INSECT POLLINATION OF CULTIVATED CROP PLANTS

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1967. GROWING FLOWERING CRABAPPLES.
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CRANBERRY

Vaccinium macrocarpon Ait., family Ericaceae

The large or commercial cranberry of the United States is grown only in Massachusetts, New Jersey, Oregon, Washington, and Wisconsin. Practically all cranberries are grown commercially, as compared to many fruits and vegetables that are also produced in dooryard plantings. In 1970, 21,445 acres produced 2,038,600 barrels of cranberries, for which the growers received $23.6 million. Massachusetts led with 10,900 acres. Other producing States were Wisconsin with 5,700 acres; New Jersey, 3,100 acres; Washington, 1,000 acres; and Oregon, 745 acres.

Plant

The cranberry plant is a low, creeping, semievergreen perennial that roots freely along the runners to form a mat. The runner sends up many slender, fruiting branches 6 to 18 inches high. Its leaves are oblong and ⅓ to ½ inch long. Flowers on the 1-year-old shoots (uprights or fruiting spurs) eventually produce a red globular fruit, a true berry, ¼ to ½ inch in size. There may be five or six blossoms per shoot, but one to three full-sized berries per shoot (fig. 99) may result in an excellent harvest (Sibert *1967*), depending upon the density of the uprights. The crop is confined to cool, moist, natural, or artificial bogs that can be flooded or drained as desired. A bog may remain productive for many successive years. Some bogs in New Jersey and on Cape Cod have been productive for more than 75 years (fig. 100).

Inflorescence

The cranberry flower in silhouette resembles the neck and head of a crane, hence the name "craneberry," which became contracted to "cranberry" (Marucci *1967a*). The tiny blossom, ¼ to ⅓ inch in size, begins to open in the morning and is fully open in 2 hours. As it expands in opening, the petals spring spart suddenly and visibly, and within a few minutes they curl back on themselves, leaving the sexual parts of the flower, the stamens and style, exposed. The petals of newly opened flowers are white or only slightly pink. If the flower is not pollinated, these petals may hang on the vine for 2 or 3 weeks, during which time they change to a rosy pink.

The five to eight individual brownish stamens fit so closely together they form a tube (Cross *1953*, Darrow et al. *1924*, and Franklin *1940*). As the anthers in the stamen mature, they release the dry pollen which falls out the tip of this tube. The pollen is relatively heavy and is not wind blown, nor is it likely to come in contact with its own stigma. The grain is a tetrad, or a four-part grain, apparently capable of germinating into four functional pollen tubes (Roberts and Struckmeyer *1942*). For this reason, not a lot of pollen is needed to fertilize the two to three dozen ovules in the four-carpel ovary.

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FIGURE 99.—Cranberry plant with mature fruit.

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FIGURE 100.—Harvesting cranberries from a large bog.

Marucci and Filmer (*1964*) and Marucci (*1966*) also found that flowers receiving pollen from other cultivars produced more berries per stem, and larger berries with more seed than selfed flowers. This indicated that mixed lines in the bog might be more productive than a single line. Where insect pollinators were excluded, Filmer et al. (*1958*) found that the berries that set had only 2.7 seeds, were small, and not uniform.

Just inside the base of the stamens is a ring of nectaries (fig. 101), surrounding the base of the style. At opening, the style is slightly shorter than the stamens. When the pollen is shed, the stigma is dry. The next day, the style lengthens so the stigma extends about 1/16 inch beyond the no-longer functioning stamens, and it becomes moist and sticky. It is not receptive to pollen until 24 to 36 hours after pollen shedding begins (Rigby and Dana, *1972*).

When the bee thrusts its head and proboscis or "tongue" into the staminal tube to reach the nectar, the pollen rains down upon the bee. Then when another more advanced flower with a receptive stigma is visited, the pollen is accidentally transferred, and fertilization is accomplished. As previously stated, if the flower is not fertilized, it may hang on for 2 or 3 weeks, and the petals will take on a rosy hue. A key to identification of inadequate pollination is the presence of this pinkish cast in the field. Prompt pollination causes the petals to shed and fruit development to proceed before this can occur. The fruit ripens in a couple of months.

The production of pollen and nectar of cranberries, vital in the pollination and fruit-set of the crop, seems to vary with conditions and location. Caswell (*1962*) stated that the blossom secreted little nectar, in some locations practically none, but produced generous quantities of pollen. This seems to be the general rule. Bergman (*1954*) found that cold injury further reduced or even stopped nectar secretion. Marucci (*1967a*) stated that cranberry blossoms are apparently poor producers of nectar and pollen, and honey bees do not eagerly work them. Stricker (*1953*) stated that bees work cranberries in New Jersey only for pollen. However, Gates (*1911*) reported that nectar from cranberries produces a superior grade of honey. Caswell (*1962*) and Oertel (*1967*) list cranberries as a nectar and pollen source. Beekeepers occasionally obtain a reddish honey they associate with bee activity on cranberries. There seems little doubt that the plant is more attractive to honey bees for its pollen than its nectar, but if bees visited it solely for its pollen, which is available before the stigma is receptive, little pollination would occur. Shimanuki et al. (*1967*) showed that some colonies consistently collect more pollen from cranberries than other seemingly similar colonies. This may lead to the development of specially selected bees for cranberry pollination.

