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PUMPKIN AND SQUASH

Cucurbita spp., family Cucurbitaceae

There is no satisfactory association between the common and scientific names of pumpkin, squash, summer squash, winter squash, vegetable marrow (primarily a British term), cushaw (Louisiana French for "big pumpkin"), and ornamental gourds. Four species of *Cucurbita* of economic importance are involved: *C. maxima* Duch., *C. mixta* Pang., *C. moschata* Duch. ex Poir., and *C. pepo* L. Botanical identification of the specimens is according to the type of stem (trunk) or peduncle (flower stalk). To the general public, however, a plant, or its fruit, may be known as a squash or pumpkin to one individual and as a cushaw or gourd to another. Botanical classification is further complicated by the fact that all cultivars of the species will readily intercross (Tapley et al. *1937*, Whitaker and Bohn *1950*, Whitaker and Davis *1962**). The proposal by Whitaker and Davis to separate the species according to culinary usage has not been accepted.

From the pollination standpoint, the four species and their types and cultivars are subsequently treated herein as a unit, and are collectively referred to as "pumpkin and squash."

In addition to the use of pumpkin and squash as human food, they are also used as livestock food, some cultivars much more than others. Also, the seeds are eaten whole as a confection or crushed to extract the oil, which is about equal to peanut oil production on a per-acre basis. This oil is used as a high-quality liquid vegetable fat and as a sandwich spread (Curtis *1948*). The fruit of plants more frequently known as gourds is used for containers, musical instruments, and ornamentation (Whitaker *1964*).

Although the USDA, Agricultural Statistics, 1971, does not show the acreage devoted to these four species of cucurbits it gives the acres devoted to seed production and the volume of seed produced in 1969 as follows:

Crop	*Acres*	*Lbs. seed X1,000*
Pumpkin	226	109
Squash:		
Summer	1,039	551
Winter	500	210

This amount of seed should be sufficient to plant several hundred thousand acres (Jones and Emsweller *1931*, Thompson et al. *1955*, Whitaker and Davis *1962**).

Pumpkin and squash are grown throughout the country, with Illinois, New Jersey, California, Florida, and Texas having the greatest acreage, although State positions vary from year to year because of season and market conditions (USDA *1964*). Individual plantings usually range from home-garden size to about 40 acres.

Plant

All of the *Cucurbita* spp. are annuals. Most of them are prostrate with trailing branches, reaching a length of 40 to 50 feet, but some have short, semierect stems (Castetter and Erwin *1927*). The leaves are large, sometimes exceeding 12 inches across, and are borne on petioles up to 24 inches in length. The plants are susceptible to frost but do well in relatively cool climates. If the fruit is consumed in the immature stage, it must be harvested at frequent intervals. Otherwise, it is left to mature on the vine. The fruits vary greatly in size, from a few ounces to more than 100 pounds, and in shape from globular and oval to gooseneck, crookneck, and other grotesque shapes.

Inflorescence

The flowers are large (to 3 inches), solitary, showy, creamy white to deep orange-yellow, and are open for only 1 day. Plants are normally monoecious, but hermaphroditic flowers occur (Jones and Rosa *1928**). Battaglini (*1969*) recorded 10 staminate flowers for each pistillate one. Staminate flowers are at the end of a thin stem, and have three anthers producing relatively large pollen grains (fig. 162). The morphology of the staminate flowers was described by Chakravarty (*1958*). Pistillate flowers are on a short peduncle, the style is thick, and the stigma two-lobed. The showy corolla of the pistillate flower is attached to the end of the easily recognizable ovary (Whitaker and Jagger *1937*). Tapley (*1923*) recorded 24 to 34 pistillate blooms per squash plant with 5.5 to 43.7 percent set. Both pollen and nectar are produced in the staminate flowers and nectar in pistillate flowers. Verdieva and Ismailova (*1960*) stated that most bees visit the squash flowers for nectar only. Nectar is secreted from a ring of tissue surrounding the style and just inside the perianth tube. The ovary is divided into three to five carpels. Eisa and Munger

Agriculture Handbook No 496, 1976
Ag Research Service, USDA.

