Short History of Pollination

How doth the little busy bee
Improve each shining hour
And gather honey all the day
from every opening flower

by PETER LORING BORST

Pollination has been in the news so much lately, but many folks don't realize that the understanding of pollination and the role animals play in it is a relatively recent discovery. In fact, I read a statement by a local entomologist (who ought to have known better) in the local paper that the settlers brought honey bees with them from Europe to pollinate fruit trees. Did he think there weren't fruit trees here already and that they somehow didn't have bees here, either?

Of course, the so-called New World as well as Australia, has always had fruit trees, flowers, and the whole range of plants which require insects to pollinate them. Among the many fruits and vegetables that existed in the New World and were maintained by native pollinators we can include native crab apples, plums and cherries; raspberries, blackberries and gooseberries. Vast areas were covered by blueberries, cranberries, and huckleberries. There are thousands of species of native bees, pollinating beetles and flies, birds and bats, that pollinate flowers, and many of these plants are also self-pollinated or pollinated by the wind. Missing was what we call the honey bee, *Apis mellifera*.

When the northern Europeans settled the colonies, they brought honey bees in order to have honey to eat. They found no native honey bees outside of the tropics. Honey bees spread so rapidly that pretty soon it seemed as if they were always here. But believe it or not, it simply was *not known* that insects were required to pollinate flowers. It was actually thought that bees robbed pollen from the flowers and damaged them as well as fruit. Here an author is defending honey bees from spurious charges:

> **I am not ignorant of the fact that very much has been laid to the charge of the bees. We are sometimes told that bees eat grapes as ravenously as chickens do worms, never stopping until they have destroyed whole vineyards. We occasionally hear of them devouring crates of peaches and various other fruits. We have not had any report yet as to their capacity for eating corn, pumpkins, and the vines and trees after they have made way with the fruit thereon; but then this is an age of discovery, and we cannot tell what may come to light. (Nebraska State Horticultural Society Annual Report, 1889)**

Discovery

The discovery of pollination was made in the 1700s, but the idea took a while to catch on, like new ideas often do. Sprengel is usually credited with this, but the 1761 work of Joseph Kolreuter actually predates him. Evidently, he was the first to declare the necessity of insects in the pollination of flowers. Perhaps the title of his work limited his audience: "Vorlaufige Nachricht von einigen das Geschlecht der Pflanzen betreffenden Versuchen und Beobachtungen." Herr Joseph conducted numerous experiments involving hybridization, with which he demonstrated the pollination requirements of numerous plants including all cucumber plants, irises, and many of the mallows. It was by preventing the access of pollinators that their necessity was proved.

It must be granted, though, that Christian Konrad Sprengel really got the study of pollination going. He called his book "Nature's Secrets in Flower Life and Fertilisation Revealed." Published in 1793, it was filled with minutely detailed engravings of flowers and the intricate structures that have coevolved in them as a result of their long-term relationship with pollinating animals. There is a memorial plaque at the Berlin Botanical Gardens, decorated with illustrations from his book. Unfortunately, due to the decidedly sexual aspect of pollination, the importance of his work was not immediately embraced.

Sprengel was very keen, however, on promoting beekeeping. His second book carried the title "The Usefulness of Bees and the Need for Beekeeping." Chief among his declarations were the outstanding importance of beekeeping and the need for governments to give strong support to its development. He went so far as to declare: "The State must have a standing army of bees." Further, he emphasized that the production of honey and wax is not the principle value of honey bees, but it is their value in the "fertilization of flowers and the furthering of rich harvests."

