INTERGENERIC AND INTERSPECIFIC CROSS-POLLINATION STUDIES OF CAPSICUM, LYCOPERSICUM, PHYSALIS AND SOLANUM

by

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INTRODUCTION

The Solanaceae, or the Nightshade family, is represented by about 85 genera and about 1,700 species. This is not exceptionally large, but it is one of the economically important groups, having such members as the potato, the tomato and tobacco. Most of the species are tropical and sub-tropical, but many occur in the temperate zone. The family includes herbs, vines, shrubs and trees.

Considerable breeding work has been done in the Solanaceae, especially with the varieties of certain genera. There have been numerous interspecific crosses attempted, with varying success. On the other hand, there have been very few intergeneric crosses attempted and no reported hybrids.

In order to learn more about interspecific and intergeneric crosses, the author felt it would be interesting and worthwhile to gather several species of four different genera in Solanaceae and observe the results of cross-pollination. No attempt was made to determine why they would or would not cross, nor to prove definitely their compatibility or incompatibility.

This paper is not meant to be conclusive, but rather a record of observations made in attempting to cross several members of Solanaceae. The main objectives of these experiments were (1) to make preliminary observations of the compatibility of the members involved, (2) to compare and describe any resulting hybrids, and (3) to observe and discuss parthenocarpy in these genera.

REVIEW OF LITERATURE

Compatibility

Interspecific and intraspecific crosses in the genera *Solanum*, *Lycopersicum* and *Capsicum* were mentioned in the literature, but nothing was found pertaining to intergeneric crosses. No intergeneric breeding work was reported on the genus *Physalis*.

Of the plants in this experiment belonging to the *Solanum* genus only *S. Melongena* has had any work published on it. Sarvaya (21) found that a cross between *S. Melongena* and *S. xanthocarpum* produced hybrids of an intermediate appearance. Others working with various members of *Solanum*, have made interspecific crosses but no one has reported an intergeneric cross involving this genus.

Westergaard (25), working with Jorgensen in Denmark, made a number of interspecific crosses using the *Morella* group of the genus *Solanum*. He divided the group by chromosome number into monobasic, dibasic and tribasic species. He found that some of the monobasic species did not cross. The dibasic species were more closely related to each other and could be crossed with the monobasic, except for two species. The tribasic plants were found to be likewise closely related. In all three cases there were many sterile plants produced.

Jorgensen* recently wrote of attempting to cross members of the Morella group with S. Melongena, S. Pseudo-capsicum and Lycopersicum esculentum. He was unable to obtain a cross.

Lamm (14), Propach (19), and others working on disease resistance, made many interspecific crosses in the subsection of Solanum, Tuberarium.

Considerable breeding work has been done with the genus, Lycopersicum. Lesley and Lesley (15), Porte, Doolittle and Wellman (17), Afify (1), and Powers (18) have made successful interspecific crosses. No one has reported work on intergeneric crosses in this genus.

Since there is so much disagreement as to what constitutes a species and what constitutes a botanical variety in Capsicum, it is difficult to say whether a given cross is interspecific or intraspecific.

Halstead (10) made an apparent interspecific cross using Capsicum frutescens and Capsicum annuum.

Lindstrom, as cited by Erwin (8), made several intraspecific crosses using the botanical varieties of Capsicum: cerasiforme, grossum and acuminatum. Viable seeds in the F_1, F_2 and backcross of all of these crosses were secured.

Nothing in the literature indicates that Capsicum

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* Personal correspondence March 26, 1949

has been crossed with any other genus.

From these studies we see that it is not uncommon for genera of Solanaceae to be interspecifically fertile, but little or nothing is intimated regarding the likelihood of successful intergeneric crosses. Since crosses between genera are rather rare, hybridization is doubtful, yet the possibility remains. Perhaps the genera of Solanaceae are more closely related genetically and morphologically than the genera of most families. For instance, intergeneric crosses occur quite frequently between the genera in the Orchidaceae and also in the Gramineae.

Judging from the previous work one could expect any resulting hybrids in this experiment to be somewhat intermediate in appearance or be very much like the mother parent.

Parthenocarpy

Generally parthenocarpy is defined as fruit developed without fertilization. Gustafson (9) has defined parthenocarpy as including all seedless fruit except those in which embryo abortion is known to follow fertilization.

In some species parthenocarpy occurs without pollination and is called "vegetative" or "autonomic." Where it is caused by pollen stimulation, it is called "stimulative" or "aitionomic."

Cochran (6) states, "The so-called stimulus from pollination does not seem to be essential for fruit-setting in the pepper. This is shown by the fact that flowers which were emasculated and bagged prior to anthesis, set fruit as well as did those that were pollinated." In the case of the tomato, Bouquet (5), Schneck (22) and Watts (24) reported fruit set to be a result of pollen stimulation. Robbins (20) observed parthenocarpy in *S. Melongena*.

MATERIALS AND METHODS

The plant material used in the hybridization experiment belongs to four genera and seven species. The plants were grown from seed in the college greenhouse and on the college farm at Corvallis, Oregon, in the spring and summer of 1948.

Seed resulting from the controlled pollinations was planted and grown to maturity in the college greenhouse and on the Tucson farm of the University of Arizona in the spring and summer of 1949.

Materials

A brief description of the plants used in the experiment follows:

Solanum Melongena Linn. var. *esculentum* Nees. The eggplant, a native of India, is an annual, erect, branching, finally becoming subwoody, plant. It is about one to three feet in height, has scurfy, spiny leaves, and large purple fruit. It is commonly self-pollinated, although according to Robbins (20) some crossing may occur.

