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Results of Crossing Cucurbits.

BY L. H. PAMMEL.

The writer has on several occasions expressed his views on the subject, crossing of cucurbits. The views expressed have met with some opposition among professional gardeners, horticulturists and many farmers who cling tenaciously to the old notion, that pumpkins and melons will "mix." So far as I know the results of our work at the station are in harmony with those made by other investigators in both Europe and America.

In a former bulletin of this station the results of our work for 1892 were given. In this bulletin will also be found references to some of the literature on the subject.1

From experiments made in 1892 we concluded that it was impossible to obtain hybrids between pumpkins and squashes—(Cucurbita pepo and Cucurbita maxima) Nor would water melons "mix" with pumpkins or cucumbers with musk melons and sugar melons. These conclusions were warranted not only from

1On the Crossing of Cucurbits, bulletin No. 19, Iowa Agricultural Experiment Station, pp. 595-600, November, 1892.

The writer has also contributed the following articles on this subject:


The Crossing of Cucurbits, proceedings of the sixth annual convention of the Association of Agricultural Colleges and Experiment stations, New Orleans meeting, November 15-19, 1893, pp. 94-97.


Crossing of Cucurbits, read by title before the section of botany, A. A. A. S., Madison meeting, August, 1898. Bulletin of the Torrey Botanical Club, volume xx, September, 1893, pp. 358-359.

Experiments in Crossing Cucurbits, American Gardening, volume xiv, pp. 459-460, with figures.

Do Pumpkins and Melons Mix? Farm and Dairy, September 15, 1893.
Rural Life, March 30, 1893.
Weekly Iowa State Register, Aug. 25, 1893.
our own experiments but those recorded by Bailey and Munson. Those made by Naudin confirmed these in every respect.

**Distinction of Species:**—It may not be out of place in this connection to briefly describe the different cultivated genera and species commonly grown in Iowa as there is much confusion concerning them, especially of the species *Cucurbita maxima* (Hubbard, Turban, etc.) and *Cucurbita pepo* (Common pumpkin, Crookneck, etc.) This confusion results partly from the fact that the term squash is frequently applied to forms of *Cucurbita pepo*, while the term pumpkin is frequently applied to *Cucurbita maxima*.

**Cucurbita maxima**, Duch. This species is represented by the Hubbard, Mammoth, Chili, Marblehead, Turban, American Turban, Ohio Squash, etc.; leaves large, kidney shaped, rounded, never deeply divided; leaves and stems covered with stiff hairs which never become spiny; flowers large and often quite fragrant; plant strictly monoecious; peduncle or stalk of the fruit round, without ribs; seed always smooth, somewhat variable in size and color. Mr. Stewart found in a gramme 3.85 to 4.8\(\frac{1}{3}\) seeds, or a pound contains from 1,755.85 to 2,797 seeds. Vilmorin\(^2\) finds that a gramme contains three seeds, a pound would have 1,360.

**Cucurbita pepo**, L. Represented by Common Pumpkin, Sweet Sugar, Vegetable Marrow, Long Warted, Summer Crookneck, Bush Scalloped, Brazilian Sugar, Perfect Gem, etc., leaves with well defined lobes, frequently deeply cut in Vegetable Marrow; hairs on stems and leaves numerous, in some forms quite spiny, in all cases pubescence more harsh than in *C. maxima*; peduncle or fruit stalk with five prominent ribs and frequently five secondary ribs. Becoming hard and never swollen as in *C. maxima*. The flowers have a decided odor but not as pleasant as in *C. maxima*. The rind of the fruit is sometimes hard, at other times thin and easy to cut. The seed varies greatly in size, in the Nest Egg Gourd it is small while that of Common Pumpkin is large. Mr. Stewart found 6.15 to 14.13 seeds in a gramme; a pound contains 2,790.9 to 7,333.07 seeds. Vilmorin\(^3\) states: that the seeds of the genuine *Cucurbita pepo*

\(^2\) Vegetable garden—English translation, 1885, pp. 252

\(^3\) I. c. p. 261.
weigh on average 425 grammes to a liter, a gramme containing from 6 to 8 seeds, or 2,721 to 3,628 seeds to a pound.

