*, *Osmia*, and *Bombus*. New York hosts a total of 416 wild bee species.

Figure 2. *Andrena* (*Melandrena*) female on a dandelion (*Taraxacum*). *Andrena* are ground-nesting bees that are important early spring pollinators of apples, cherries, strawberries and many other flowering trees. Photo credit: Bryan Danforth
Bee Diversity in New York

We estimate that there are a total of 416 bee species in New York state. Forty-two of the 425 genera of bees in the world (Michener 2007) occur in New York (Figure 1). Our most common (and speciose) genera are Andrena, Lasiosglossum, Nomada, Sphecodes, Megachile, Colletes, Osmia, Hylaeus, Melissodes, Bombus, and Coelioxys (Figure 1). A survey of bee species in Pennsylvania (Donovall and vanEngelsdorp 2010) documented a total of 371 species, comparable to the number we report here for New York, but likely an underestimate given the size of Pennsylvania.

The majority (54%) of bees in New York State are digger bees (ground-nesting, solitary bees, such as Andrena, Lasiosglossum, Colletes, and Melissodes). Species of Andrena (Figure 2) are typical of ground-nesting bees in their life history. At the start of the nesting season (in the spring, summer, or fall, depending on the species), female Andrena begin constructing burrows in the soil. At the end of these subterranean burrows they construct brood cells, which are lined with waterproof secretions from the Dufour’s gland. Once a brood cell has been constructed, a female provisions it with a mixture of pollen and nectar collected from flowering plants in the vicinity of the nest. Foraging ranges in these solitary bees are small — on the order of 500 m maximum — so nests are typically close to the floral resources. Once the provisions have been collected, the pollen/nectar mixture is sculpted into a spherical pollen ball and an egg is laid on top. The brood cell is then closed and the female begins constructing a new brood cell. Brood cells range in depth from just a few inches to several feet. A typical solitary female might produce just 10–15 offspring over a period of two to three weeks of active foraging.

While the majority of bees in New York State are ground-nesting, several species also make nests in preexisting cavities, such as twigs, hollow stems, beetle burrows, or in sites above ground. These aboveground, cavity nesters include the mason bees, the wool carder bees and various resin bees. Mason bees in New York State include genera such as Osmia, Hoplitis, Prochelostoma, and Heriades. Mason bees comprise roughly 7 percent of the species of bees in New York State. Other cavity- and stem-nesting bees include the leaf-cutter bees in the genus Megachile (Sheffield et al. 2011b), carder bees in the genus Anthidium, Pseudoanthidium, and Panathidium, and the yellow-faced bees in the genus Hylaeus. Megachile females line their cells with circular pieces of leaf that they cut from rosebushes and other plants. Hylaeus females line their burrows (constructed in plant stems or other hollow tubes) with a cellophane-like material produced by the Dufour’s gland. Hylaeus are unusual bees because they carry pollen internally and not externally, as do most pollen-collecting bees.

Another important group of bees are the carpenter bees. In North America we have both small (Ceratina) and large (Xylocopa) carpenter bees. These bees construct nests in wood or preexisting cavities. Xylocopa virginica is a common bee in New York State (Figure 3). Nests are conspicuous because males hover in front of the nests (typically located in fence posts, wooden park benches, and houses) and engage in aggressive territorial battles.

Cleptoparasitic bees comprise 23 percent of the bee species in New York. The two largest genera of cleptoparasitic bees in New York are Sphecodes and Nomada. Parasitic bees are fascinating creatures. They have lost the morphological structures associated with nest construction and pollen collection in most other bees. Instead of constructing and provisioning their own brood cells, parasitic bees enter the nests of other bees (usually when the host female is away) and lay their eggs within the host nest. Once the host female has laid her egg and closed the cell, the parasitic larva hatches from its own egg and kills either the host egg or young larva, then feeds on the host’s pollen. Parasitic bees have devious methods for hiding their eggs from the host females. For example, Nomada and relatives (in the subfamily Nomadinae) put their eggs in the cell wall of the host bee’s nest.

So far, the great majority of bees we have mentioned are solitary (or parasitic). Important eusocial bees in New York State include both advanced eusocial taxa in which queens and workers are morphologically distinct (such as Apis mellifera, the introduced honey bee) and primitively eusocial taxa, in which queens and workers are distinguishable from each other based only on size or behavior. Important primitively eusocial taxa include Bombus (bumblebees; Apidae), as well as Augochlorella, Halictus, and some species of Lasiosglossum (Halictidae). We estimate that approximately 19 percent of the bee species in New York State are eusocial.