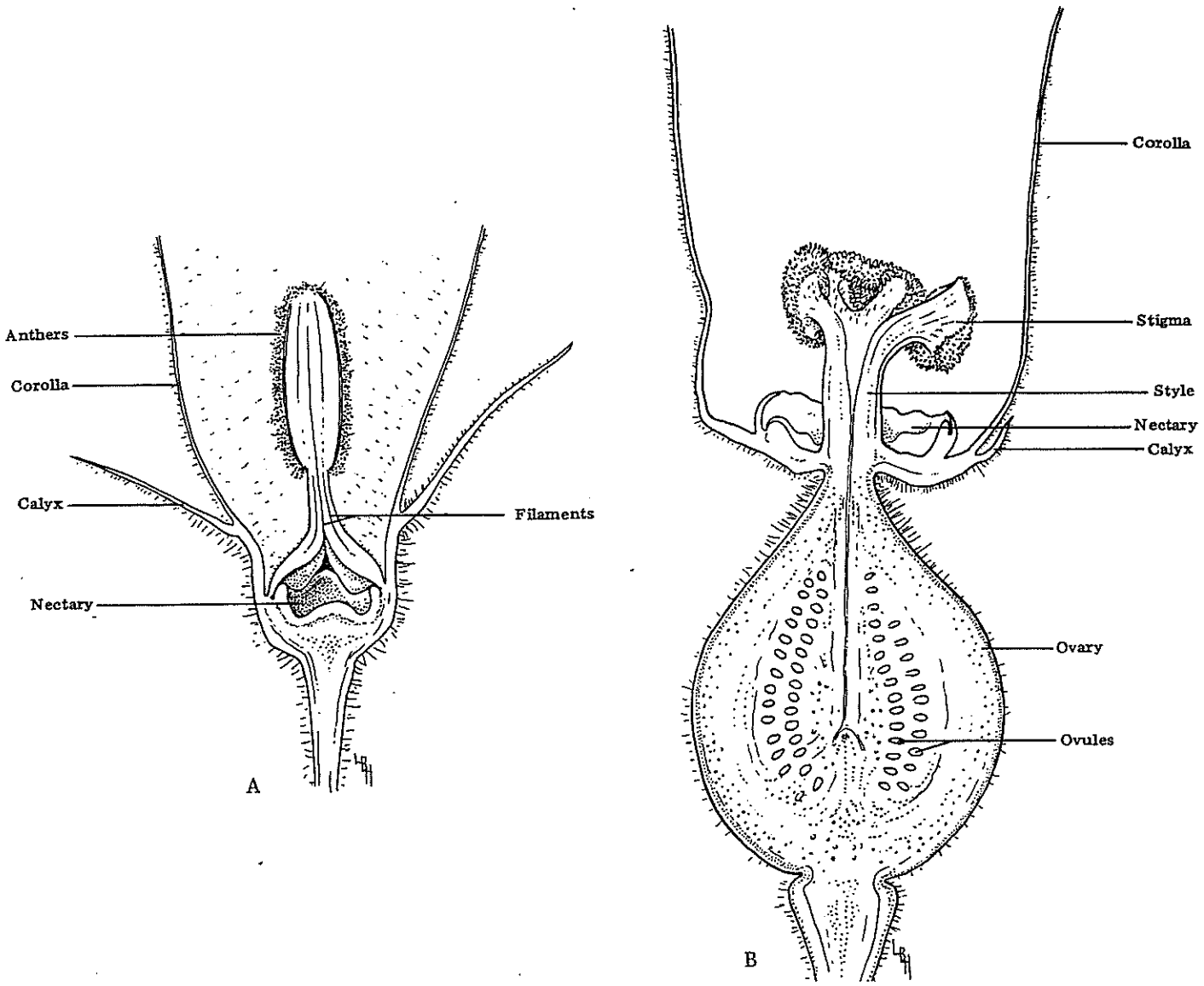

FIGURE 162.—Longitudinal section of reproductive portions of acorn squash flowers, x 2. *A*, Staminate, or male flower; *B*, pistillate, or female flower.

(*1968*) reported that male and female sterility have been observed in *C. pepo*, and Scott and Riner (*1946*) reported male sterility in *C. maxima*.

The squash blossom is the emblem of fertility to the Hopi Indians of the Southwest, whose more expensive pieces of jewelry include the squash blossom necklaces.

Pollination Requirements

Because the anthers are in one flower and the stigma is in another, the mechanical transfer of pollen is essential to fruit set. Hayase (*1953*) stated that the seed number and fruit weight was increased in proportion to the amount of pollen deposited on the stigma. The period of receptiveness has not been thoroughly worked out. Sanduleac (*1959*) observed that honey bees worked the flowers most intensively from 6 a.m. to noon with maximum activity from 8 to 9 a.m. Amaral and Mitidier (*1966*) stated that the flowers of *C. pepo* open before sunrise and close by 11 a.m. Atwal (*1970*) recorded that pollinating insects visited the flowers from 7 to 10:30 a.m., "when the flowers began to close." Hurd (*1966*) noted that, depending upon the weather and season, the flowers of the host (cucurbits) open some time before daylight or shortly thereafter, and in hot weather they wither and close by 8 to 9 a.m., otherwise they may stay open until noon. Hawthorn and Pollard (*1954**) also stated that the flowers open about 5 a.m. and close about noon. Pollination, therefore, is most effective in the early morning—primarily before 9 a.m.

Bailey (*1890*) indicated that "squash" and "gourd" were self-sterile, but Bushnell (*1920*) stated that the 'Hubbard' squash was not self-sterile, and if there was sterility apparently it no longer existed. Bailey (*1937*) further stated that in "gourds" it is doubtful whether there is ever impregnation between two flowers on the same plant because experimental efforts to do so are unsuccessful. He felt, therefore, that seeds of the "gourds" are always produced from crosses between two plants.