S. Pseudocapsicum Linn. var. *nanum* Hort. The Jerusalem cherry is a small branching leafy shrub, sometimes reaching three to four feet but usually less than a foot when grown in a greenhouse. It has an erect growing habit and is completely glabrous. It is widely distributed in tropical and semi-tropical regions. Bailey (2) presumes it to be a native of the Old World, perhaps Madeira. It is an old-fashioned greenhouse plant grown for its small, showy, scarlet fruits.

S. integrifolium Poir. The Chinese Scarlet egg-plant or ornamental eggplant is a coarse, annual, bushy herb, two to three feet tall with hooked spines and scarlet to orange globular fruit. It is probably indigenous to Africa.

S. quitoensis Lam. The naranjilla is an erect, branching, herbaceous perennial. At maturity it reaches a height of six to twelve feet, becomes quite woody, and has small, hairy, orange fruit. It is native of the West Coast of South America. About ninety per cent of the commerical production is found between 2° N. and 5° S. latitude, 79° and 85° W. longitude at elevations between 3,000 and 7,000 feet. It is of importance only in a limited area because of the special ecological requirements of the plant.

Capsicum annuum Linn. var. *grossum* Bailey. The tomato pepper is characterized by having a distinctly oblate fruit of four locules which bear a close resemblance to the tomato. The fruit is usually flattened at both ends, the size being two to four inches in diameter and half as thick. The walls are furrowed and thick. The flowers are one-half to three-quarters of an inch across, and bell-shaped when open. The peduncles are large and long. The plants are from two to three feet tall with erect branches.

C. annuum Linn. var. *conoides* Bailey. The ornamental pepper is a small, dwarf type, plant with cone-shaped fruit, three-fourth to one and one-fourth inches long. The color of the fruit changes in maturation from yellowish-green to purplish to orange-red. The fruits are three loculed, erect and very abundant, appearing above the foliage. The peduncles are short, thin and straight. The flowers are quite small, white, and the filaments white with dark purple anthers. It is commercially used as a potted house plant.

Lycopersicum esculentum Mill. var. *vulgare* Bailey. The common tomato is a large spreading plant with dark green curled leaves and slender ascending shoots with either red or yellow fruits. The flowers are normally self-pollinated. Wind pollination seldom occurs, and the only insect observed visiting the flowers is the bumblebee.

Physalis isocarpum Brot. The tomatillo is an erect growing annual with smooth foliage, fast growing branches, medium sized flowers with bright yellow petals and five dark brown spots in the throat of the flower. The fruit is a sticky, purplish fruit almost completely covered with an enlarged purple veined calyx. The tomatillo is of very little economic importance as its only use is in making chili sauce and in meat dressings. It is found growing wild from Texas to California and Mexico.

Methods

Since this study was chiefly a problem of pollination and the plants used were both self- and cross-pollinated, the methods involved were those needed to insure controlled cross-pollination. Due to the many differences in the plants used, certain practices had to be followed and certain precautions taken. Because of these variations and the many difficulties that arose, the methods used are given in detail.

Gathering the Material

The plants were grown from seed planted about the first of March 1948 in the college greenhouse. The experiment was started with ten Potentate tomato, five tomatillo, eight New Hampshire Hybrid eggplant, eight Hlavacek's Masterpiece Jerusalem cherry (Ball strain), eight ornamental pepper, eight garden pepper, and eight naranjilla plants. Later, during the course of the pollinating, fifteen tomato plants, four tomatillo plants, six eggplants, one Jerusalem cherry plant, six garden pepper plants and four scarlet eggplants were added.

Some of each of the kinds of plants were planted on the college farm and the remainder were grown in the college greenhouse. All of the plants except the tomato, tomatillo and eggplant had to be returned to the greenhouse because of unfavorable growing conditions. The plants were brought into flowering about the first of May, 1948.

Pollination

The proposed goal was to make 100 cross-pollinations and 100 reciprocal cross-pollinations with each of the eight plant groups, totaling 5,600 pollinations. Due to inadequate flowering and other difficulties, only 3,129 were made. However, the proposed number was completed in several crosses (see Table I, IV, VII, X).

Through trial and error, the best time to emasculate and pollinate was determined for each set of plants. In the case of the tomatillo, a few hours before the flowers opened in the morning proved best. If the flowers were allowed to open, the almost immediately dehiscing anthers would pollinate the stigma. The same was true of the peppers and Jerusalem cherry. The latter two did not dehisce quite as rapidly as did tomatillo; however, they extruded pollen soon enough after the flower opened to make it necessary to pollinate just before the flower opened. The anthers of the eggplant, scarlet eggplant and naranjilla do not shed pollen until after the flower has been open for several hours, so the best time to pollinate seemed to be just after the flowers opened. The tomato anther opened soon after the flower opened; therefore, emasculation and pollination were accomplished just before or after opening.

Forceps were used to remove the anthers and a small dissecting knife was used to procure and apply the pollen.

Pollen varying in age from that collected at anthesis to three days old was applied to the stigmatic surfaces of the mother plant. It was applied during all hours of day from sunrise to sunset and during all kinds of weather.

Pollination began May 8, 1948, and was continued through November 14, 1948, thus covering a considerable variation in day length.

It seems reasonable to assume that most of the possible factors and combinations of factors influencing pollination were covered during the long period over which pollen was applied. Naranjilla is possibly an exception to this since it was out of its natural habitat.

