

Those Blueberry Pollination Blues

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While the relationship between the honey bee and the blueberry flower takes some effort to understand, it is an extremely useful and valuable case study of pollination and bee botany. Blueberries are rapidly growing in popularity due to their anti-oxidant properties and as a highly edible berry. The plants are grown in a number of states in the USA and Canada and there are different species in these regions. Each cultivated type has varieties (cultivars) that are variable in their relationship with different pollinator species.

Native to North America, the blueberry genus *Vaccinium* spp. is commercially represented by highbush, lowbush and rabbit eye species grown in different parts of the continent. In areas like Michigan, New Jersey and adjoining states, the highbush blueberries were selected from two species: *V. australe* and *V. corymbosum*. These berries are sold fresh and for processing. The rabbiteye blueberry is the southern species *V. ashei* and is being planted in an expanding range as growers tap into the early market for the berries. The lowbush blueberries of Maine (and elsewhere) are hybrids of *V. augustifolium* and *V. myrtilloides*, although hybrids of lowbush and highbush blueberries are found as numerous clones throughout the northeastern part of the continent. Most of these berries are used in processing or offered in the frozen food section.

With this wide range of genetic diversity, we would expect a similar diversity in pollinators, but that has not been the case. Bumble bees are identified as the most common native pollinators on the plant, and reflect a strong co-evolutionary relationship between flower and bee. Indeed, other than the introduced honey bee, there are relatively few pollinator visitors to blueberry flowers other than bumble bees. The challenge of using bumble bees, of course, is the difficulty of providing them in large enough numbers for commercial plantations in areas where they do not appear naturally, although low bush blueberry growers in Maine are promoting their natural bumble bee populations. Since bumble bees visit blueberry flowers under cooler, wetter and more overcast conditions than honey bees, there are seasons when a small number of bumble bees are responsible for a significant portion of the pollination activity in the plantings. As a result, some growers rent both honey bee and bumble bee colonies as added protection for crop production.

Blueberry flowers of some varieties set fruit through self-pollination, but the fruit are smaller and very slow to ripen. Certain cultivars are completely or nearly self-sterile, so cross-pollination with another cultivar is essential and economically vital to set a good berry crop. This has resulted in the recommended cultural practice of inter-

planting different cultivars of blueberries in the same plantation, allowing for increased pollen transfer from one cultivar to another. (Ironically, some early research reported that blueberry flowers were self fertile, and as a result, huge blocks of single cultivar plantings were made in New Jersey and Michigan resulting in chronic low berry yield). This changed when studies like one reported in 1969 showed that berry production and seed yield increased when increased with levels of hive rental on highbush blueberries in Michigan and Indiana (see table below). It dramatically showed the role and advantage of honey bee pollination on the production of this crop. The yield in weight of berries increased by a factor of two, but the number of seeds increased nearly six-fold.

Number of colonies	Berry Weight (ounces)	Seeds per berry
None	160	4.9
2 colonies per acre	290	23
5 colonies per acre	335	28

A well-pollinated blueberry is easily identified by its larger size and the presence of developed tissue inside the ring of seeds. Un- and poorly-pollinated berries do not have a center area of developed tissue, while well-pollinated berries have tissue that has developed around the seeds as a result of plant hormone secretion by the developing seeds.

This is just one study showing the benefit of supplemental honey bee colonies in blueberry pollination. In all areas of the continent where blueberries are produced, growers rent honey bee colonies for increased yields using anywhere from five to ten colonies per acre to pollinate unattractive cultivars that require bee visits. Less attractive highbush cultivars include “Weymouth”, “Coville” and “Earliblue,” but this list is far from complete. Even plantings of attractive cultivars indicate a need for one or two hives per acre as justified by increased berry production.

To take the photos for this article I visited a commercial Connecticut grower where three cultivars were growing in parallel row blocks. With temperatures in the low 80s and in bright midday sunshine, only one cultivar had any honey bee visitors working the flowers; two varieties were not observed to have any pollinators on the flowers other than one or two bumble bees. The variety attracting honey bees had a large, attractive, bell shaped corolla and honey bee foragers were able to put their head into the opening of the corolla (see photos). The honey bee attractive variety had a wonderful fragrance while the other cultivars did not, suggesting that there are factors

other than nectar production affecting bee activity. If honey bees did visit the other two cultivars when I was not looking they might have difficulty getting their head into the corolla. This *might or might not* interfere with their ability to collect nectar from the flower. To pollinate these flowers, bees must be supplied in large numbers to saturate the area with foragers, thus increasing the number of flower visit attempts.

