PLEIOTROPY: EXTRA COTYLEDONS IN THE TOMATO

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Aristotle noted that living things develop according to type. If we are to ascribe development of kinds to natural selection we must believe that the plan of an organism is incomplete and tenuous; so much so that among the chance variants there are some which are superior to their parents, along with others which are inferior. Yet among the variants which are hereditary, nearly all are inferior and this study describes such a strain. The data favor the idea that the type is important.

A tomato plant with an extra cotyledon might be considered an advantageous type but in these observations it was found to be inferior in germination, rate of growth, and resistance to frost. A few morphological peculiarities were noted.

History

The first lateral structures formed on a seedling plant differ from true leaves and are called cotyledons. In species where the normal number is two cotyledons, three or more cotyledons appear occasionally. Holtorp[1] found that in mustard, *Brassica*, tricotyledony (3 seed leaves) is heritable and can be changed by selection. He did not note the weakness which I have found, probably because he chose the best specimens and gave them superoir care.

Dessureaux[2] found four cotyledons occasionally in alfalfa as well as three. He found the two-cotyledon condition to be dominant although incompletely so. He has reported that an average of 3.55 cotyledons has been recorded in one selected strain.

Tashima,[3] a graduate student in the Ohio State University, found that the tricotyl condition in tomatoes is hereditary but does not follow any simple Mendelian ratio. The present author suspects chromosomal aberration, but the chromosomes of the tomato are hard to examine.

Elton F. Paddock[4] of the Ohio State University has found a split leaf condition and the stem division (bifurcation) to be associated with the tricotyl condition in tomatoes.

Procedure

In 1968 a tomato plant came up in a flower bed from a stray seed. Since the plant had vigor and produced fruits that were smooth and ripened evenly I saved seeds from it The next year, 1969, one plant from the seeds of this plant had three cotyledons, spaced evenly around the stem. Another abnormality was a terminal leaflet split along the midrib, resembling observations by Paddock. Set out 100 feet away from others, in good soil, fruits on this plant started to ripen 11 days later than other plants of the same set of seeds (sibs). The fruits were numerous but slightly smaller than those of the sibs.

In the summer of 1969 I planted 100 seeds from fruits of this mutant, 3-cotyledonous tomato plant. A total of 69 plants developed: 3 with 3 cotyledons and 66 with 2 cotyledons. By December 25, 1969, the following results were recorded:

3 coty. plant no. 1: 4 in. high 5 green leaves
3 coty. plant no. 2: 8 in. high 10 green leaves
3 coty. plant no. 3: 14 in. high 8 green leaves
2 coty. plant, typical: 17 in. high 8 green leaves

On March 1, 1970, I planted seed from the mutant 3 cotyledon plant of 1969 in good soil with favorable moisture and temperature. A total of 37 plants developed: 7 with 3 cotyledons and 30 with 2 cotyledons. By April 30, 1970, the following results were typical:

3 coty. plant no. 1: 4 in. high
3 coty. plant no. 2: 4 in. high
3 coty. plant no. 3: 4 in. high
3 coty. plant no. 4: 2.5 in. high
3 coty. plant no. 5: 1 in. high Came up late
2 coty. plant no. 1: 11 in. high
2 coty. plant no. 2: 7 in. high
2 coty. plant no. 3: 3.5 in high—Growth from axillary branch only
2 coty. plant no. 4: 3 in. high—Growth from 2 axiliary branches only

Of particular interest is the fact that plants number 3 and 4 of the 2 cotyledon plants stopped growth of the stem at an early age for no apparent reason. Growth was resumed at axillary branches, retarding the maturity of the plants. It should be noted that: these plants are heterozygous for extra cotyledons, suggesting that this crippling abnormality is associated with the break-down of cotyledon type.

All of these plants bore normal fruits, although of reduced size, and they started bearing at the same time as controls, of non-mutant ancestry, planted a month later.