Because the plants of this experiment are naturally self- and cross-pollinated, it became necessary to eliminate pollen contamination by other means than merely removing the undehisced anthers. The first attempt to prevent uncontrolled pollination was "bagging" in which the flowers were emasculated, pollinated, tagged and covered with a small cellophane bag. This procedure worked well on the eggplant where the flower was large and pistil strong, but was not successful on the rest of the plants. The emasculated flower afforded very little protection for the very tender pistil. Only the slightest movement was needed to snap the pistil at the junction of the style and ovary. Regular paper bags and tissue paper were also used, but to no avail. These attempts at "bagging" were all done inside the greenhouse. Wind movement made it almost impossible to cover the flowers outside except in the case of the eggplant.

A cheesecloth cabinet was constructed into which the potted plants were placed for twenty-four to forty-eight hours after being emasculated, pollinated and tagged. All of the unpollinated flowers were removed to eliminate as much foreign-pollination as possible. Five tests of ten to twenty emasculated flowers were used to check effectiveness of the cabinet. There were no fruits on these plants. We cannot take these results as final because of the many variable factors involved. For example, throughout the experiment there were many days when none of the pollen was effective. The cabinet worked satisfactorily on the smaller potted plants, but was impractical for the larger plants such as the naranjilla and tomato.

Finally it was decided that such means of avoiding pollination were impractical. In order to determine the amount of natural cross-pollination occurring, tests of ten to twenty flowers were emasculated, tagged and left setting in their usual places. The results indicated that no natural cross-pollination took place; however, here again we must consider the variables upon which the pollen germination and ultimate fertilization depend. The three tests, run at intervals of several weeks, were inadequate, but perhaps give some indication. Due to the lack of flowers, more and larger tests were not made.

Absolute pollen control was not imperative, since the F_1 was grown and observed. No matter what precautions one takes, it is doubtful if absolute control could be accomplished.

Records

It was necessary to maintain a running record of crosses made, both on the plant in the form of tags and in notebooks. The parents, number and date were recorded.

Further records kept included the number of resulting fruit, number of seeds per fruit, germination percentage and number of resulting hybrids. These data are found in the included tables.

DISCUSSION OF RESULTS

The results of this experiment are presented in the form of observations made during an attempt to cross eight members of the Solanaceae. The goal of one hundred cross-pollinations for each combination was reached in only a few cases. However, a sufficient number was accomplished to give some indications about each cross attempted. The data are presented in a series of tables. The actual number of crosses can be found in Tables I, IV, VII and X.

The results are discussed on the basis of the following assumptions:

1. If the percentage of fruit set with seeds resulting from a cross equaled zero, there was probably no compatibility.
2. If the percentage of fruit with seeds resulting from a cross was either low or high there could have been a cross, but if the F_1 very closely resembled the female parent, there was probably no cross. If the F_1 was intermediate in appearance, there could have been a cross.
3. If the number of seeds per fruit was many, it would suggest self-pollination or foreign-pollination.

4. If the resulting number of seeds per fruit was few, it would suggest a possible cross because artificially applied pollen usually results in fewer seeds.
5. If the percentage germination was very high, it would suggest selfing or the results of foreign-pollination.
6. If the percentage germination was low, it could mean either a cross, because interspecific and intergeneric crosses usually result in the production of very few viable seeds, or it could mean that the seeds were immature.
7. Since parthenocarpy is the development of fruit without fertilization, it has no significance as far as determining the compatibility of a cross.

Summary of Hybridizations

I. Solanum (Tables I, II, III)

a. S. Melongena when used as the female parent resulted in only one cross with a high enough percentage of fruits to be of any significance. The 14.7 per cent fruit with seed in the cross S. Melongena X Capsicum annuum var. grossum appeared to be a legitimate intergeneric cross, but when the F_1 plants very closely resembled the female parent, it became apparent that the resulting fruit was more likely due to self-pollination or foreign-pollination. The minimum and maximum rate of germination, 0 and 100 per cent, suggests that the latter were self-pollinated and the former were merely immature seeds. Due to harvesting many immature fruits of this species, the number and percentage germination of the seeds have very little significance.

b. S. Pseudocapsicum when used as the female parent produced no fruit and consequently it can be assumed that there was no compatibility with the other members of Solanaceae.

c. S. integrifolium when used as the female parent produced no fruit. It also can be considered incompatible with the other plants of these experiments.

d. *S. quitoensis* when used as the female parent produced no fruit. Since it is very difficult for *S. quitoensis* to set fruit by artificial or natural means outside its native habitat, it is impossible to draw any conclusions.

II. *Capsicum* (Tables IV, V, VI)

a. *C. annuum* var. *grossum* when used as the female parent produced 16.7 per cent fruit with seed when cross-pollinated with *S. Melongena*. However, the F_1 was typically an eggplant; therefore, probably no crossing occurred. The minimum number of seeds was one and the maximum was thirty-four. Here, again, the latter was probably a selfed plant and the former was the result of a stray pollen grain or perhaps only one ovule developed. The minimum and maximum per cent germination, 0 and 100 per cent, seemed to support this explanation.

b. In the cross *C. annuum* var. *grossum*

X C. annuum var. conoides the high percentage of fruit with seeds (55 per cent) intimated an actual cross. The F_1 had an intermediate appearance. The F_1 seedling stage resembled var. grossum as did the mature stage, but the hybrid plant was much shorter and more bushy. The leaves were ovate-lanceolate, resembling var. grossum in length but considerably broader. The flowers were typical of the genus, tending to be larger than either parent. Grossum was considerably coarser than the hybrid, and conoides was a little less coarse than the hybrid (fig. 1). The hybrid had a comparatively longer pistil and ovary. The corolla was shaped like var. grossum and somewhat less coarse in appearance. The fruit was different than either parent. It was smaller in circumference than var. grossum and larger than var. conoides. It was intermediate in shape but resembled var. conoides a little more than *grossum*. The final color and the color and the color development resembled var. *grossum*. A cross-section proved the fruit to be two or three-lobed. The peduncles were straight and erect, similar to var. *conoides*, and not curved and drooping as in var. *grossum*. They were intermediate in length and thickness.