*Citrullus vulgaris.* Schrad. To this species belong our watermelons, well known varieties are Colorado Preserving, Mountain Sweet, Ice Cream, Black Spanish, Perfection Gem, under this we would also place the citron which is chiefly used for preserving. The citron is sometimes made a variety of *Citrullus vulgaris,* but it is scarcely distinct. The Perfection Gem offers more characters for separation as a variety than does the Citron, and botanists would scarcely make this form a variety.

The species is characterized by its climbing habit, leaves deeply cut, from three to four lobes which are again divided into segments more numerous in the Perfection Gem than in Mountain Sweet and that class. Divisions and segments rounded in outline. Branches and leaves covered with long and soft hairs. Flowers are monœcious or polygamo monœcious.4

Fruit varies from dark green, variegated, marbled or pale greenish white. The flat or oval, short seeds vary greatly in color. They are white, black, yellow or brown. Vilmorin5 states that one gramme contains 5 to 6 seeds and a liter weighs 460 grammes.

*Cucumis melo* L. Represented by Montreal Improved, Bay View, Cantaloupe, Banana Musk Melon, etc.—It is characterized by its climbing habit. Leaves vary greatly in size, usually kidney shaped, and slightly folded or somewhat wavy around the margin, sometimes cut into several lobes, sometimes entire, in others the leaves, branches and petioles are covered with short, thick hairs, somewhat harsh to the touch. In systematic works the species is usually described as monœcious but in many varieties in Iowa and elsewhere in the United States it is polygamo monœcious. The staminate flowers are clustered in the axils of the leaves while the fertile occur singly. The smooth seeds are yellowish or oblong slightly concave and the funiculus or seed stalk remains in the pulp. Mr. Stewart found that one gramme contains 36.4 seeds, a pound contains 16,513.6 seeds, Vilmorin6 finds on average 35 seeds to a gramme.

4 Pistillate flowers in Perfection Gem bear stamens.
5 I c, p 343.
6 I c, p 323.
Cucumis sativus L. Represented in our gardens by the Early Russian, White Spine and Improved Long Green. It is a creeping plant, having flexible angular stems, harsh to the touch, leaves angular, heart shaped and more or less acutely lobed, the middle lobe being more prominent. The leaves and petioles have numerous small spines, the young fruit also bears spines. The elongated oval flattened seeds are yellowish white in color. Mr. Stewart found in a gramme 45 seeds, one pound contains 20,411.67 seeds. Vilmorin 7 found 35 seeds to a gramme; a liter of seeds weighs 500 grammes.

IMMEDIATE EFFECTS.

So far as I know most observers agree that in cucurbits there is no immediate effect. Prof. Bailey 8 says: “There is no immediate influence whatever, except such as is due to imperfect development caused by inefficient or impotent pollen.”

Prof. Munson says: concerning the ease with which this should occur, and show itself in mixed plantations “I have repeatedly looked for this difference, but have never seen it; nor have I observed it when several flowers on the same plant were artificially crossed with pollen from different varieties or species” Crozier 9 says: An examination was made of twelves varieties of squashes and melons growing near together upon the station grounds “but no case of mixture with a neighboring variety was found.”

Crozier mentions having obtained fruit by applying pollen from Hubbard on Perfect Gem. If the Perfect Gem is the same as commonly sold for that variety I doubt very much that the fruit found by him was a result of the application of Hubbard pollen. In 1892 we had two cases where Hubbard pollen was used on Nest Egg Gourd which produced fully matured fruit. We doubted very much at the time of its being a hybrid. Planting the seed this year plainly shows that we were correct in our views. It is often difficult to keep the striped cucumber beetle out, unless special precautions are taken.

7 1 c, pp 212.
8 Bull. No. 25 Cornell University Agrl. Experiment Station, p. 181 Dec, 1890.
9 Bulletin No. 3 Vol. I, Iowa Agricultural Experiment Station, p 92.
I am inclined to think that much of the so called immediate effect in cucurbits is due to a previous cross. I have still to find a case, although I have examined hundreds of cucurbits, and our own experiments show conclusively that this does not occur.

