NOTES ON INDIAN PLANT-TERATOLOGY*

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It is the object of this paper to record some of the observations of the writer on abnormalities that were discovered in the course of his other studies. The cases that have been discussed belong to three categories—Forking, Proliferation and Fasciation—according to Worsdell (7). The abnormalities are described as fully as material permitted and possible explanations offered for each case.

Forking.

Saccharum officinarum L.—Figs. 1, 2. An interesting case of abnormal dichotomy was observed in one of the plants grown on the Agricultural College Farm at Cawnpore. The axis bifurcated into equal sized branches at one of higher nodes during the early stages of its growth. The internodes preceding the node which marked the bifurcation were flattened and the division line was clearly visible on these, though they were not actually bifurcated. There existed thus a bifurcating tendency in the flattened portion of the axis.

The internode preceding the point of bifurcation was much shorter. Very likely the physiological disturbance which accounts probably for the fission interfered in the growth of this internode. The length of the internodes of the two branches was equal.

The primary axis—was it—seems to have been developed from the combined growing points of the two branches and the phenomenon of fission can be considered as a case of separation of the two growing points which gave rise to the branches. The transverse section of the primary axis fig. 2 also suggests a combination of the two axes.

The phenomenon may be explained according to Church (7) as resulting from the original single 'growth centre' being replaced by two. Whatever may be its origin, the fact is that the axis carried two equally balanced growth centres from the beginning and the 'branching to which it gave rise was an approach to dichotomy' (7).

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* The same title as adopted by Mr. Hallberg in his paper—Jour. Ind. Bot. Soc. Vol. III, No. 1—has been used to facilitate ready reference for continuation of the study of Indian Plant Teratology.

Anacardium occidentale L.—Figs. 3 to 13. The phenomenon of forking was observed in the case of leaves. Some of the seedlings of this plant in my gardens showed various degrees of forking. All the stages between partial fission and complete division into two distinct leaflets were observed.

In cases of plants with partial or complete fission of the leaves or with a forking tendency the normal alternate phyllotaxis is disturbed and the internodes are considerably reduced. An apparently decussate phyllotaxis is developed. Normal leaves forming a false opposite pair alternate with the next false opposite pair with one or both the leaves being forked. Forking in successive pair of leaves does not occur.

The ancestors of this plant might have been characterised by decussate phyllotaxis with forked or compound leaves and the phenomenon of fission as observed might be taken as a case of reversion (?).

The figures show the various stages between alternate and decussate phyllotaxis and the various degrees of forking.

Michelia Champaca L.—Figs. 14 to 15. Some of the seedlings raised from seeds of a variety with orange flowers from Haldawani had one of the cotyledons forked. The degree of fission varied in different seedlings. There was no forking in the organs developed later.

Pennisetum Typhoideum Rich.—Fig. 16. Cobs of the varieties grown on the Botanical Research Farm, Cawnpore, presented cases of binary and multiple fission. In one of the varieties, forms of both binary and multiple fission were found. These cases of forking are grouped under different forms according to the mode and degree of fission. Numbers in the figure refer to the types of the various forms.

Form I, Fig. 16*a* was divided unequally along the whole axis.

Form II, Fig. 16*b* was normal at the base but a little above was bifurcated. One of the branches developed into a fully-formed cob, though it was thinner than the normal cob of the variety. The other branches resembled the halved portion of a normal cob split longitudinally, the face adjacent to the fully-developed branch bearing no seeds or traces of flowers.

Form III, Fig. 16*c* arose from the same variety as form II and resembled it in the mode of fission to a great extent. The division, however, started almost at the base. One of the branches was fully formed as in form II. The other branches resembled the halved spike in form II except at the apex where it was somewhat fully formed. Branches were unequal in diameter.

Forms IV–VI, Figs. 16 *d*, *e*, *f* presented types of multiple fission. Division started a little above the base in all the cases. In form IV Fig. 16*d* there were four branches while in form V Fig. 16*e* and VI 16*f* five and seven branches, though much smaller in size, appeared

respectively. All the branches were cylindrical and fully formed. Considering the shape and orientation of the branches, the phenomenon of multiple fission seems to have been evolved from binary fission. The cobs characterised by multiple fission in this plant resemble to some extent the normal cobs with digitate or whorled spikes in *Eleusine*. The two genera are, however, in no way botanically allied. The phenomenon of forking may, therefore, be one of reversion (?) or be resulting from the original single 'growth centre' being replaced by two or more.

Proliferation.

Brassica oleracea L. var. *caulorapa* (Knol-Khol).—Fig. 17 presents a case of axillary proliferation. The stem in this plant is tuberous and bears leaves which have broad leaf bases and leave prominent scars when they are removed or drop off. It forms an important vegetable crop and plants are dug out before the stems become hard.

When the plants are left in the ground for seed purposes, numerous floral shoots are produced from the apex of the tuberous stem. The plant at this stage becomes fibrous and woody and is no more useful as a vegetable.

Amongst plants left for seed purposes, some developed lateral vegetative shoots and the floral shoots in these were suspended. These shoots arose at the scars left by the foliage leaves and were axillary. These were spirally arranged round the tuberous stem which was at this stage considerably elongated.

The seed from which these plants were raised was imported from Europe. The phenomenon of proliferation in these plants appears, therefore, to be a case of growth correlation which was brought about by the stimulus of the change in the climate and edaphic factors to which the plants were not acclimatized.

Fasciation.

Cases of fasciation were observed amongst certain flax varieties of *Linum usitatissimum L.*—Figs. 18, 19, 20, *Garden Roses*—Fig. 21, *Daisies*—Fig. 22, *Eutoca viscida Benth.*—Figs. 23, 24, and in species of *Cucurbita maxima Duchesne*. The phenomenon in the former has been recorded by Master (5) but not described.

