Ascidia on the Leaf of Semecarpus Anacardium, Linn.

BY

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With five figures in the text.

Semecarpus Anacardium is a native of Asia and tropical Australia, and is particularly abundant in the mountainous region of India. It is known as the " marking-nut tree "—an extract made from the nuts being used for marking cotton cloth.

The plant on which these observations were made is now at the Royal Botanic Garden, Edinburgh, where it has been growing under glass at an average temperature of 60° F. Its present height is about 2 feet, with leaves from 5 to 7 inches long and 2 to 3 inches broad, although in its native habitat these may be as much as 30 inches in length, and 12 inches in breadth. They are oblong-ovate with an entire margin. The midrib gives off laterally many secondary veins which run parallel to each other, half an inch apart, and are connected by a network of small veins.

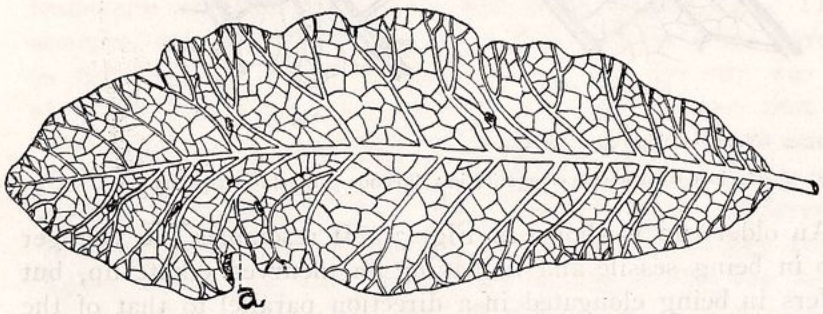

FIG. 1.—Lower Surface of Leaf with ascidia in early stages of development ; a, point of distortion of lamina. × ⅔.

For some years, the larger leaves have developed minute cup-like outgrowths or ascidia on their lower surfaces. These occur about midway between two secondary veins, and usually at about a third of the distance between the midrib and the margin of the leaf. The lamina of a leaf bearing these outgrowths becomes distorted and thrown into folds, especially where many cups are grouped together, and at these points growth in breadth is arrested. Fig. 1 is a drawing of a leaf of *Semecarpus* with

ascidial cups at an early stage of development, and at *a* distortion of the lamina is already beginning to show. The smallest leaf on the plant with outgrowths present was 4½ inches long; only one cup was borne on its under surface, and the lamina had not yet become distorted. The larger leaf which bore cups was 9 inches long and had 25 large cups on its under surface, in addition to many small ones. In this case the lamina was much folded and varied in breadth according to the number of cups present in any one area.

When the cups first appear, they are more or less circular in shape, and are 1 or 2 mm. in diameter, and 1 mm. in depth. Such a cup is shown in Fig. 2. It is sessile with a slightly incurved lip fringed with small hairs. The two secondary veins, between which the cup arises, are included in the diagram, and it will be observed that while the smaller veins show signs of being drawn towards the base of the cup, the secondary veins are still more or less parallel to each other, and the portion of the leaf which bears the cup has not yet become folded or arrested in growth.

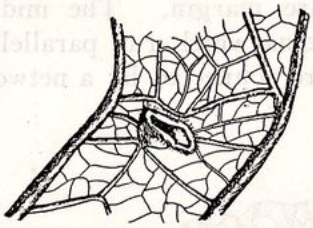

Fig. 2.

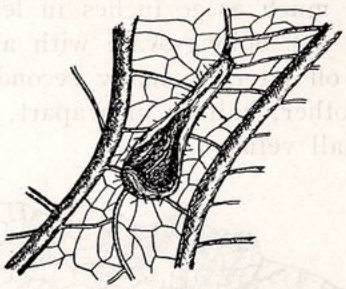

Fig. 3.

FIG. 2.—Young ascidial cup. × 5.

FIG. 3.—Ascidial cup showing elongation in a direction parallel to secondary veins. × 5.

An older cup is shown in Fig. 3. It resembles the younger cup in being sessile and in having an incurved ciliate lip, but differs in being elongated in a direction parallel to that of the secondary veins. Elongation of the cup takes place always in this direction, and at the same time the sides become deeper and somewhat frilled or folded. The largest cups had assumed this form and measured fully half an inch along their long axis. At this stage, not only do the veins of the network show the same arrangement in relation to the base of the cup as in Fig. 2, but the larger veins are also drawn in towards it. This disturbance of the vascular system occurs where any cup showing elongated growth is present, and in parts of the leaf where there are many such cups the arrangement of the originally parallel secondary veins has become so distorted that it is

scarcely recognisable. Since the larger veins remained parallel where the younger cup (shown in Fig. 2) was present, it may be assumed that the subsequent distortion of the leaf is due to the further growth of the cup, the presence of which in some way upsets the normal form of the leaf. Where the adult cups occur on the leaf that part of the lamina towards the margin is thrown into folds, and does not expand with the rest of the lamina.