Darwin's New World

Our world was completely changed by the work and writings of Charles Darwin. He is primarily known for bringing the concept of Natural Selection to the world in 1859, and the fame and attention this brought him no doubt paved the way for the recognition of his other work, especially that with insects and flowers. In his 1876 book "The Effects of Cross and Self Fertilisation in the Vegetable Kingdom" he described in detail the results of painstaking experiments in which he compared the consequences of self-fertilization and outcrossing in a number of different plant species. In a 2009 Scientific American interview, John Williams (the current beekeeper at Darwin's Down house) tells us:

> **He had an observation hive here in Down. We don't know exactly where it was because the laboratory hadn't been built at that time he had the observation hive, which was in 1858, when he had a few types of hives here trying to solve the**

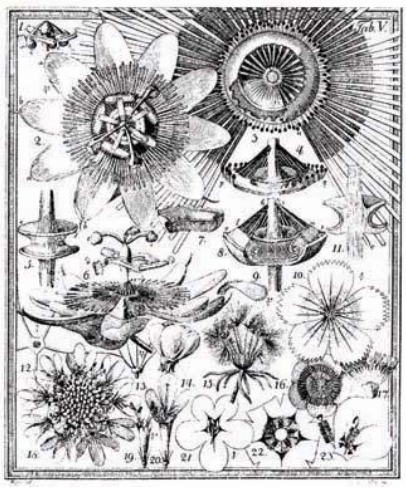
question of "How will bees build the hexagonal cells?" Many people thought it was the mathematical skills they were given especially by God to build the cells, but Darwin was able to explain how the building of the cells was achieved in evolutionary terms.

On the other side of the ocean, the world of beekeeping was undergoing a revolution as well. A. I. Root, seeing the commercial potential of a modern beekeeping industry, standardized hives and equipment and ushered in the era of large-scale honey production. One of Root's most significant contributions was the compilation of his wonderful "ABC & XYZ of Beekeeping" which with its over 150 years of publication can give a wonderfully complete history of the development of the bee craft.

Pollination and Pears

Ironically, in the 1882 edition very little emphasis is made on the role of bees in fruit production and the word "pollination" never appears. It is clear that beekeepers understood the necessity of pollen in the proper nutrition of the bees, but the paramount importance of bees to fruit growers had not yet been grasped. Under the heading "Do bees injure fruit by taking the honey from the blossoms?" Mr. Root writes of a town that outlawed bees because of the supposed damage they were doing to fruit. They soon found out that:

After a year or two had passed, the fruit growers decided that they would rather have the bees brought back, because so little fruit was set on the trees, in proportion to the amount of blossoms appearing. As it was a fruit growing district, it was a matter of considerable moment, and the bees were brought back. Of course, with the bees, came fruit in abundance, for many kinds of fruit absolutely depend on the agency of bees in fertilizing the flowers, to enable them to produce fruit at all. It seems that the small drop of honey which nature has placed in the flower is for the express purpose of attracting bees and other insects, that the blossoms may be surely and properly fertilized.



So it seems! As the country began to expand, large acreages were planted to marketable fruit such as apple, cherries and pears. Lovell writes in his excellent book "The Flower and the Bee" that in 1875 the Old Dominion Fruit company had some 22,000 Bartlett pear trees along the James River, in Virginia. They always bloomed abundantly and yet the pear crop was always a disappointment, running three fifths of a peck per tree when they should have yielded five times that.

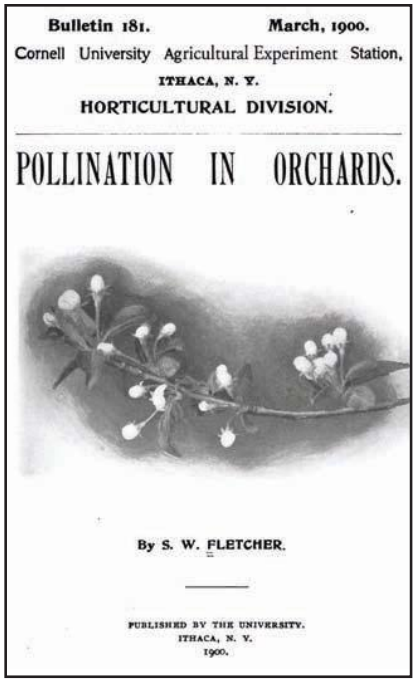
The groundbreaking work at this time was done by M. B. Waite who published "Pollination of Pear Flowers" in 1895. He covered the fruit trees with netting and proved beyond doubt that by excluding bees, many varieties of apples and pears would have absolutely no fruit. He also showed the need for planting different varieties in proximity in order that they might cross pollinate. He recommended to plant every third or fourth row to "Clapp's Favorite, or some other variety that was capable of fertilizing the blossoms of the Bartlett."