Other Results Obtained

Comparison under adverse conditions; under slat frame out of doors. By July 29, 1970:

40 seeds planted from 3 coty. mutant: 18 plants
40 seeds planted from 2 coty. normal: 16 plants

Plants still living on September 14, 1970:

3 coty. parentage: 1 plant, number leaves 3
2 coty. parentage, 6 plants, avg. no. leaves 3.8

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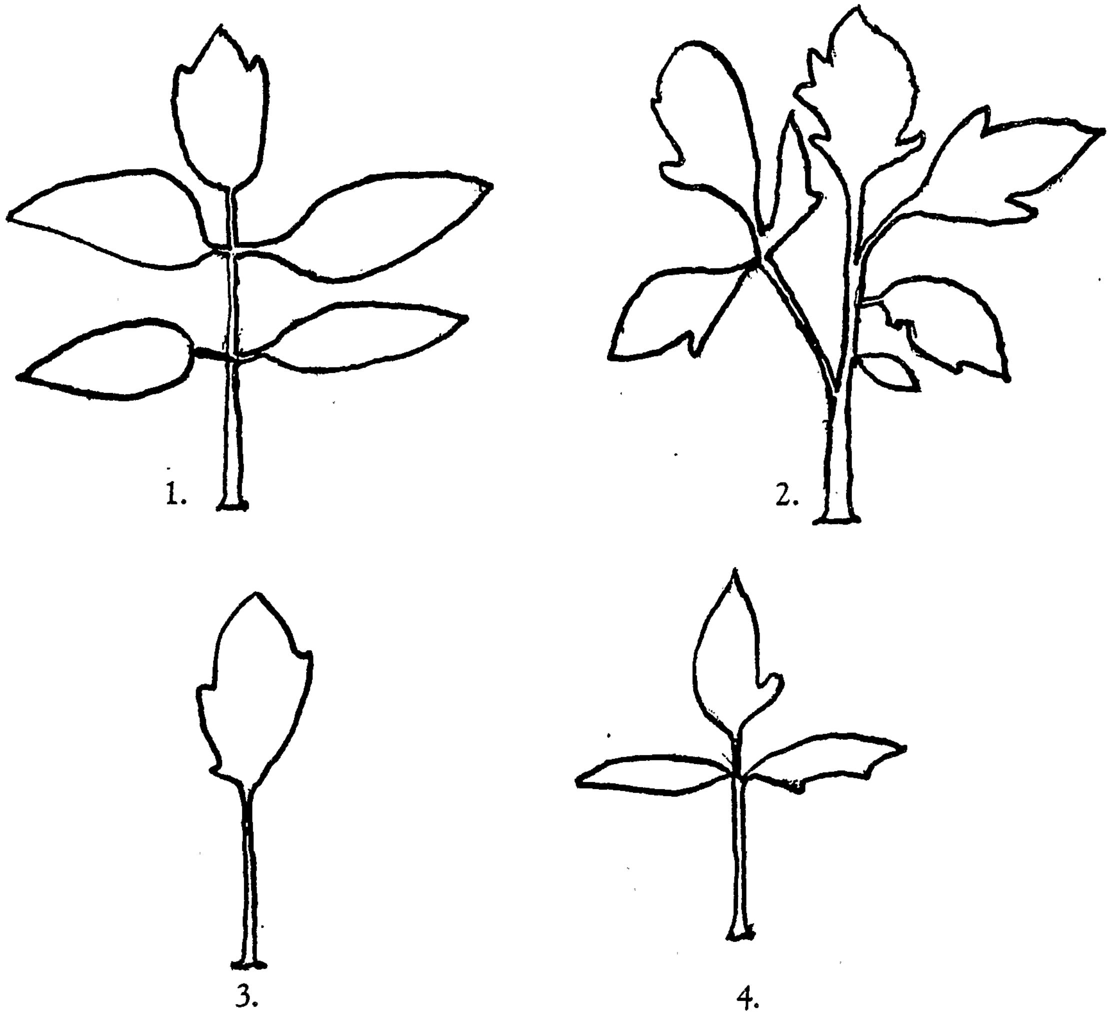

Figure 1. Four leaf shapes in tomatoes having 3 cotyledons. 1. Normal tomato leaf. 2, 3, and 4. Various shapes on 3 cotyledon plants. Normal size.

Resistence to frost by October 17, 1970:
First 3 coty. plant: frosted leaves 95, intact 31
Second 3 coty. plant: frosted leaves 34, intact 18
First 2 coty. plant: frosted leaves 55, intact 50
This 2 cotyledonous plant had no mutant ancestry.