Cranberry breeders might benefit the industry by selecting plant strains that produce more nectar or that have more attractive nectar for pollinating insects.

Pollination Requirements

Earlier publications (Eastwood *1866*) made no mention of pollination of cranberries. However, Gates (*1911*) recommended that growers keep bees for this purpose, and Franklin (*1911*) concluded that bees were beneficial and he recommended the placing of colonies of honey bees near cranberry bogs at blossoming time. Later, he (*1912*) reported that the area from which the bees were excluded bore at least a half crop of berries, this exclusion of bees had no effect on production from the plots the following year (*1914*). Darrow (*1924*) reported that many growers in Massachusetts kept apiaries, and even though Wisconsin growers did not consider bees essential they did consider them of value in hastening pollination which resulted in more even maturity. Roberts and Struckmeyer (*1942*) believed that pollination was affected by wind, but this has been discounted by the various tests, which showed that plants caged to exclude bees were unproductive (Filmer and Doehlert *1955*). Hutson (*1924, 1925, 1926, 1927*) devoted considerable time to cranberry pollination studies and concluded that in most instances there were sufficient wild bees in New Jersey cranberry fields, but as insurance against those years when there were insufficient wild bees, the grower should rent colonies of honey bees.

Farrar and Bain (*1946, 1947*) and Bain (*1946*) did the best work on cranberry pollination from the standpoint of showing the value of honey bees. They showed that one cage with bees produced berries at the rate of 171 barrels (bbl) per acre, whereas another cage in the same field without bees produced none. In another less productive field, the cage with bees produced 64 bbl/acre, whereas the beeless cage produced 3 bbl/acre. They recommended that the grower use one strong colony for each 2 acres of this crop.

Filmer (*1949*) studied the effect of four-tenths of a colony per acre on two bogs and learned that bee distribution was not uniform over the bogs. In bogs 400 feet wide, pollination decreased toward the center. He recommended that colonies be placed around, or on roadways in the middle of any bog 400 feet or more across. Later, Filmer and Doehlert (*1952*) showed that only 15 berries per square foot set where bees were excluded, but 90 to 152 berries set where bees were plentiful. Even at the then current rental price of $5 to $7 (with one colony per 5 acres recommended), the bees were quite profitable. One berry per square foot produces about 1 bbl/acre. Filmer and Doehlert (*1959*) recommended one colony for each 2 or 3 acres "if the population of wild pollinators is near normal." Filmer (*1953*) showed that increasing the number of colonies from one-half to one per acre increased cranberry production 12 to 34 bbl/acre.

Swenson (*1958*) concluded that "no bees" meant "no cranberries" and reported that by adding one colony per acre the yield was increased 50 percent, and when the population was doubled the yield increased another 60 percent.