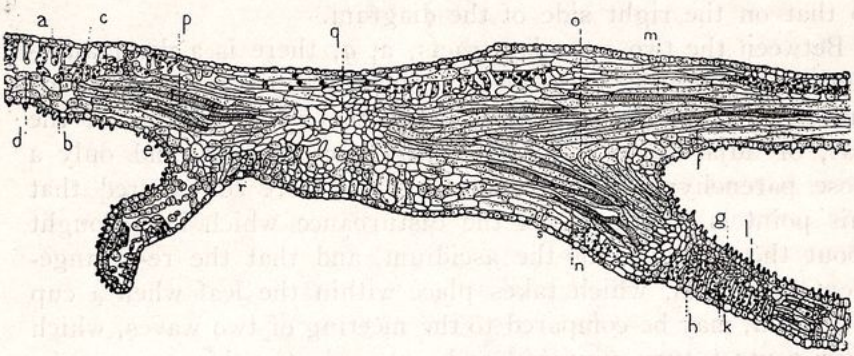

FIG. 4.—Transverse section of ascidial cup; a, upper epidermis of leaf; b, lower epidermis of leaf; c, palisade parenchyma of leaf; d, spongy parenchyma of leaf; e – f, area of attachment of cup to leaf; g, outer epidermis of cup; h, inner epidermis of cup; k, palisade parenchyma of cup; l, spongy parenchyma of cup; m, xylem of vascular strand in leaf; n, xylem of vascular strand in cup; o, cells showing curvature in vascular strand; p, vascular strand; q, area of disturbance in tissues; r – s, section of epidermis corresponding to the lower epidermis in Fig. 5. × 50.

To investigate the internal anatomy of the ascidia, serial transverse sections were cut through both cup and leaf. These sections, one of which is shown in Fig. 4, were made parallel to the direction of the secondary veins, i.e., the cup was cut along its long axis. In the section it will be seen that the upper epidermis is composed of elongated cells (*a*) with smooth outer walls, while the lower epidermis consists of cells with peg-like protuberances (*b*). The mesophyll shows differentiation into palisade parenchyma (*c*) above, and spongy parenchyma (*d*) below. The area of attachment of the cup to the leaf extends from *e* to *f*, and at either end of this area the sides of the cup (seen in section) extend downwards and outwards. These have on the outside an epidermis (*g*), similar in character to that of the lower surface of the leaf, and continuous with it, while on their inner surfaces, the peripheral cells (*h*) are like those of the upper epidermis of the leaf. In this respect, the ascidia obey the law of laminar inversion, i.e., opposed laminar surfaces are similarly constituted. Furthermore, reversal is seen to have taken place also in the mesophyll; thus at *k* the palisade parenchyma is next to the inner epidermis, and at *l* the spongy parenchyma is adjacent to the outer epidermis. Moreover, when the vascular supply to the wall

of the cup is examined it is found that whilst in the leaf the xylem (*m*) lies towards the upper surface, in the cup it lies towards the lower inner surface (*n*), the tissue having become distinctly curved at *o* before passing into the wall of the cup, and a reversal of the relative positions of xylem and phloem having resulted. In another section of the series, the vascular strand (*p*) at the left side of the diagram was seen to curve downwards into the left wing of the cup in a similar manner to that on the right side of the diagram.

Between the two vascular tracts, at *q*, there is a disarrangement of the tissues; no clearly marked palisade parenchyma can be distinguished either towards the upper surface of the leaf, or adjacent to the inner surface of the cup, and only a loose parenchyma is present. It is therefore conjectured that this point is the centre of the disturbance which has brought about the formation of the ascidium, and that the re-arrangement of tissues, which takes place within the leaf when a cup is formed, may be compared to the meeting of two waves, which after contact turn upwards and outwards (in this case downwards and outwards) together.

In order to determine if possible the cause and origin of these ascidia, sections were now made through a leaf which outwardly was unaltered and perfectly normal in appearance. These sections were cut in the same direction as before, i.e., transverse, and parallel to the secondary veins, and one of them is shown in Fig. 5.