c. The cross *C. annuum* var. *conoides* X *C. annuum* var. *grossum* produced forty-eight per cent fruit with seed. The F_1 was intermediate in appearance from the seedling stage through to the mature plant. It was about the same size as var. *conoides*, but was considerably coarser (fig. 3). The stem and branches were large in diameter, the flowers were less frequent and less fruit was produced per plant. The glabrous leaves were very similar in size and shape to var. *conoides*, except for the upper leaves which tended to remain large, whereas, the upper leaves of var. *conoides* tended to be smaller. The flowers were larger than in the *conoides* parent and sometimes as large, or larger, than its *grossum* parent. They were intermediate in shape and size and the flower parts had a more slender structure throughout (fig. 4).

III. *Lycopersicum* (Tables VII, VIII, IX)

a. *L. esculentum* when used as the female parent produced a small percentage of fruit with seed in each cross (Table VII). The F_1 all resembled the female parent, and, consequently, it is very doubtful if any intergeneric hybrids were produced. The number of seeds per fruit (Table VIII) and the average per cent germination (Table IX) were very high, adding to the probability of self-fertilization.

IV. *Physalis* (Tables X, XI, XII)

a. *P. ixocarpum* when used as a female parent produced only a very small percentage of fruit with seed. The number of seeds per fruit was very small (Table XI) and none was viable (Table XII). Therefore, as a female parent, *P. ixocarpum* was probably intergenerically incompatible with the other plants of this experiment.

Parthenocarpy

In this experiment, the amount of parthenocarpy was almost entirely dependent on the nature of the female parent. For example, parthenocarpy averaged as high as 23.5 per cent in the crosses of *S. Melongena* and as low as zero in *S. Pseudocarsicum* and *S. integrifolium* (Table XIII). There was no consistently high parthenocarpy stimulating pollen parent. *S. Melongena* and *P. ixocarpum* were the plants of this experiment showing the most parthenocarpy. There was no indication that botanical relationship had a bearing on the incidence of parthenocarpy. The presented data (Tables XIII, XIV, XV, XVI) do not show a higher percentage of parthenocarpy in the interspecific than in the intergeneric cross. For example, the interspecific cross *S. Melongena* X *S. Pseudocapicum* produced 14.3 per cent parthenocarpic fruit and in the intergeneric cross *S. Melongena* X *P. ixocarpum* 30 per cent was parthenocarpic. There were some instances where the reverse was true, but they were in the minority.

In comparing Tables I, IV, VII, X with Tables XIII, XIV, XV, XVI, there is no correlation between the percentage of fruit with seed and the percentage of fruit without seed.

If the resulting fruits with seeds in these experiments were considered to be a result of actual hybridization there would probably be some percentage similarities between fertilization and parthenocarpy, but this is not the case. If the resulting crosses were not true hybrids, then there is no comparison. So in the final analysis parthenocarpy presented here is most likely not caused by pollen stimulation.

Possible Explanation of Incompatibility

There are many explanations for interspecific and intergeneric incompatibility of plants. Some of the factors involved discussed by Blakslee (4) may be applicable to the unsuccessful crosses of this experiment. For example, he explained that the pollen from one plant may have failed to germinate on the stigma of another plant or if germination occurred the pollen tubes burst before reaching the ovules. This may have been due to the inherent length of the pollen tube, its growing too slowly, or differences in the transmitting tissue of the style through which the tube grows. The pollen tube may have reached the ovary but the male and female gametes may have failed to unite. Fertilization may have occurred, but cell division stopped after the development of a few cells or the embryo may have developed considerably, but the ovule failed to develop into a viable seed.

The effect of the environment on pollination was undoubtedly a reason for some of the unsuccessful crosses, and manifests itself in the morphology of the flower parts.

Temperature was found to have a greater effect on the time of bud formation and the time of anthesis than any other factor in Cochran's (6) work on peppers. He found by altering the temperature under which the plants were grown, the set of fruit varied from 0 to practically 100 per cent. No blossoms set fruit at 90°-100° temperature. Reduction in temperature from 90°-100° to 70°-80° and from 70°-80° to 60°-70°, resulted in increased percentage of fruit set. When plants were kept under 50°-60° temperature throughout the growth period, they made practically no growth and formed only one blossom which was dropped.

Smith (23) working with tomatoes found that extremely high temperatures caused the styles to elongate abnormally and exceptionally early. This condition results in destruction of the stigmatic surfaces before pollination could take place. He further stated that pollen germination was greatly affected by high temperatures. At 100° germination was extremely poor and pollen tubes were very short. Optimum germination occurred at 70°-85°. At 50° germination was slightly greater than at 100°.

Soil moisture, available nitrogen, day length, and humidity were found by Cochran (6) to be influential in blossom set.

Howlett (11) found that maximum pistil length in relation to stamen length was obtained when the plants were growing during a period of relatively short day length, under light of low intensity and with an abundance of readily available nitrogen.

These findings show very definitely the effect of environment on pollination and fruit set.

Insufficient data were taken on the effect of temperature on pollination to illustrate it graphically, but during the hot weather and especially in the greenhouse the styles grew considerably longer. They usually grew so long they protruded outside the bud before it opened. This condition was also apparent in growing the same plants in the much warmer Arizona environment.