Looking at the structure of the blueberry flower we see a remarkable flower form that seems to be designed for a buzz pollinator like the bumble bee. There are eight to 10 stamens with anthers at the end of the filament, each with a long anther tube with an open pore at the bottom. Pollen is not released inside the flower like it might be in apple flowers, but must vibrate or fall down the anther tube and onto the body of a bee clinging to the downward pointing flower. This design is perfect for a bee that vibrates or buzz-pollinates the flower as bumble bees do. Honey bee movement on the flower causes varying amounts of pollen to fall, but in the buzz-pollination scenario, more pollen is vibrated by buzz vibration and falls out of the anther tube and onto the bee's body. This is similar to the bumble bee pollination of tomato flowers (honey bees are not attracted to tomato flowers and do not pollinate them), but in the case with blueberry flowers honey bees are able to collect nectar from the floral nec-

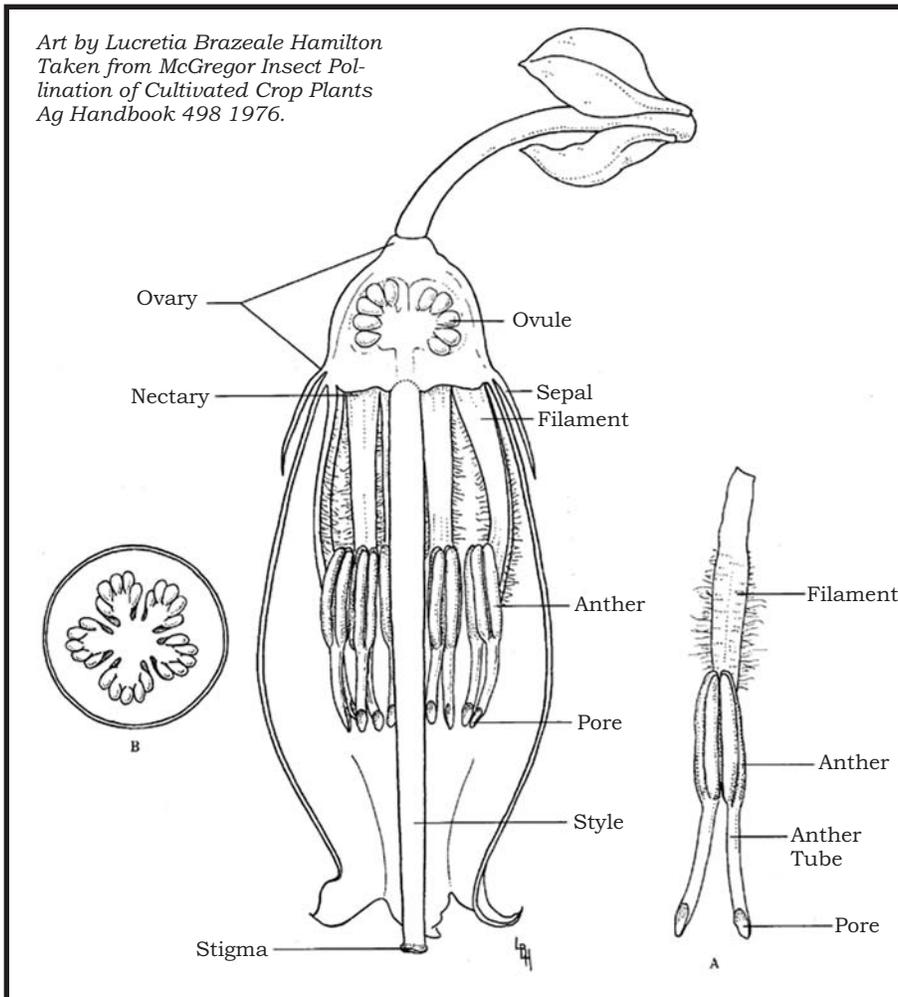
taries at the base of the corollas by inserting their tongue into the open corolla, even if their head cannot get into the corolla. Blueberry honey is obtained by bees foraging on those selected cultivars that have good sunlight, easy access and few visiting bees. Since not all cultivars produce much nectar, further study might help identify the characteristics that make certain varieties attractive to bees; these traits should be incorporated into blueberry breeding programs.