The stems are for a varying distance cylindrical and gradually become fattened and ribbon-like in the upper part. The apex of the flattened stem is usually slightly curved and somewhat dentate or forked; it is crowded with scale-like leaves and presents a hooded

appearance. The fasciated apex with tiny axillary lateral branches which arise from the lower portion seems to indicate that the phenomenon is caused by the crowding together of the growth centres of the lateral shoots. Some disturbances in the physiology or the genetic constitution of the plant interfered with the growth of the apical growth centre and the growing points of the lateral shoots were embedded in a common matrix in the mother axis.

In all the cases that were studied fasciation affected only the main axis. The lateral branches were stunted in their growth but were not fasciated; they arose a little behind the apex and were crowded together. The terminal fasciated portion is, in some cases, spirally twisted when the growth centres of the lateral shoots vary in their vigor. Flowers as well as the capsules form a complex of a number of parts and present a fasciated appearance.

The fruit from the fasciated plant of *Cucurbita maxima* was not available and the information about the nature of the flower and fruit as well as the characters of the offsprings from fasciated plants is lacking.

Transverse sections of the lower portion of the fasciated plant of *Linum usitatissimum* are circular in outline—Fig. 20 a, while those of the fasciated portion are flattened and irregularly undulated in outline—figs. 20 b, c. The irregular outline arises from the presence of numerous growth centres of the lateral shoots. These growth centres, though not actually expressed into shoots, permit various degrees of development. The arrangement of the vascular bundles and the central ground tissue are also modified owing to the mechanical pressure of general growth in one plane fig. 20 c. Transverse sections of the portion between the fasciated apex and the apparently normal axis present various stages of the fasciated structure.

From the character of the flowers, capsules, the grouping together of the lateral branches towards the apex of the ribbon-like shoot and also from the anatomical evidence, it seems that the numerous independent growth centres of the lateral shoots placed in close proximity are grafted together on one another to form a single shoot. This grafting is the result of the mechanical pressure exerted by the general growth. The case can be partly explained by the Fusion Theory (7). The union in one plane of the growth centres of the lateral shoots, the flowers and the capsules can be explained by the 'Expansion-Theory of Moquin-Tandon' (7). 'The retardation in the dissociation of the parts' (7) was to some extent responsible for the union of growth centres. Pleiotomy-Theory of Blaringhem also, therefore; to some extent helps in explaining this phenomenon of fasciation.

One single theory, therefore, cannot fully explain the phenomenon in these particular cases but all the three theories together are to be taken into account for a satisfactory solution of the problem if the phenomenon is accepted as a physiological one.

I am inclined, however, for the following reasons to believe that fasciation may be of a genetic origin. It has been repeatedly observed that in spite of careful roguing out of fasciated plants, the latter appeared amongst plants raised from the seed of non-fasciated ones. Amongst plants raised from the seed of the fasciated capsules both fasciated and non-fasciated plants appeared. As a result of crosses between plants of this fasciated variety with those of non-fasciated varieties, all plants in F_1 generation were non-fasciated but in subsequent generations fasciated plants—though few and isolated—appeared in every case. The data regarding the proportion is not available. The phenomenon can, therefore, also be of a genetic origin and the susceptibility to fasciation is proved to be a transmissible character of recessive nature. There is scope for further investigation in this direction.

Summary.

1. Fission may affect all the parts of the plant and be caused by division of the single growth centre into two or more. In some plants the phenomenon appears to be a case of reversion.

2. Multiple fission may be evolved from binary fission.

3. Proliferation in *Brassica oleracea L. var. caulorapa* appears to be a case of growth correlation.

4. Fasciation affects all parts of the shoot. The phenomenon in *Linum usitatissimum* may be a physiological one or more likely be of a genetic origin.

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PLATE I.

1–2. *Michelia Champaca.*

1. One leaf normal, the other less than half-forked.
2. One leaf normal, the other more than half-forked.

3–13. *Anacardium occidentale.*

3. Leaves normal and opposite.
4. Leaves normal but placed slightly one above the other.
5. One leaf slightly forked, the other remaining normal.
6. One leaf nearly half-forked, the other remaining normal.
7. One leaf forked nearly to the base and placed slightly above the opposite leaf which is normal.
8. One leaf completely divided into two, the other remaining normal.
9. One leaf forked near the apex and the other completely divided.
10. Both leaves unequally forked.
11. Both leaves completely divided. One pair consisting of normal leaves and the other placed close together and the adjacent laminas running down the petioles which are very short.
12. One leaf normal and the other completely divided into two.
13. Both leaves of the pair completely divided, there being two pairs at each node. One pair with leaves placed closer together.

PLATE II.

14–15. *Saccharum officinarum.*

14. Photograph of the bifurcated shoot.
15. Transverse section of the primary axis showing combination of two axes.
16. *Pennisetum Typhoideum.*

Forked cobs showing types of binary and multiple fission.

17. *Brassica oleracea* var. *Caulorapa.*

Tuberous stems showing axillary proliferation.

18–21. *Linum usitatissimum.*

18. Fasciated plant with normal and fasciated branches and fasciated capsules.
19. Transverse sections of the stem of a normal plant.
20. Transverse sections at different levels of a fasciated branch.
21. *Garden Rose.*

Fasciated branch.

PLATE III.

22. *Daisy* with normal and fasciated stems.

23–24. *Eutoca viscida*

23. Normal plant.
24. Fasciated plant.

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14

15

f e d c b a

16

17

18

19 a b c d

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22.

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