These environmental effects were probably best exemplified by Solanum Pseudocapsicum, S. quitoensis and S. integrifolium which in addition to being crossed, were selfed. They produced only a very few fruits with seed in the selfed plants and no crosses.

Probably a combination of the factors discussed above were involved in these experiments and partially responsible for the incompatibility in this family.

SUMMARY

In this study eight members of the *Solanaceae* were cross-pollinated. The following were observed and discussed:

1. Pollination was very dependent on environment, especially temperature.
2. Out of the 3,129 cross-pollinations there were 96 fruits with seeds, 275 without seeds, 2 successful intervarietal crosses (*Capsicum annuum* var. *grossum* X *C. annuum* var. *conoides* and *C. annuum* var. *conoides* X *C. annuum* var. *grossum*), no positive interspecific crosses and no intergeneric crosses.
3. In reviewing the literature there was no case of an intergeneric cross reported. Several references to interspecific crosses, usually very closely related, such as *Lycopersicum* and *Tuberarium* were found. There were innumberable intraspecific crosses throughout the literature.
4. Positive compatibility of the interspecific and intergeneric crosses of

this study could not be determined within the limits of this experiment and would require a more comprehensive study.

5. Parthenocarpy was prevalent in all the plants but S. Pseudocapsicum, S. integrifolium and S. quitoensis. The percentage parthenocarpy was especially high in S. Melongena and P. ixocarpum.

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APPENDIX

Fig. 1, (1) C. annuum var. grossum. (2) C. annuum var. conoides. (3) Hybrid of grossum X conoides.

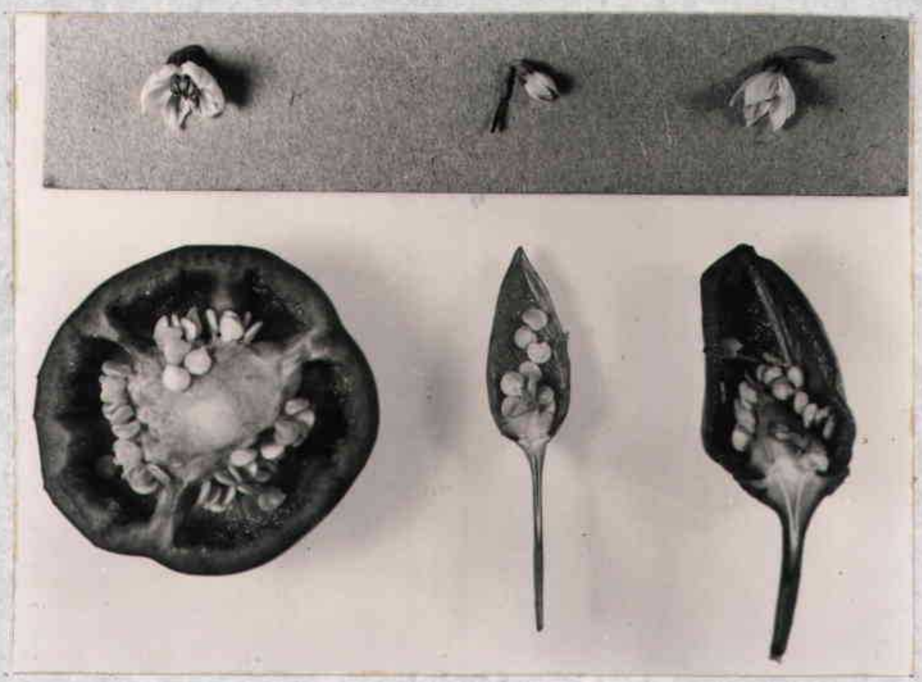

Fig. 2. Flowers and fruit: (1) C. annuum var. grossum. (2) C. annuum var. conoides. (3) Hybrid of var. grossum X conoides.

Fig. 3. (1) C. annuum var. conoides. (2) C. annuum var. grossum. (3) Hybrid of conoides X grossum.

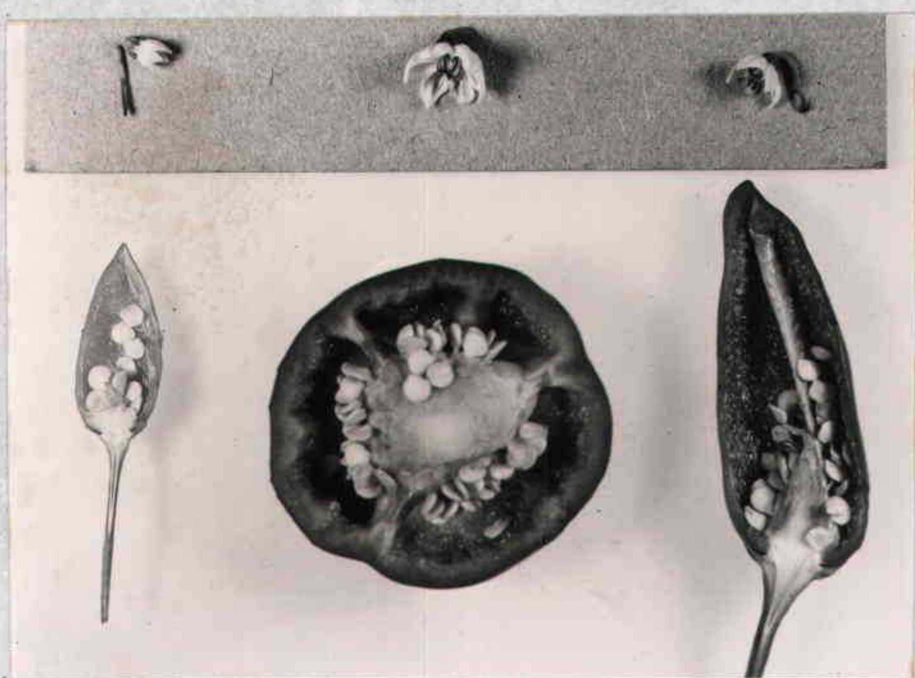

Fig. 4. Flowers and fruit: (1) C. annuum var. conoides. (2) C. annuum var. grossum. (3) Hybrid of var. conoides X grossum.