It is well known however that immediate effects of crossing does occur in many plants, The St. Valery apple which has aborted stamens, and is artificially pollinated produces fruit which differs from one another in size, flavor and color but resembles in character the hermaphrodite kinds by which they have been fertilized, Darwin mentions other cases, and I may add that instances of this kind are said to be not uncommon. Some of these should be studied more thoroughly. Prof. Bailey cites a case of a cross between the Louise Bonne and Howell pears which showed its effect the first year, the fruit was more slender than Louise Bonne with a long thick lower portion. it also ripened later than either of the varieties, M. B. Waite and D. G. Fairchild have also shown that there is an immediate effect in some varieties of pears when cross-fertilized with other varieties. The self-fertilized fruit is quite different than the cross-fertilized. But further testimony on these points must be looked for in the literature cited.

We now introduce a record of some of the fruit produced in 1892 and the result of the crop of 1893.

**Common Pumpkin on Perfect Gem;** 1892.—Circumference 16.5, length (outside) 8.5 inches, apex with a slight projection peduncle 3.5 inches long, color of fruit, yellowish white. It approached the type, and was like other fruits on the vine. 1893.—The fruit this year was yellowish white in color, much larger, barrel shaped, in fact an elongated pumpkin. Its texture was that of the common pumpkin. In leaf and vine it resembled Perfect Gem.

**Common Pumpkin on Long Warted,** 1892:—The plants in this hill were not true to type being smooth without warts, greatest circumference, 11 inches; length 11 inches. Fruit smooth, with slight indications of furrows, fruitstalk prominently ribbed 1.6 inches long, leaves lobed and spiny. Color of fruit mottled with orange and lemon yellow. 1893:—Specimens

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FOR EXPLANATION SEE PAGE 917.
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varied in size, of those measured, one was 11.75 inches in length and 6.125 inches in circumference, peduncle with five prominent ribs, fruit orange yellow, like Common Pumpkin, seeds like Common Pumpkin but somewhat smaller. The different specimens varied in quality. The rind had the texture of Common Pumpkin and in some cases the meat was firm, fairly good in quality, and close grained.

*Common Pumpkin on Nest Egg Gourd*, 1892:—Length 4 inches, in shape like an egg, largest transverse circumference 6.5 inches, cream colored fruit, peduncle prominently ribbed. 1893, — The fruit increased in size, length 7.75 inches, diameter 4.25 inches, peduncle with five prominent ribs and five secondary ribs, color dark green with lighter green and yellow spots, rind very tough, meat white and coarse grained. A second specimen from the same seed produced a smooth creamy colored fruit with meat of coarse texture,

The peduncles were dark green in color, leaf and vine resembling the mother plant more than the Common Pumpkin. Seeds like pumpkin but somewhat smaller.

*Figure 1.* Italian striped on Sweet Sugar season 1892, (Am. Gardening August 1893.)

*Italian Striped on Sweet Sugar*, 1892:—Transverse circumference 30.50 inches, longitudinal circumference 26 inches, peduncle 2.5 inches long prominently ribbed, slightly furrowed
apex indented, color pumpkin yellow, no indication of Italian striped. 1893,—Smooth fruit much longer than broad, color orange yellow, mottled with dark green confluent spots, these occurring in rows, 5 ribbed peduncles with intermediate ones well developed, small, rind tough, meat firm and solid, pale in color, leaves as in Italian Striped, more lobed than in Sweet Sugar, vines dwarfed, showing but little tendency to produce long vines as Sweet Sugar does.

![Figure II. Two groups of Nest Egg Gourds. Season of 1892, showing the great variation. From photographs (American Gardening August, 1893.)(image)](image)

**Vegetable Marrow on Long Warted, 1892:**—Length 12 inches greatest circumference 10 inches, least circumference one inch from peduncle 4.5 inches. Fruit straight, apex narrowed to a point, surface roughened with numerous “warts.” No indication of Vegetable Marrow. 1893,—Length 13 inches, 3 inches in diameter at the narrow peduncular end, “warts” numerous, color light lemon yellow between Vegetable Marrow and Long Warted, long creeping vines with the smaller and
more deeply lobed leaves of Vegetable Marrow. Seeds rather small. Meat not coarse grained and pale in color.

In the cases so far enumerated the parentage is known. We can now consider a few of which the female parentage only is known.