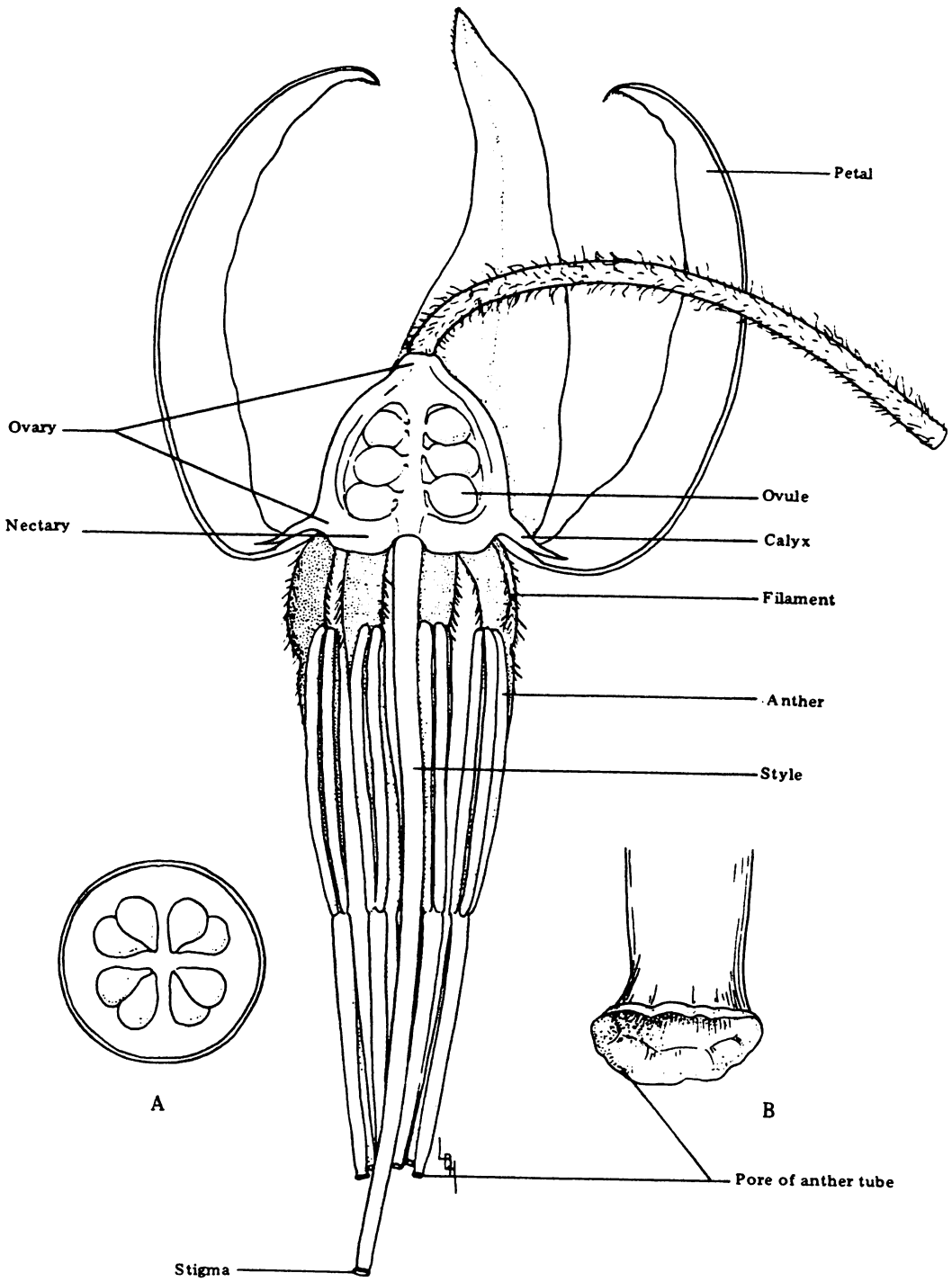
Sibert (*1967*) stated that bog owners were renting about one colony per acre. Although the national average production is about 60 bbl/acre, he stated that a well-managed bog should produce 150 bbl/acre. When such high production occurred, he stated that the ground at harvest time is solid red with berries.

The data establish that bees are essential to cranberry

production; in most areas there are not enough bumble bees so honey bees at the rate of one colony per acre or more should be used to supplement the native bees. Pollination must be accomplished during a 3- to 4-week period, and rain, wind, or cold almost always interferes with insect activity during this period.

Pollinators

There is little doubt that bumble bees are excellent pollinators of cranberries; 3 per rod^2 are considered sufficient. Johansen and Hutt (*1963*) recommended the placement of bumble bee hives or other nesting domiciles around cranberry bogs, for the queens to occupy. They also recommended the planting of flowering plants nearby for bumble bees to forage on, protected from pesticides, as a means of increasing the bumble bee population. Unfortunately, bumble bee populations continue to decrease in most areas, but their activity can be supplemented with honey bees. Various other wild



bees have been reported from time to time on cranberries in different locations, but none of them can be depended on as a stable source of pollinators. Because cranberries are not highly attractive to honey bees, the bee population should overflood or saturate the competing plants so the bees will visit the cranberry flowers.

Marucci (*1967b*) stated that flowers that do not set but remain on the plant are called "blasts," and he noted that high bee concentrations reduced the number of blasts present.

Pollination Recommendations and Practices

The pollination recommendations for cranberries lean constantly toward the use of more colonies of honey bees per acre. Earlier recommendations called for one colony per 5 acres (Doehlert *1940*), one colony per 2 to 3 acres (Filmer and Doehlert *1959*), one colony per 2 acres (Cross *1953*, *1966*), one colony per 1 or 2 acres (Filmer *1953*), and one colony per acre (Swenson *1958*). Farrar and Bain (*1946*) stated that one strong colony per 2 acres was satisfactory, if weather conditions are favorable, but under unfavorable conditions 5 to 10 colonies per acre might be needed. Stewart (*1970*) and Stewart and Marucci (*1970*) recommended one colony per acre. In general, one strong colony per acre is currently used. Usually, by the time cranberries bloom, the honey bee colonies have become populous so that strong colonies are common.

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