TABLE NO. I

PER CENT FRUIT WITH SEEDS RESULTING FROM CROSSING THE SOLANACEAE AND THE GENUS SOLANUM MADE MAY 8 TO NOVEMBER 14, 1948; CORVALLIS, OREGON

Cross	No. of Cross-pollinations	No. of Fruit With Seed	Per Cent Fruit With Seeds
Solanum Melongena X			
S. Pseudocapsicum	63	3	4.76
S. integrifolium	38	-	-
Lycopersicum esculentum	44	1	2.27
Capsicum annuum var. grossum	34	5	14.70
Capsicum annuum var. conoides	26	1	3.85
Physalis ixocarpum	40	-	-
Solanum Pseudocapsicum X			
S. integrifolium	80	-	-
S. Melongena	75	-	-
Lycopersicum esculentum	90	-	-
Capsicum annuum var. grossum	76	-	-
Capsicum annuum var. conoides	90	-	-
Physalis ixocarpum	89	-	-
Solanum integrifolium X			
S. Melongena	47	-	-
S. Pseudocapsicum	49	-	-
Lycopersicum esculentum	22	-	-
Capsicum annuum var. grossum	42	-	-
Capsicum annuum var. conoides	31	-	-
Physalis ixocarpum	31	-	-
Solanum quitoensis X			
Lycopersicum exculentum	17	-	-

TABLE NO. II

MINIMUM AND MAXIMUM NUMBER OF MATURE SEEDS PER FRUIT
IN THE SOLANACEAE CROSSES OF THE GENUS SOLANUM
MADE OCTOBER, 1948; CORVALLIS, OREGON

Cross	No. of Fruit With Seed	Min. No. of Seeds Per Fruit	Max. No. of Seeds Per Fruit
Solanum Melongena X			
S. Pseudocapsicum	3	11	48
S. integrifolium	-	-	-
Lycopersicum esculentum	1	1	1
Capsicum annuum var. grossum	5	6	21
Capsicum annuum var. conoides	1	8	8
Physalis ixocarpum	-	-	-
Solanum Pseudocapsicum X			
S. integrifolium	-	-	-
S. Melongena	-	-	-
Lycopersicum esculentum	-	-	-
Capsicum annuum var. grossum	-	-	-
Capsicum annuum var. conoides	-	-	-
Physalis ixocarpum	-	-	-
Solanum integrifolium X			
S. Melongena	-	-	-
S. Pseudocapsicum	-	-	-
Lycopersicum esculentum	-	-	-
Capsicum annuum var. grossum	-	-	-
Capsicum annuum var. conoides	-	-	-
Physalis ixocarpum	-	-	-
Solanum quitoensis X			
Lycopersicum esculentum	-	-	-

TABLE NO. 111

RANGE AND AVERAGE PER CENT GERMINATION OF SEED FROM THE SOLANACEAE CROSSES OF THE GENUS SOLANUM TESTED APRIL TO JULY, 1949; TUCSON, ARIZONA

Cross	Minimum Per Cent Germ.	Maximum Per Cent Germ.	Average Per Cent Germ.
Solanum Melongena X			
S. Pseudocapsicum	-	81	40
S. integrifolium	-	-	-
Lycopersicum esculentum	100	100	100
Capsicum annuum var. grossum	-	100	50
Capsicum annuum var. conoides	100	100	100
Physalis ixocarpum	-	-	-
Solanum Pseudocapsicum X			
S. integrifolium	-	-	-
S. Melongena	-	-	-
Lycopersicum esculentum	-	-	-
Capsicum annuum var. grossum	-	-	-
Capsicum annuum var. conoides	-	-	-
Physalis ixocarpum	-	-	-
Solanum integrifolium X			
S. Melongena	-	-	-
S. Pseudocapsicum	-	-	-
Lycopersicum esculentum	-	-	-
Capsicum annuum var. grossum	-	-	-
Capsicum annuum var. conoides	-	-	-
Physalis ixocarpum	-	-	-
Solanum quitoensis X			
Lycopersicum esculentum	-	-	-

TABLE NO. 1V

PER CENT FRUIT WITH SEEDS RESULTING FROM CROSSING THE SOLANACEAE AND THE GENUS CAPSICUM MADE MAY 8 TO NOVEMBER 14, 1948; CORVALLIS, OREGON

Cross	No. Of Cross-pollinations	No. Of Fruit With Seed	Per Cent Fruit With Seeds
Capsicum annuum var. grossum X			
Solanum Melongena	78	13	16.70
S. Pseudocapsicum	63	3	4.76
S. integrifolium	73	7	9.60
Lycopersicum esculentum	62	-	-
Capsicum annuum var. conoides	20	11	55.00
Physalis ixocarpum	73	1	1.37
Capsicum annuum var. conoides X			
Solanum Melongena	100	-	-
S. Pseudocapsicum	100	-	-
S. integrifolium	99	5	5.04
Lycopersicum esculentum	102	-	-
Capsicum annuum var. grossum	25	12	48.00
Physalis ixocarpum	97	4	4.13