Introduced (Non-native) Bees

There are known to be a total of 23 introduced bees in North America, and 21 of them occur in New York State (Ascher 2001, Cane 2003, Sheffield et al. 2011a). All of the known introduced bees have been transported from the Old World (Eurasia) either accidentally or through intentional introduction. The most common and conspicuous of our introduced European bees is the honeybee, Apis mellifera, which is managed commercially for honey and pollination services. Other introduced bees include species of Megachile, Hylaeus, Chelostoma, Hoplitis, Anthidium and Andrena (Ascher 2001, Miller et al. 2002, Cane 2003, Sheffield et al. 2011a). Ascher (2001) estimated that accidentally
introduced bees account for 0.5 percent of the North American bee species. While they comprise a small number of species, introduced bees make up, in some cases, a large proportion of the individuals in New York State. This is especially true of the European honeybee. Most accidentally introduced bees are stem- or cavity-nesting species. These species (in the Hylaeinae, Megachilidae, and Xylocopinae) are easily transported in plant materials (e.g., wood) or in man-made materials.

Nonnative bee species can have a negative impact on native species for a variety of reasons. Nonnative species may compete with native species for floral and nesting resources, they may carry pathogens that can infect native species, and they can cause mating disruption when they are closely related to native species (Stout and Morales 2009). Unfortunately, we know very little about the impact of nonnative bees on native eastern North American bees.

Transcontinental transport of bumblebee colonies for greenhouse tomato pollination is thought to have led to the introduction of nonnative bumblebee pathogens — specifically microsporidian pathogens in the genus Nosema (Cameron et al. 2011, Cordes et al. 2012). Introduction of nonnative pathogens is one of the leading hypotheses for the decline in several bumblebee species in North America, including Bombus affinis, B. terricola, and B. pensylvanicus.

Osmia cornifrons, also known as the horn-faced bee, is a nonnative mason bee that was intentionally introduced into the US (along with Osmia taurus) for fruit pollination in the 1970s (Batra 1979, 1982). Both non-native Osmia species have host-plant ranges and nesting requirements that are similar to those of our native “blue orchard bee” (Osmia lignaria). Apparent declines in Osmia lignaria in the eastern US may be linked to the arrival of O. cornifrons and O. taurus, but a careful examination of the historical data on the abundance of O. lignaria has not been conducted. A recent report by Hedtke et al. (2015) indicates that feral populations of O. cornifrons in the US host Ascosphaera pathogens originally reported from Japan, suggesting that intentional introduction of O. cornifrons has led to the unintentional introduction of a nonnative fungal pathogen into North American Osmia populations. Whether this pathogen is present in O. lignaria populations has not yet been established.

Megachile sculpturalis, also known as the giant resin bee (Figure 4), was introduced into the southeastern US (North Carolina) in the early 1990s (Mangum and Brooks 1997, Mangum and Sumner 2003, Hinojosa-Diaz et al. 2005, Mayer 2009). It has since spread throughout much of eastern North America (as far north as Ontario), as far south as Alabama (Mangum and Sumner 2003), and was recently reported as far west as Kansas (Hinojosa-Diaz 2008). The bee is also a nonnative invader that is spreading across much of western Europe from Belgium (Vereecken and Barbier 2009) to Italy (Quaranta et al. 2014). This large, aggressive resin bee has been reported to forcibly usurp active nests of our native large carpenter bee (Xylocopa virginica). Roulston and Malki (2012) reported an attack on an active carpenter bee nest in which the giant resin bee attacked and physically removed adult carpenter bees guarding the nest entrance. During the attack the resin bee grabbed the legs of the carpenter bee, bit the carpenter bee near the head, and made repeated attempts to sting it. In addition, the resin bee appeared to use sticky resins to gum up the wings of the carpenter bee—a remarkable case of what appears to be chemical warfare in the bee world. Laporte and Minkley (2012) reported a similar example of nest usurpation that included the use of sticky resin against the resident carpenter bees in Rochester, NY. The rapid spread of the giant resin bee throughout the eastern US (and Europe) and the reports of nest usurpation suggest that this bee may have a very significant impact on native carpenter bee populations across an enormous geographic range.