**Vegetable Marrow.**—Some seed from each specimen of this variety grown in 1892 was saved and planted in the spring of 1893. The crop in 1893 was a very heterogeneous mass. Some were true to type, and evidently were cross or close fertilized. Most of the specimens were smooth, all more or less elongated, some were warty but nearly straight, in color they all approached the mother plant more nearly than the variety from which the pollen came. Some specimens plainly showed the character of the Common Pumpkin with vine and leaf like the mother plant, the specimens with warts were not so dark in color as the Long Warted, nor did they have the color of Vegetable Marrow, being lighter, as to texture they were of inferior quality. Mrs. Pammel who tested some for me pronounced the specimens with “warts” as somewhat “stringy” “watery” and that they did not cook well.

**Perfect Gem.**—In 1892 we observed that this variety in some cases was not true to type. A few seeds of the different kinds were selected and planted this spring. In this lot we found many different forms, few were of the type, some plants showed Common Pumpkin, a few were warty, some were considerably elongated and barrel shaped. The vines in all cases approached Perfect Gem.

**Nest Egg Gourd and New Golden Bush.**—These were of many different forms. The Nest Egg Gourd varied greatly in shape, and showed some variation in color. The vine closely resembled Nest Egg Gourd.

**Squashes (Cucurbita maxima).**—Mixed seed of New Prolific Marrow and Mammoth Chili showed no indications of “mixing” the Marrows were evidently close or cross-fertilized as they were true to type. The Mammoth Chili varied in color but leaf stems and fruit showed that the plants were true squashes.

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12 By cross-fertilized I mean that the pollen came from some other plant of this variety.
Perfection Gem Watermelon (*Citrullus vulgaris*).—In 1892 we saved the seed from two watermelons that had fully matured. This seed was planted in 1893 in a heavy black loam. The melons were of two types, one large and of the color of Perfection Gem but with coarser leaves, the second was evidently cross-fertilized or close-fertilized. The leaves of this plant were more finely divided, flowers of two kinds perfect and stamineate (polygamo monoecious). A rather small melon with greenish yellow rind, red flesh, and small seeds. In 1892 these melons were growing between Sweet Sugar Pumpkin, and if the popular notion concerning "mixing" is correct these certainly had an opportunity, but the melons of 1892 and those of 1893 showed no indications of "mixing" with pumpkin and their quality was excellent.

Montreal Improved Musk Melon.—Seeds were saved of different melons of this variety and planted in 1893. We had several types but in no case was "mixing" with other cucurbits observed. We may state that in 1892 as in 1893 they grew intermingled with cucumbers.

The same may be said of all the different varieties of cucumbers. None showed "mixing" with other forms of cucurbits. It is true that some of our varieties were not true to type. In one case we had what appeared to be atavism in the form of a white cucumber.

**IMPOTENCY OF POLLEN.**

Several interesting questions have come up, which we may now briefly discuss.

The subject of impotency was briefly discussed in Bulletin No. 19 of the Experiment Station. The statement was made that in many plants the pollen is self impotent, the pollen of Red Clover when taken from the same flower does not cause fertilization. We have also shown that musk melons like the Montreal Improved which have hermaphrodite flowers fail to set fruit when covered. This fact is also recorded by Profs. Bailey and Munson of some varieties. They show further that when pollen is taken from the same plants in squashes and gourds and applied to pistils of that plant the re-
suit is poor seed. From this it is made more than probable that cross-fertilization is the rule in this class of plants. That insects are of great service in carrying pollen cannot be questioned.

**PREPOTENCY.**

It has been shown by numerous observers that when two races are crossed or the product a hybrid between two distinct species the result is a blending of the characters of both. It has even been asserted by some investigators that this character is shown in the make up of the cell-tissues.\(^{13}\) Macfarlane\(^{14}\) in an interesting address before the American Association for the Advancement of Science in Washington has shown that some hybrids are exactly intermediate in histological character between parents, and that normally there is an equal blending of both parents. We have had under observation in interesting hybrid between DeSoto Plum (*Prunus americana*) and an Oregon Plum (*Prunus domestica*?) In habit of tree and foliage the hybrids assume the character of *Prunus americana* our Wild Plum. This variety is strongly prepotent in transmitting a tendency to take a disease (*Cladosporium carpophilum*) which does not occur on our cultivated European Plum\(^{15}\) (*Prunus domestica*). But this is by no means the invariable rule. Darwin\(^{16}\) says. "It would appear that in certain families some ancestor, and after him others in the same family have had great power in transmitting their likeness through the male line." Henry L DeVilmorin\(^{17}\) says:

"In framing the character of the progeny the action of each parent is often very unequal, according to the power of each in transmitting its characters. The one that is better endowed in


\(^{15}\) Cross Breeding of Plants and Heredity, Rural Life, Oct. 19, 1893, p 12.