With some cultivars, honey bees are able to collect a large amount of blueberry pollen, suggesting that there is considerable difference in the amount of pollen released during flower visits as determined by cultivar. Some cultivars are apparently more successful in releasing pollen to honey bee pollinators than others.

The white or pink corolla is bell shaped and may be one-quarter to one-half inch in size. The corolla hangs downward to facilitate vibration/buzz pollination, and once pollinated the flower points upward and is no longer visited by pollinators. A single pistil is as long or slightly longer than the corolla and is positioned away from the opening of the anther tube pore so that self-pollination is unlikely; but the stigma is easily covered by pollen by visiting pollinators. It will remain receptive for five to eight days but is usually pollinated in less than three days. Once pollinated the flower loses its attractiveness

to bees, then the fruit take two to four months to mature, and each blueberry has the potential to hold up to 65 seeds. The presence of developing seeds in the blueberry has been shown to increase sugar content of the berry, making it more attractive to human consumers. The advantage to the grower from honey bee pollination is a larger, faster ripening, and sweeter berry crop. In my own limited experience of growing blueberries in my yard, every year I found a few berries that developed slowly, not ripening until October or November. On examination, these berries were small, seedless, and unattractive to taste. The well pollinated berries were harvested in August.

Growers quickly moved to increase colony rental for blueberry pollination in the 1960s after a Michigan State research project showed the benefit of honey bee saturation. To this day, blueberry plantations are provided with five or more colonies per acre when cultivars unattractive to bees are in production. Further horticultural-genetic work is needed to identify the cultivars that are attractive to



bees (due to increased nectar secretion, sugar concentration, floral odor and other factors of floral attractiveness) that would allow growers to inter-plant desirable varieties that fully support pollinator activity.

As in many pollination scenarios, growers frequently blame any failure in crop set on insect damage or frost. This was often the case when there were reduced blueberry crops, but the real factor is the lack of adequate pollinator activity on the flowers, and the lack of a compatible cultivar for cross pollination. In high bush blueberries the percentage of flowers that should be set is close to 100%, and a viable crop is obtained only when 80% or more of the berries develop. Low bush blueberries have traditionally had much lower berry set, perhaps as low as 10%, yet Maine apiarist Tony Jadczyk reports that blueberry barren owners (often large timber companies) are investing in the improvement of the barrens by removing large rocks, providing increased plant nutrition, regulating pests, and saturating the area with rental colonies. Each year somewhere between 50,000 and 65,000 colonies of honey bees are moved into Maine blueberries for the pollination peak, which occurs around the end of May.

Beekeepers should recommend to growers who have blocks of unattractive cultivars to move bee colonies in and out of the plantation on a rotational basis during the bloom period (and at an increased fee). This provides the bees with new and unfamiliar forage. The bees must reorient to the new field, but only after they have made many flower visits near the hive. Plus, when large numbers of colonies saturate the area, there is increased competition for forage and worker

bees visit fewer attractive flowers. By using a combination of saturation and rotation, the number of bees visiting unattractive flowers will increase, and so will the set of the berry crop.

Over the years there has been strong beekeeper resistance to placing bees on blueberries due to the timing of the placement. They have resisted placing more than one or two colonies per acre because late May and early June is when beekeepers often expect to produce a honey crop. When unattractive cultivars are involved, and over

five colonies per acre are required for good pollination, a high pollination fee is needed to justify the number and effort it takes to place bees on blueberry plantations and barrens. If there are attractive pollen- and nectar-producing varieties, this will help maintain colony strength, and perhaps provide a crop of surplus honey, and increase the incentive for the beekeeper. If larger concentrations of colonies are placed into a block of blueberries, the increased pollination speed will increase fruit set; the berries will ripen earlier and command a premium price. This should be encouraged, but with increasing demand for rental colonies in almond pollination in California, migratory pollinating beekeepers must carefully weigh the costs of blueberry pollination with fuel costs, labor, and lost honey production. **BC**



On the road again, Larry Connor wrote this article in the basement office of Blacklick Ohio retired teacher, retired commercial beekeeper/queen breeder, rare bee book dealer and digitizer, and gentleman Dana Stahlman. Larry sends a huge public thank you to Dana and Mary Stahlman for their considerable hospitality.