Unfavorable environment: basement 55-60 degrees, feeble light (April 1, 1971):
100 seeds planted from 1970 3 coty. plants
100 seeds planted from normal 2 coty. plants
On May 29, 1971, of the 3 coty. planting, 20 living
On May 29, 1971, of the 2 coty. planting, 37 living

All the living plants had two cotyledons. We concluded that the homozygous 3 coty. seeds did not germinate under these unfavorable conditions.

Discussion

One might think that an extra cotyledon when a plant has no other leaf surface would be a benefit, which it probably is. But the disruption of its genetic code works more harm than this change works of good. There is an error in the genetic information received by the zygote which reduces the vigor. This is characteristic of mutants in general, and needs to be mentioned more frequently.

In addition there is association of morphological changes: extra cotyledon, split leaf, and stoppage of growth in the main stem. One plant, not hitherto mentioned, stopped growth of the-main stem in winter when light was unfavorable and continued growth by sending out a branch. One would expect all branches to die and growth to continue on the slender main stem.

Another change not mentioned above and with no tricotyledon ancestry, was a cotyledon split half way from the apex to the base.

Conclusions

Tricotyledony or the more inclusive condition, pleiotropy, in tomatoes is evidently hereditary and recessive but the ratio of normal to mutant has not been determined.

Like mutations in general, this change reduces the vigor of the plant. Loss is manifested in later bearing and less resistance to cold and other unfavorable environmental factors. This loss is another difficulty for the theory of evolution, which is dependent upon mutation.

Literature Cited

[1]H. E. Holtorp. 1944. Tricotyledony, *Nature,* 153:13-14.

[2]L. Dessureaux. 1967. *Canadian Journal of Genetics and Cytology,* 9:658.

[3]Masayuki Tashima. 1950. A study of the inheritance of multiple cotyledons, fruit color, dwarfness and potato leaf in the tomato. Ohio State University Thesis.

[4]Personal letter to the author.

ONE MAN'S VIEW ON THE TEACHING OF ORIGINS IN THE PUBLIC SCHOOL SCIENCE CLASSROOM

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The teacher in public school must avoid coercion and unfair dogmatism in the presentations of origins. Students should be given empirical data bearing on origins and then be allowed to examine alternatives to the evolution concept. This objective might be achieved in part if student teachers were asked to write about arguments opposing evolution during their own college preparation. It is also suggested that data regarding competitive theories be collected into an appendix or addenda for use with all types of textbooks or laboratory manuals.

The word evolution means different things to different people. I find that, as I am asked to speak on the subject of "Teaching Evolution in the Classroom," I am often confronted with this problem in semantics. To be sure that this is not the case in this paper, let me clarify what I mean.

That evolution is *"the continuous genetic adaptation of organisms or species to the environment by the integrating agencies of selection, by hybridization, inbreeding and mutation"* is the biological definition often used. In this respect evolution or adaptation is constantly going on around us and would be difficult if not nearly impossible to deny.

There is another aspect of evolution, however, that impinges upon origins. I am referring to the evolution of all species from a single coacervate cell, or some substance, that has spontaneously developed from some primordial soup.

Now this is where the problem comes into view and I wish the reader to understand that this is what I am referring to. It is this point of view that brings some of the most bitter controversy, a controversy that I personally cannot avoid because it is dealt with in practically every biological textbook, and science curriculum (K through 12) is inescapably my business.

I begin, then, with "One Man's View" that may well be considered unorthodox and totally unacceptable to some.

Background Observations

Some time ago an article appeared in a science journal in which the author was reacting to the non-evolutionist, and he stated that any educated person who says evolution was not the case is basing his position upon rejection of scientific evidence and not the application of it. (This statement was made from the point of view of the *amoeba to man hypothesis.)* Then he went on to say:

> This rejection may be for a variety of personal reasons, which we must respect. In a democracy a citizen can believe anything that he wishes and, in a large country such as ours, surely every conceivable point of view must have at least one adherent. Some believe the earth is flat; others do not believe that micro-organisms can cause disease. But we can hope that few of the former will become pilots of our planes and ships, and few of the latter will become physicians and surgeons. *We can also hope that few who hold these views, or reject evolution, will have the responsibility for teaching science to our young people."*[1] (Emphasis in original.)

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