\(^{16}\) Animals and Plants under Domestication Vol. II, p 40.

\(^{17}\) Pedigree or Grade Races in Horticulture, Gardners’ Chronicle Vol. XIV, 3d series p 301, p 332, See p 332.
that respect stamps its features more firmly on the cross-bred plant. Discussions have arisen on the influence of the male and of the female progenitor on a cross. I believe that the strongest organism of the two, the one rather which is best endowed with the power to transmit its characters will predominate in the progeny, whether it comes from the male or female parent."

In cucurbits we have found well marked cases of prepotency and other investigators have found this likewise true. Prof. Munson in speaking of cucurbits remarked to the writer that the Nest Egg Gourd is strongly prepotent. Naudin\textsuperscript{18} has shown that one variety l'Orangin has such prepotency in transmitting its character, that when crossed with other varieties a vast majority of the seedlings come true. The long warty in all of our experiments plainly showed its prepotent character where the pollen was used on Perfect Gem and Vegetable Marrow. On the other hand when the pollen of Common Pumpkin was used on long Warted, the prepotent character of the Common Pumpkin was plainly shown in the fruit. The general habit in all our crosses shows that the characters of the vine and leaf partakes more of the character of the female plant.

In the Nest Egg Gourd, the structure of the fruit, character of the vine and leaf partakes more of the Nest Egg Gourd, fruit very poor in quality, rind tough and scarcely fit for culinary purposes.

What can we conclude from these experiments?

1. That pumpkins (\textit{Cucubita pepo}) and squashes (\textit{Cucurbita maxima}) will not hybridize.

2. That Pumpkins and watermelons (\textit{Citrullus vulgaris}) will not "mix" nor will squashes and melons "mix."

3. Cucumbers (\textit{Cucumis sativus}), sugar and musk melons (\textit{Cucumis melo}) will not hybridize. Nor will they "mix" with Pumpkins.

4. The different forms of \textit{Cucurbita maxima} will readily cross with each other, Mammoth Chili, Hubbard, New Prolific Marrow, American Turban, etc.

\textsuperscript{18} See Darwin:—\textit{Animals and Plants under Domestication}, Vol. I, p 880
5. The forms of *Cucurbita pepo* as the Long Warted, Nest Egg Gourd, Vegetable Marrow, New Golden Bush, Bush Scalloped, Italian Striped, Perfect Gem, Common Pumpkin, and Sweet Sugar will readily cross with each other.

6. The hermaphrodite flowers of musk melon are self impotent, and this is true also of some squashes.

7. Certain varieties are prepotent as shown in character of fruit, vine and leaf. It is, however, often not well defined, both parents transmitting equally.

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**EXPLANATION OF PLATE.**

**Figure 1.** Leaves of New Prolific Marrow (*Cucurbita maxima*.)

**Figure 2.** From a mixed lot of seed of Vegetable Marrow (*Cucurbita pepo*). The figure to the left shows fruit prominently ribbed with numerous warts, evidently fertilized in 1892 with Long Warted. The figure to the right shows the type of Vegetable Marrow in leaf, character of peduncle, and fruit.

**Figure 3.** Mammoth Chili (*Cucurbita maxima*) from a mixed lot of seed. The characters of this species are shown in fruit, leaf, and peduncle.

**Figure 4.** Mixed lot of seed of Perfect Gem (*Cucurbita pepo*). Five different types are shown. The longest one in the background, warted, evidently fertilized in 1892 with Long Warted. The one to the extreme right evidently fertilized with Common Pumpkin. The color in all these is creamy yellow.

**Figure 5.** Common Pumpkin on Nest Egg Gourd (*Cucurbita pepo*). As shown in the character of leaf, peduncle, and fruit.

From photographs made by F. A. Sirrine.