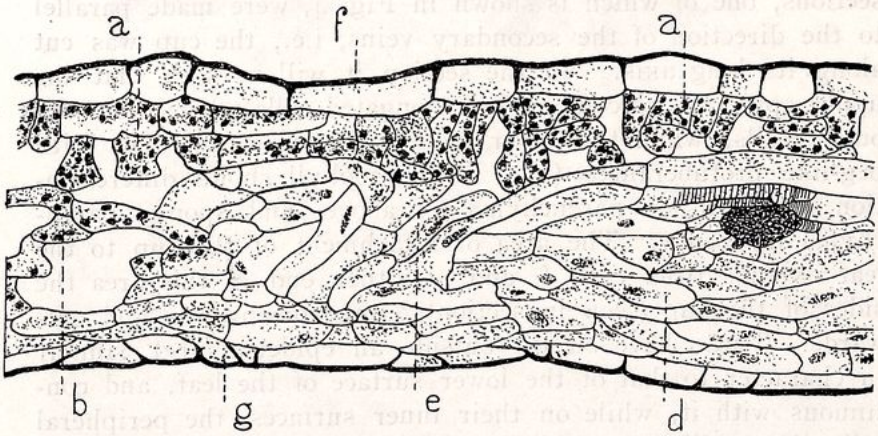

FIG. 5.—Transverse section of leaf; a, palisade parenchyma; b spongy parenchyma; d, tissue composed of elongated cells; e, point of contact of two "waves" of tissue; f, upper epidermis; g, lower epidermis. × 100.

Towards the extreme left of the diagram, a small portion of mesophyll is included which consists of palisade parenchyma (*a*) above, and spongy parenchyma (*b*) below. To the right of this the upper cells retain the characters of palisade cells,

but the spongy parenchyma has been replaced by a closely-packed mass of elongated cells (*d*). At *e* is the point of contact of two distinct curves in this tissue. These curves appear to have originated towards the upper surface of the leaf below the palisade parenchyma, to have met at the point *e*, and to have been continued towards the lower epidermis, inclined to it at an angle of 45°. This arrangement of the tissue shows a striking resemblance to that seen at the base of the adult cup in Fig. 4. The epidermis, both above and below, is composed of elongated cells, but when the section on either side of the part included in the diagram was examined, the lower epidermis was seen to consist of cells with peg-like outgrowths, similar to the cells of the lower epidermis of the leaf shown in Fig. 4.

Further examination revealed the fact that in all normal parts of the leaf the lower epidermis is " pegged " in character, and that only in the immediate neighbourhood of a disturbance in the mesophyll are the protuberances absent. It is therefore assumed that the abnormal lower epidermis in Fig. 5 is equivalent to the epidermis lining the interior of the adult cup in Fig. 4, from *r–s*, and might be regarded as representing the floor of a cup, the walls of which had not yet been produced.

There is no other record of the occurrence of ascidia on the leaves of *Semecarpus Anacardium*, and the examination of herbarium material failed to reveal any malformation of the leaves. There was no evidence that the ascidia on the leaves of the plant in question were due to insect bites. Phenomena of the same type have been observed in other plants, e.g., *Brassica oleracea*, where the outgrowths, stalked or sessile, may appear on either surface of the leaf, but usually arise from the midrib. Their formation is said to be due either to fission or fusion, the presence of a cup or pitcher, either as part or whole of the leaf, being considered to be the imperfect manifestation, in a superficial position, of a second leaf.

Had the two " waves " of tissue which meet in the formation of the cup in the case of *Semecarpus Anacardium*, come together in a direction at right angles to that of the secondary veins, it would have suggested the possibility of these cups being the first outward manifestation of an attempt to reproduce the pinnate type of leaf which is characteristic of some other members of the Anacardiaceae. The two parallel edges of an elongated cup would in that case represent the edges of two successive leaflets which have come together and have fused near their margins.

The opposing " waves," however, meet in a direction parallel to that of the secondary veins, and it therefore seems more probable that the formation of the ascidial cups is an attempt

by the leaf to increase its surface-area; the constitution of the organ having been upset, only malformations have arisen as a result of its mis-directed tissue-forming energies. Pitcher-formation by the whole leaf, and such cup-formation as is seen in the leaves of this *Semecarpus,* are placed in the same category as laminar outgrowths from the mid-rib, and all are considered to be forms of facial fission of the leaf.

It is usually accepted that all other types of foliar organs have been derived from the leafy sporophyll, and that modification of the leaf is a progressive phenomenon. Such phenomena have appeared in many forms and in many genera throughout the plant kingdom. In some cases they appear regularly, e.g., the formation of pitchers in *Nepenthes,* in other cases spasmodically, as for example, the formation of ascidia in *Brassica oleracea.* In the latter case, the production of ascidia on the leaf has not yet found a place among the definitely heritable characters of the species, and those plants exhibiting the phenomenon are therefore known as " sports." This would appear to be the case in this particular plant of *Semecarpus Anacardium,* the genetic constitution of which differs from that of the species in general, in that the plant exhibits a peculiar and progressive tendency towards an increase in the amount of its photosynthetic tissue, resulting in the production of these ascidia.

For the provision of facilities to carry out this work I wish here to express my indebtedness to Professor Wright Smith.

REFERENCES.

(1) Ghose, S.L. : An Example of Leaf-enation in Allium ursinum, Linn., New Phytologist, xxii, 1923, p. 49.
(2) Worsdell, W.C. : The Principles of Plant Teratology, Vol. II, 1916.
(3) Masters, M.T. : Vegetable Teratology, 1869.