ANATOMY OF THE PSEUDOCARP IN
ANACARDIUM OCCIDENTALE L.*

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Received January 13, 1964
(Communicated by Prof. V. Puri, F.A.SC.)

INTRODUCTION

Anacardium occidentale L., a native of Brazil, is one of the economically important species of Anacardiaceae. The tree bears a pear-shaped, yellow or reddish juicy “fruit”, the pseudocarp, which is the swollen pedicel and the disc. The true fruit is a reniform nut, borne on the distal end of the pseudocarp which together with the massive, plano-convex cotyledons are edible. The former is of special significance to the plant as it aids in the dispersal of the hard nut by birds.

Some aspects of this interesting plant have been worked out. The works of Sieck (1895) on the development of resin ducts, Sarin (1938) on the physiological behaviour of the wounded leaves, Ventura and Hollanda (1959) on the amino-acids present in the cashew apple, Copeland (1961) on morphology, floral anatomy and a few aspects of embryology, are worth mentioning. But no detailed work on the developmental anatomy of the pseudocarp is available and this is the justification for the present attempt.

MATERIAL AND METHODS

The pedicels of Anacardium occidentale at different stages of development were collected from Kerala State by one of us (T. M. V.) and fixed in formalin-acetic-alcohol. Usual methods of dehydration and embedding were followed and sections were cut at 10–14 μ and stained with safranin-fast green combination.

OBSERVATIONS

The young pedicel is slender and uniform (Fig. 1). But after fertilization it enlarges gradually together with the disc and form a succulent, juicy pseudo-
carp commonly known as cashew apple measuring up to 42–45 mm. at the distal end (Figs. 12, 14, 17, 19 and 24).

Serial transections of young pedicels were examined. Below the unilayered epidermis which is interrupted by a number of stomata (Fig. 8), there are a few layers of cortical cells with tannin. At the basal portion of the pedicel the vascular tissue forms a dissected siphonostele which at a higher level divides into a number of bundles arranged in a ring. A few bundles appear in the centre also. The former as well as the latter divide and redivide to form a number of bundles at the upper portion (Figs. 2–4). The division of the bundles is quite interesting. The vascular elements in the bundle expand laterally and shift gradually in opposite directions in such a way that the protoxylem elements usually face each other. Later on these elements group themselves into two or rarely more units and get separated by tanniniferous cells to form two or more bundles with the sister bundles having their protoxylem elements usually facing each other (Figs. 5–7). Thus there is a gradual increase in the number of bundles from base upwards (Figs. 2–4). There are a number of resin ducts dispersed throughout the peduncle. Usually these ducts occur on the outer side of the vascular bundles (Fig. 4).

As Copeland (1961) has pointed out the occurrence of resin ducts is a characteristic feature of the family Anacardiaceae. It is, therefore, interesting to note the development and nature of these structures. The number of ducts is more at the terminal portion of the pedicel than at the base. In the developing pseudocarp the number of ducts increases. As has been noted by Harada (1939) in young fruits of Rhus and Venning (1948) in Mangifera small groups of special cells were distinguishable from the neighbouring cells by their thick contents, and have been designated as precursors of resin ducts (Fig. 9). These form long columns in the pedicel, usually on outer side of the phloem. The layer of cells just outside these group of cells attains dark contents (Fig. 10), while the layer encircling the cells with thick contents divides by tangential walls to form 3–4 layers of cells. The cell-walls of the ‘precursor’ group of cells disappear leaving the contents inside the canals. When the pedicel grows to maturity the cells of the endothelial layer with thick contents breakdown as they fail to keep pace with the enlarging duct. Three to four layers of radially elongated cells just outside this layer form the endothelium during the later stages, and their tangential walls become stretched as the growth of the pseudocarp is in progress (Fig. 11). The enlargement of resin ducts has a significant role in increasing the bulk of the pseudocarp. Copeland (1961) noted that the pith region of the pedicel does
Figs. 1–11. Fig. 1. The developing fruit with the pedicel. Figs. 2–4. The transection passing through the portions marked in Fig. 1 as 1, 2, 3 respectively, showing the increase in bundles, resin ducts and definite distribution of tannin. Figs. 5–7. The mode of division of bundle. Fig. 8. Stoma in the epidermis of the pedicel. Figs. 9–11. The developmental stages of the resin ducts.
An Anatomy of the Pseudocarp in Anacardium occidentale L. not contain any resin duct. But during the present study resin ducts were noticed in the pith region also.

The growth of the pedicel is an interesting point to be noted. The bundles in most portion of the pedicel are concentric with the phloem surrounding the xylem and protoxylem group facing each other (Fig. 15). It is to be noted that most of the cells in the bundles, except the xylem vessels have compressed walls when the growth starts. Some of the cells outside the xylem vessels are well marked with prominent nuclei which are the procambial cells. These cells form more or less a discontinuous ring (Fig. 15). As the growth starts, the walls of the cells are stretched out and the cells with prominent nuclei enlarge and divide repeatedly increasing the bulk of the bundle, towards the xylem as well as towards the phloem. In the growing pseudocarp some of the bundles at the distal end get divided into two or more segments and each one behaves as a separate unit and grows independently to form concentric bundles, thus contributing to the enlargement of the pseudocarp (Figs. 20–21). After the pseudocarp attains about 22–25 mm. in diameter (distal end) the bundles stop its growth and the parenchymatous cells of the ground tissue around the bundles enlarge considerably (Figs. 13, 16, 18, 22 and 26). The enlargement of all the cell-walls is equal in earlier stages but subsequently the radial walls grow longer. The resin ducts also enlarge considerably by the elongation of the radial walls of the endothelium and surrounding cells. A group of parenchymatous cells constituting the disc at the distal end of the pseudocarp where the nut is attached become lignified (Fig. 23). The lignification of these cells is significant as it fortifies connection of the nut with the pseudocarp and hence helping the dispersal of the nut to distant regions by birds.