In March 1900, there appeared a definitive work on pollination, titled "Pollination in Orchards" by Samuel William Fletcher. The slim 33 page Bulletin 181 was published by the Cornell University Agricultural Experiment Station, Ithaca, N.Y. In it, Mr. Fletcher makes plain the value of native bees, and the issues that have resurfaced as the study of native bees has intensified over the past decade:

There are many kinds of insects which aid more or less in the cross-pollination of orchard fruits, principally bees, wasps and flies. Of these, the wild bees of several species are probably the most important. In a wild thicket of plums or other fruits, they are usually numerous enough to insure a good setting of fruit. But few if any wild bees can live in a large orchard, especially if it is well tilled. As the extent and thoroughness of cultivation increases, the number of these natural insect aids to cross-pollination decreases; hence it may become necessary to keep domestic honey bees for this purpose.

And yet, according to David B. Johnson, writing in "Meade, Bees, and Externalities" it is not until 1910 that we can locate the first record of colonies being rented for the purposes of pollination of crops. Prior to that time, writers often recommended to orchardists that they maintain bee colonies of their own, which no doubt some did.

I referred earlier to Lovell's "The Flower and the Bee" which came out in 1918. In it he nicely summarizes the history of pollination, and points out the importance of bees to the gourd family (Cucurbitaceae). This group includes not only gourds, but pumpkins, squash, cucumbers and watermelon. These plants are entirely dependent on bees and without them they will not bear fruit nor set seed. We now know that some of the ideal pollinators of these flowers are the squash bees, native solitary bees belonging to the two genera, *Peponapis* and *Xenoglossa.*



Bulletin 181. March, 1900.

Cornell University Agricultural Experiment Station,

ITHACA, N. Y.

HORTICULTURAL DIVISION.

POLLINATION IN ORCHARDS.

By S. W. FLETCHER.

PUBLISHED BY THE UNIVERSITY.
ITHACA, N. Y.
1900.

Pollination in orchards

Almonds and Apples

The California Gold Rush took place during the years from 1849 to 1855. The population of the state exploded from 90,000 to 300,000 during this time. It was soon learned that there was more to be found in California than gold, not the least of which was the Mediterranean climate. Almonds were first planted there in 1853, according to a 1922 pamphlet on "Almond Pollination," by Tufts and Philp. They state that by 1885, failures were pointing to the necessity of cross pollination between different varieties to produce decent crops of almonds. And, this cross pollination could only be effected by bees. They suggest growers obtain bees, even if they "may not care to go into the honey business," and point out that profitable quantities of honey could be made from alfalfa later in the season. They suggest scattering hives at the rate of one per acre. Further, they emphasize that for almonds, the honey bee is the most reliable pollinator.

Everett Franklin Phillips became professor of apiculture at Cornell University in 1924, after a long stint with the United States Department of Agriculture in Washington, DC. One of the tasks he took on was to survey the native pollinators among New York State's extensive apple orchards. In 1933, he published the results of that inquiry. To give an idea of the scope of the work: it took 459 man hours of collection and yielded 3,555 individuals, which evidently disappointed Dr. Phillips since he referred to it as only 7.75 insects per man hour. Scientific work, especially the study of pollinators, is quite labor intensive!

Phillips found the most abundant insects visiting apple blossoms in Monroe County to be flies (Diptera) and solitary bees. Of the flies, *Eristalis* was the most common, being

Wild bee on apple

Bumble bee on allium

a member of Syphridae family. These are known to non-entomologists as hover flies, drone flies, or "good news bees" (the good news is: they don't sting). Nearly a third of the pollinators collected were syrphid flies. Of the solitary bees, *Halictus* (sweat bees) and *Andrena* (mining bees) were the most prevalent. He states that honey bees were deliberately not collected and were found to far outnumber by a ratio of three to one, all the other pollinators in 1930. He also found them out earlier in the morning and later in the day than the others, except for bumble bee queens which seem to tolerate cool temperatures. As to how to increase the native bee population, he seemed to think that it had little potential for improvement, especially as natives tend to forage near where they live and the orchards are fairly inhospitable to them.