Pollinators

Practically all authorities give primary credit to the

honey bee in pollinating *Cucurbita* (Pammel and Beach *1894*, Jones and Rosa *1928**, Jones and Emsweller *1931*, Thompson et al. *1955*, Whitaker and Davis *1962**, Battaglini *1969*, Langridge *1952*, Nevkryta *1953*, Robinson *1952*, Sanduleac *1959*, Verdieva and Ismailova *1960*, Wolfenbarger *1962*). Michelbacher et al. (*1964*) and Hurd (*1966*) credit both honey bees and wild bees. Some species of wild bees are most efficient pollinators of *Cucurbita*, but they are frequently so limited in number or in range as to be of no great economic significance. Durham (*1928*) gave some credit to the cucumber beetle; Tontz (*1944*) to ants; and Fronk and Slater (*1956*) to the wild bees, *Peponapsis* spp. and *Zenoglossa* spp., with a minor role played by *Diabrotica* spp. beetles. Hurd (*1966*) stated that "other insects are involved such as cucumber, scarab and meloid beetles, and flies and moths but to a lesser extent than are bees."

Michelbacher et al. (*1964*) concluded that even though honey bees are poorly adapted as pollinators of squash, pumpkin, and gourd, because of the small size of the insect and the relatively large pollen grains, still the importance of honey bees as pollinators of these crops should not be minimized. Langridge (*1954*) stated that if pollination was inadequate, the introduction of honey bees was the only solution.

For commercial production of Cucurbits, there seems little doubt that the honey bee is the only effective pollinator that can be provided in sufficient numbers for adequate pollination. Wadlow (*1970*) reported that with only about 1,000 colonies, at $10 per colony, he provided pollination for squash and other crops valued at over $1 million.

The value of bees as pollinators has been shown in terms of fruit produced. Wolfenbarger (*1962*) showed the following correlation between colonies per acre and increased production in baskets of squash per acre: No colonies provided, 148 baskets; one-half colony per acre, 155 baskets; one colony per acre, 161 baskets; two colonies per acre, 168 baskets; and three colonies per acre, 173 baskets. In open plots, he obtained 4.20 squash per yd^2; whereas in plots caged to exclude bees, he produced only 0.82 per yd^2. Verdieva and Ismailova (*1960*) reported 47 to 57 kg squash from plants pollinated by honey bees compared with 25 to 30 kg from plots pollinated by other (unspecified) methods. Nevkryta (*1953*) increased cucurbit production 3.0 to 3.4 times with increased bee activity, attributed to stimulative feeding of the bees. Battaglini (*1969*) recorded a set of 61.2 percent of pistillate flowers exposed to bees in comparison with a set of 6.8 percent of caged flowers. The agent responsible for the set of the caged flowers was not given.

Not only are bees largely responsible for the fruit set on standard cultivars, but their value is enhanced on plants in which hybrid vigor has been demonstrated. Curtis (*1939*) obtained 59 fruits from a hybrid compared to 25 and 27 from the two parents.

Hutchins and Croston (*1941*) also obtained significantly greater yields from 7 out of 10 crosses, and production of all crosses was significantly earlier than in the parental lines. With male sterility now available in *Cucurbita* (Eisa and Munger *1968*), techniques involving the crossing of inbred lines by honey bees provide plant breeders with the opportunity to develop improved hybrid cultivars.

Pollination Recommendations and Practices

Unfortunately, concrete data are scarce on the pollination of crops of the genus *Cucurbita*. As a result, most publications merely generalize with such statements as " . . . largely insect pollinated" (Thompson et al. *1955*), "Transfer of pollen is usually accomplished by insects, chiefly honey bees" (Jones and Rosa *1928**, Purseglove *1968**), "Honey bees are the usual agents . . . " Hawthorn and Pollard (*1954**), or "insect pollinated" (Whitaker and Davis *1962**). The "one colony of honey bees per acre" recommended for cantaloups (McGregor and Todd *1952**) might be expected to apply to *Cucurbita* also, but proof should be established.

Sanduleac (*1959*) reported one to two colonies per 25 acres in the area of his test. Eckert (*1959**) suggested that one strong colony per 2 acres of squash may be enough under irrigated conditions in California. Jaycox (*1969*) listed pumpkins and squash along with many other crops and generalized without supporting data that most crops require one strong colony per acre. Wolfenbarger (*1962*) showed continued increase in squash production in Florida up to three colonies per acre without hitting a peak in production.

Available evidence shows that the plants must be insect pollinated, and that honey bees are the chief pollinators. Detailed studies, correlating bee visits to flowers with yield, quality, and related factors have not been carried out. Where yields are low, an additional one to three colonies per acre should be provided for at least 3 years to determine their value. The literature indicates that colonies nearby are most effective.

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