In a growing pedicel considerable changes take place in the amount and distribution of tannin also. The tannin contents are less in the young pedicel (Fig. 13). They increase gradually in quantity and when the pedicel starts enlargement 8–10 layers of the cells in the cortex, just below the epidermis and most of the cells separating the bundles are completely filled with tannin. Up to this stage the distribution of tannin follows a definite pattern (Fig. 16). Later on the tannin occurs in all cells except the vascular elements and the cells surrounding resin ducts (Fig. 18). After the pedicel attains 22–25 mm. in diameter the amount of tannin starts decreasing and when the pseudocarp approaches maturity, located only in the centre of the cells (Fig. 22). In mature pedicel (cashew apple) the tannin contents disappear completely and the cells become enriched with globular bodies probably glycogen (Fig. 26). At this stage the pseudocarp is edible.
Figs. 12–26. Figs. 12, 14, 17, 19 and 24. Developmental stages of the pseudocarp. Figs. 13, 16, 18, 22 and 26. Cells of the ground tissue from the portions marked 'a–a' in Figs. 12, 14, 17, 19 and 24 respectively. Figs. 15 and 25. Bundles from the portion marked 'a–a' in Figs. 14 and 24 respectively showing the contents. Figs. 20 and 21. The bundles from the portion marked 'a–a' in Fig. 19, for showing the segmentation and independent growth of the bundles. Fig. 23. Lignified cells of the disc from the portion marked 'b–b' in Fig. 19. Note: The marked cells in Fig. 15 are procambial in nature.
Anatomy of the Pseudocarp in Anacardium occidentale L.

DISCUSSION

The developmental anatomy of the pseudocarp of *Anacardium occidentale* is interesting in several ways, especially the increase in the size of the pedicel, in the development of resin duct and changes in the tannin contents at different stages of development.

Increase in the size of the pseudocarp is due to three factors. The growth up to 20–25 mm. diameter is chiefly due to the enlargement of the bundles brought about by some of the procambial cells around the xylem elements. However, the bundles at the distal end of the pseudocarp breaks up into several groups and each of them grows independently, contributing to the size of the pseudocarp. When the growth of these bundles almost stops, the parenchymatous cells throughout the pedicel enlarge rapidly. The increase in number and size of the resin duct is another factor which contributes to the enlargement of the pseudocarp.

There has been some difference of opinion as to the mode of formation of resin canals in Anacardiaceae. Engler (1896) described them as schizo-genous in the family Anacardiaceae, whereas Sieck (1895) who studied them in the mature fruits of *A. occidentale* referred to them as Schizo-lysigenous. Recent investigation of Venning (1948) showed that the development of these ducts is Schizogenous in the stems and leaves of *Schinus* and in the developing fruits of *Mangifera*. In the leaves and stems of *Spondias* and *Mangifera*, however, they develop Schizo-lysigenously. The development of resin ducts is lysigenous in the floral pedicels and receptacles in *Spondias* and *Mangifera*. The formation of resin ducts in the pedicel of *Anacardium occidentale* is lysigenous and thus resemble the condition in *Spondias* and *Mangifera*.

SUMMARY

The present work deals with the changes during the development of the Pseudocarp in *Anacardium occidentale*, which is morphologically the pedicel and the disc.

The number of bundles increases from the base towards the distal end in a peculiar way, which has been described in detail. Some of the bundles appear to arise de novo in the pith whereas the others form a continuous system from base to top.

The development of resin ducts in the pseudocarp is described in detail. They develop lysigenously.

The growth of the pseudocarp is also dealt with. There are three factors which helps in the enlargement of the pseudocarp (1) segmentation
and enlargement of the vascular bundles, (2) the enlargement of the parenchymatous cells in the cortex and pith and (3) the increase in number of the resin ducts and their enlargement.

The amount of tannin contents in the cortical and medullary cells was also studied. The tannin contents increase gradually up to the time when the pseudocarp is 22-25 mm. in diameter. Thereafter, they reduce gradually and disappear, completely.

ACKNOWLEDGEMENTS

The authors are highly thankful to Prof. V. Puri, D.Sc., F.A.Sc., F.N.I., for his valuable guidance, constant help and continuous encouragement. They are also thankful to Dr. Y. S. Murthy for his kind help in several ways and to Mr. Deshpal Singh for inking a few outline diagrams.

REFERENCES


Ventura, M. M. and Hollandia, L. I. .. "Free amino acids of cashew apples (*Anacardium occidentale* L.)" *Phyton*, 1959, 12, 31-34.

* Not seen in original.