S. E. McGregor

No discussion of the history of pollination would be complete without mentioning Samuel Emmett McGregor. He lived from 1906 to 1980 and is chiefly remembered for his "Insect Pollination of Cultivated Crop Plants" which he wrote after he had retired as an Apiculturist for the Agricultural Research Service, Western Region, in Tucson, Arizona. As Keith Delaplane says, S. E. McGregor is one of the most misquoted individuals of our time. When people say that bees are responsible for one-third of our food, they are repeating what S. E. McGregor did *not* say. It would be well to quote him exactly:

> **Worldwide, more than 3,000 plant species have been used as food, only 300 of which are now widely grown, and only 12 of which furnish nearly 90 percent of the world's food. These 12 include the grains: rice, wheat, maize (corn), sorghums, millets, rye, and barley, and potatoes, sweet potatoes, cassavas or maniocs, bananas, and coconuts. The grains are wind-pollinated or self-pollinated, coconuts are partially wind-pollinated and partially insect pollinated. Superficially, it appears that insect-pollination has little effect on the world's food supply – possibly no more than 1 percent.**

Of course, there's more to it than that, or he wouldn't have written a 400 page book on the subject. He explains that in 1969 about 286 million acres were cultivated in the United States. Of these, well over half was devoted to wind or self-pollinated crops such as barley, corn, oats, rice, rye, wheat, grass hay crops, sugar beets, sugar cane, potatoes, sweet potatoes, and tobacco. Only 6 million acres were planted to fruits, vegetables and nuts, most of which require insect pollination. He described the 15% of our diet that depends upon or at least benefits from pollinators. Still a lot, to be sure. And mostly the better things, as well, like apples, peaches, pumpkin pie!

McGregor further describes the harmful effect of the loss of pollinating insects would have on uncultivated areas with their soil-holding and soil-enriching plants. He adds "springtime would be bleak indeed without the usual gay flowers." In fact, shortly after this at a 1979 banquet address Herbert G. Baker of the Department of Botany at University of California Berkeley, proposed moving gradually toward an understanding of pollination ecology, which incorporates the full range of interactions and relationships between plants and pollinators. In other words, an ecosystem *consists* of these interactions and as with all complex systems, a major alteration in one area will produce major effects throughout. We tend to take many of these concepts for granted now, but it must be remembered that these realizations came about through the careful study of many pioneering individuals.

The Status of Pollinators

In 2006 honey bees started getting massive press attention after large-scale unexplained losses occurred. Honey bees had been in decline for many decades, due to a variety of factors including the aging of the beekeeper population; the trending away from small scale agricultural activities; the sagging prices on the world honey market; and the influx of a variety of exotic pests such as the Africanized honey bee and the varroa mite. The spotlight was lit and focused at this point because it seemed plausible that the pollination needs of the country could go unmet if the rate of decline continued unabated. In response to this the National Research Council took on this issue at the request of the U.S. Department of Agriculture and the U.S. Geological Survey. According to Dr. May Berenbaum, "The committee devoted more than a year to examining literature, meeting with the experts who are most familiar with the lives of pollinators, and meeting with people whose livelihoods depend on pollinator activities."

This effort resulted in the publication of the "Status of Pollinators in North America." It is an epic 320 page work which covers the full range of issues from the **Role and Importance of Pollinators**, the **Causes of Pollinator Declines and Potential Threats**, clear through to the **Findings and Recommendations.** Of course, there is no way I can attempt to condense this work into my last paragraph. But I will mention a few of the ideas found in their conclusions.

They attribute the causes of pollinator decline chiefly to introduced parasites and diseases. Both honey bees and bumble bees have clearly been harmed by these. A drastic decline in pollinators will not endanger the world's food supply, but would make it difficult and expensive to produce high quality foods such as fruit. It is hard to make clear statements on the status of unmanaged pollinators as well as the impact on non-agricultural systems. There is a potential for genetic erosion, inbreeding depression, and extinction for many plants and animals, so special attention should be given to rare species. Despite sketchy data on wild pollinators, there are viable pollinator friendly land management practices.

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