TABLE NO. V

MINIMUM AND MAXIMUM NUMBER OF MATURE SEEDS PER FRUIT
IN THE SOLANACEAE CROSSES OF THE GENUS CAPSICUM
MADE OCTOBER, 1948; CORVALLIS, OREGON

Cross	No. of Fruit With Seed	Min. No. of Seeds Per Fruit	Max. No. of Seeds Per Fruit
Capsicum annuum var. grossum X			
Solanum Melongena	13	1	34
S. Pseudocapsicum	3	1	93
S. integrifolium	7	1	32
Lycopersicum esculentum	-	-	-
Capsicum annuum var. conoides	11	9	55
Physalis ixocarpum	1	2	27
Capsicum annuum var. conoides X			
Solanum Melongena	-	-	-
S. Pseudocapsicum	-	-	-
S. integrifolium	5	1	4
Lycopersicum esculentum	1	1	1
Capsicum annuum var. grossum	12	2	39
Physalis ixocarpum	4	2	21

TABLE NO VI

RANGE AND AVERAGE PER CENT GERMINATION OF SEED FROM THE SOLANACEAE CROSSES OF THE GENUS CAPSICUM TESTED APRIL TO JULY, 1949; TUCSON, ARIZONA

Cross	Minimum Per Cent Germ.	Maximum Per Cent Germ.	Average Per Cent Germ.
Capsicum annuum var. grossum X			
Solanum Melongena	-	100	63.5
S. Pseudocapsicum	-	100	64
S. integrifolium	-	100	63
Lycopersicum esculentum	-	-	-
Capsicum annuum var. conoides	66	100	89
Physalis ixocarpum	86	100	93
Capsicum annuum var. conoides X			
Solanum Melongena	-	-	-
S. Pseudocapsicum	-	-	-
S. integrifolium	-	75	25
Lycopersicum esculentum	100	100	100
Capsicum annuum var. grossum	91	100	98
Physalis ixocarpum	-	50	27

TABLE NO. VII

PER CENT FRUIT WITH SEED RESULTING FROM CROSSING THE SOLANACEAE AND THE GENUS LYCOPERSICUM MADE MAY 8 TO NOVEMBER 14, 1948; CORVALLIS, OREGON

Cross	No. of Cross-pollinations	No. of Fruit With Seed	Per Cent Fruit With Seeds
Lycopersicum esculentum X			
Solanum Melongena	72	5	7.95
S. Pseudocapsicum	94	3	3.19
S. integrifolium	82	1	1.22
S. quitoensis	103	2	1.94
Capsicum annuum var. grossum	80	3	3.75
Capsicum annuum var. conoides	77	5	6.50
Physalis ixocarpum	81	1	1.23

TABLE NO. VIII

MINIMUM AND MAXIMUM NUMBER OF MATURE SEEDS PER FRUIT IN THE SOLANACEAE CROSSES OF THE GENUS LYCOPERSICUM MADE OCTOBER, 1948; CORVALLIS, OREGON

Cross	No. of Fruit With Seed	Min. No. of Seeds Per Fruit	Max. No. of Seeds Per Fruit
Lycopersicum esculentum X			
Solanum Melongena	5	6	53
S. Pseudocapsicum	3	12	25
S. integrifolium	1	5	113
S. quitoensis	2	1	5
Capsicum annuum var. grossum	3	11	39
Capsicum annuum var. conoides	5	5	109
Physalis ixocarpum	1	5	12

TABLE NO. IX

RANGE AND AVERAGE PER CENT GERMINATION OF SEED FROM THE SOLANACEAE CROSSES OF THE GENUS LYCOPERSICUM TESTED APRIL TO JULY, 1949; TUCSON, ARIZONA

Cross	Minimum Per Cent Germ.	Maximum Per Cent Germ.	Average Per Cent Germ.
Lycopersicum esculentum X			
Solanum Melongena	-	100	68
S. Pseudocapsicum	39	80	55
S. integrifolium	43	100	77
S. quitoensis	40	100	70
Capsicum annuum var. grossum	54	100	64
Capsicum annuum var. conoides	4	100	56
Physalis ixocarpum	100	100	100

TABLE NO. X

PER CENT FRUIT WITH SEEDS RESULTING FROM CROSSING THE SOLANACEAE AND THE GENUS PHYSALIS MADE MAY 8 TO NOVEMBER 14, 1948; CORVALLIS, OREGON

Cross	No. Of Cross-pollinations	No. Of Fruit With Seed	Per Cent Fruit With Seeds
Physalis ixocarpum			
Solanum Melongena	125	5	4.00
S. Pseudocapsicum	127	-	-
S. integrifolium	121	1	.83
Lycopersicum esculentum	100	-	-
Capsicum annuum var. grossum	95	1	1.05
Capsicum annuum var. conoides	96	3	3.13

TABLE NO. XI

MINIMUM AND MAXIMUM NUMBER OF MATURE SEEDS PER FRUIT
IN THE SOLANACEAE CROSSES OF THE GENUS PHYSALIS
MADE OCTOBER, 1948; CORVALLIS, OREGON

Cross	No. of Fruit With Seed	Min. No. of Seeds Per Fruit	Max. No. of Seeds Per Fruit
Physalis ixocarpum X			
Solanum Melongena	5	1	3
S. Pseudocapsicum	-	-	-
S. integrifolium	1	1	1
Lycopersicum esculentum	-	-	-
Capsicum annuum var. grossum	1	1	1
Capsicum annuum var. conoides	3	1	1

TABLE NO. XII

RANGE AND AVERAGE PER CENT GERMINATION OF SEED FROM THE SOLANACEAE CROSSES OF THE GENUS PHYSALIS TESTED APRIL TO JULY, 1949; TUCSON, ARIZONA