Rare, Threatened, and Endangered Bees

We know very little about the conservation status of most bee species in New York State because there is no long-term monitoring program for wild bees. However, one way to monitor historical changes in wild bee populations is to use specimen record data from natural history museums, such as the American Museum of Natural History and the Cornell University Insect Collection [http://cuic.entomology.cornell.edu/]. Museum
records can give us a historical perspective on the change in the absolute and relative abundance of a species over time. A recent study (Bartomeus et al. 2013) examined historical museum records for 438 bee species across the eastern US in order to identify evidence of significant declines over the past 140 years. Sample sizes were sufficient to examine historical trends in 187 species. Of those 187, 49 species occurring in NY were found to be in decline or rare and potentially threatened.

Bumblebees, because of their large size and ease of observation, are perhaps the best known bees in terms of conservation status. A number of eastern bumblebee species are known to have experienced significant declines over the past 30 years. Bombus terricola, B. bohemicus, B. insularis, B. pensylvanicus, and B. terricola are all in decline over part or all of their ranges. Bombus affinis, a common eastern bumblebee prior to 1996, is now extremely rare and may be close to extinction. The causes of these declines are not clear but may include loss of natural habitat, exposure to pesticides, and the arrival of nonnative pathogens (especially Nosema bombi from Europe; Cameron et al. 2011, Cordes et al. 2012).

Besides the bumblebees, which are well-studied and charismatic pollinators, the list of declining bee species detected by Bartomeus et al. (2013) includes solitary ground-nesting bees (e.g., Andrena, Melissodes, and Colletes [Figure 5]), solitary stem- and cavity-nesting bees (e.g., Osmia and Megachile), social ground-nesting bees (e.g., Lasio glossum subgenus Dialictus), narrow host-plant specialists (e.g., Peponapis pruinosa, some Andrena and Colletes), and cleptoparasites (e.g., Coelioxys and Epeolus). The study of Bartomeus et al. (2013) is likely an underestimate of the number of threatened bee species in the Northeast because the rarest bees were excluded from the analysis because of their small sample size.

Bees in the family Melittidae are among the rarest of New York’s bees. Melittidae is an enigmatic, seemingly ancient group of bees with its greatest diversity in southern Africa. Virtually all melittid bees are narrow host-plant specialists (Michels 2008) and many groups seem to prefer sandy soils for nesting. In New York we have just five species in two genera: Melitta and Macropis. Melitta eickworti and Melitta americana are both specialists on Vaccinium (Ericaceae). Melitta americana can be common in and around blueberry and cranberry fields (Payette 2013, Cariveau et al. 2013), but Melitta eickworti is restricted to shady forest understory with deeberry (Vaccinium stamineum; Cane et al. 1985). Macropis includes highly specialized “oil bees” that are narrow host-plant specialists on Lysimachia (yellow loosestrife). Female Macropis nest in humid, boggy habitats (where their host-plants occur) and they use the floral oils for lining the brood cell as well as for larval nutrition (Cane et al. 1983). The collection of floral oils may be an adaptation for nesting in saturated, marshy soils along streams, rivers and on the edge of ponds and lakes. In New York we have three Macropis species, all of which are rare and geographically restricted. Their narrow host-plant preferences and obligate association with oil-producing host-plants (Lysimachia) contributes to both the rarity of these bees as well as their status as potentially endangered pollinators.

Epeoloides pilosula is likely the most threatened and endangered bee species in New York (and the Northeast). E. pilosula is a cleptoparasite of Macropis, a rare bee for reasons outlined above. E. pilosula has not always been rare. There are many records of E. pilosula prior to 1940 and the known range of E. pilosula includes 18 states and 4 Canadian provinces (Sheffield et al. 2004, Wagner and Ascher 2008). However, in the past 60 years, the bee has only been collected four times: in Montana (1958), Ontario (1960), Nova Scotia (2002), and Connecticut (2008). This bee is a prime candidate for listing as an endangered species in North America.

Conclusions
Many of the wild bees we have described above are contributing economically to New York agricultural production. One can view these wild bees as New York agriculture’s insurance policy against honeybee decline. We are lucky to have a diverse native bee fauna that can fill the gap if honeybees become more expensive or are simply unavailable to New York crop producers. Wild bees do not seem to suffer from the same diseases and parasites that are linked to declines in honey bees in North America. NY residents and agricultural producers can sleep well at night knowing that New York’s wild bees are hard at work pollinating our crops – and they do it for free!

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