Cross	Minimum Per Cent Germ.	Maximum Per Cent Germ.	Average Per Cent Germ.
Physalis ixocarpum X			
Solanum Melongena	-	-	-
S. Pseudocapsicum	-	-	-
S. integrifolium	-	-	-
Lycopersicum esculentum	-	-	-
Capsicum annuum var. grossum	-	-	-
Capsicum annuum var. conoides	-	-	-

TABLE NO. X111

PER CENT PARTHENOCARPY IN THE SOLANACEAE CROSSES OF THE GENUS SOLANUM MADE MAY 10 TO NOVEMBER 14, 1948; CORVALLIS, OREGON

	No. Of Crosses	No. Of Fruit Without Seed	Per Cent Parth.
Solanum Melongena X			
S. Pseudocapsicum	63	9	14.3
S. integrifolium	38	15	39.5
Lycopersicum esculentum	44	8	18.2
Capsicum annuum var. grossum	34	8	23.5
Capsicum annuum var. conoides	26	4	15.4
Physalis ixocarpum	40	12	30.0
Solanum Pseudocapsicum X			
S. integrifolium	80	-	-
S. Melongena	75	-	-
Lycopersicum esculentum	90	-	-
Capsicum annuum var. grossum	76	-	-
Capsicum annuum var. conoides	90	-	-
Physalis ixocarpum	89	-	-
Solanum integrifolium X			
S. Melongena	47	-	-
S. Pseudocapsicum	49	-	-
Lycopersicum esculentum	22	-	-
Capsicum annuum var. grossum	42	-	-
Capsicum annuum var. conoides	31	-	-
Physalis ixocarpum	31	-	-
Solanum quitoensis X			
Lycopersicum esculentum	17	-	-

TABLE NO. XLV

PER CENT PARTHENOCARPY IN THE SOLANACEAE CROSSES OF THE GENUS CAPSICUM MADE MAY 10 TO NOVEMBER 14, 1948; CORVALLIS, OREGON

Cross	No. Of Crosses	No. Of Fruit Without Seed	Per Cent Parth.
Capsicum annuum var. grossum X			
Solanum Melongena	78	10	12.80
S. Pseudocapsicum	63	5	7.85
S. integrifolium	73	1	1.37
Lycopersicum esculentum	62	-	-
Capsicum annuum var. conoides	20	-	-
Physalis ixocarpum	73	6	8.24
Capsicum annuum var. conoides X			
Solanum Melongena	100	-	-
S. Pseudocapsicum	100	4	4.00
S. integrifolium	99	10	9.90
Lycopersicum esculentum	102	-	-
Capsicum annuum var. grossum	25	2	8.00
Physalis ixocarpum	97	-	-

TABLE NO. XV

PER CENT PARTHENOCARPY IN THE SOLANACEAE CROSSES OF THE GENUS LYCOPERSICUM MADE MAY 10 TO NOVEMBER 14, 1948; CORVALLIS, OREGON

Cross	No. Of Crosses	No. Of Fruit Without Seed	Per Cent Parth.
Lycopersicum esculentum X			
Solanum Melongena	72	1	1.49
S. Pseudocapsicum	94	2	2.13
S. integrifolium	82	11	13.42
S. quitoensis	103	-	-
Capsicum annuum var. grossum	80	1	1.25
Capsicum annuum var. conoides	77	2	2.60
Physalis ixocarpum	81	-	-

TABLE NO. XVI

PER CENT PARTHENOCARPY IN THE SOLANACEAE CROSSES OF THE GENUS PHYSALIS MADE MAY 10 TO NOVEMBER 14, 1948; CORVALLIS, OREGON

Cross	No. Of Crosses	No. Of Fruit Without Seed	Per Cent Parth.
Physalis ixocarpum X			
Solanum Melongena	125	32	25.60
S. Pseudocapsicum	127	38	29.95
S. integrifolium	121	19	15.70
Lycopersicum esculentum	100	14	14.00
Capsicum annuum var. grossum	95	21	22.15
Capsicum annuum var. conoides	96	30	31.30

TABLE NO. XV11

SUMMARY OF PARTHENOCARPY TABLES

	No. Of Crosses		No. Of Fruit Without Seed		Per Cent Parth.	
	Range	Ave.	Range	Ave.	Range	Ave.
Solanum Melongena	26-63	41	4-15	9.3	14.3-39.5	23.5
S. Pseudocapsicum	75-90	83	-	-	-	-
S. integrifolium	22-49	37	-	-	-	-
S. quitoensis	17	17	-	-	-	-
Capsicum annuum var. grossum	20-78	62	0-10	3.8	0-12.8	5.05
Capsicum annuum var. conoides	25-102	87	0-10	2.8	0-9.9	3.66
Lycopersicum esculentum	72-103	84	0-11	2.4	0-13.4	3.00
Physalis ixocarpum	95-127	111	14-38	24	14-31.3	23.2
Total	3,129		275		8.8%	

TABLE NO. XV111

STYLE LENGTH OF EIGHT MEMBERS OF SOLANACEAE
CORVALLIS, OREGON JULY 22, 1948

	Taxonomy	Approx. Ave. Length in cm.
1.	Solanum Melongena	.80
2.	S. Pseudocapsicum	.50
3.	S. integrifolium	.75
4.	S. quitoensis	.70
5.	Capsicum annuum var. grossum	.40
6.	Capsicum annuum var. conoides	.35
7.	Lycopersicum esculentum	.70
8.	Physalis ixocarpum	.60