Morphological patterns and histochemical profile in *Mimusops—Arrhenothrips* gall system

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Abstract. Morphogenetic changes involved in the gall leaves of *Mimusops elengi* Linn. (Sapotaceae) as a result of deliberate changes in the feeding sites of *Arrhenothrips ramakrishnae* Hood (Thysanoptera: Insecta) have been investigated. A comparative histochemical study of the normal as well as gall tissues revealed a higher incidence of protein, lipids, starch, tannins as well as enzymes such as acid phosphatase, peroxidase and polyphenol oxidase in gall tissues. Turgid hypertrophied cells in the gall mesophyll and their functional relationship with peroxidase evoke interest particularly in the context of the morphogenetic behaviour of gall-laminar under different experimental verifications, essentially because the causal relationship between the treatment with peroxidase and curling of root slices are known.

Keywords. *Mimusops; Arrhenothrips; galls; morphology; histochemistry.*

1. Introduction

The *Mimusops—Arrhenothrips* gall system provides a good example for the understanding of the morphogenetic phenomena involved in galling, both natural and induced. Though information is available on the biology of *Arrhenothrips ramakrishnae* (Varadarasan and Ananthakrishnan 1982) as well as on the ultrastructure of the nutritive zone (Raman and Ananthakrishnan 1983b) of the galls of *Mimusops elengi*, no attempt has been made to study the morphogenetic changes arising out of experimental induction of galls using numerically constant populations of thrips with deliberate attempts to change the feeding sites. Results presented here include (i) changes in gall faces due to alteration of feeding sites, (ii) morphological and anatomical changes involved in such reactions on the host and (iii) histochemical profile of the gall tissues in comparison with the normal tissues.

2. Material and methods

The *Mimusops elengi* galls in various stages of development were collected from the natural habitat and depending on their relative dimensions and approximate age in terms of days, supplemented further by population counts of the inhabiting thrips species, the galls were graded into various developmental stages as young (4–6 days), mature (14–22 days) and old (20–32 days). The material was fixed in FAA and cut at 7–10 μm for anatomical observations. Histochemical localisation of proteins, lipids, starch, tannins, condensed tannin precursors and also the enzymes such as acid phosphatase, peroxidase and polyphenol oxidase was made using fresh, hand-sections of normal and galled leaves in different developmental stages. Starch, lipids and proteins were localised following the techniques described by Johansen (1940),
Chiffelle and Putt (1951) and Wieme (1959) respectively. Tannin was localised using the method of Reeve (1959). Condensed tannin precursors were localised following the method suggested by Mace and Howell (1974). Activities of peroxidase, acid phosphatase and polyphenol oxidase have been localised following the methods of Isaac and Winch (1947), Gomori (1952) and Sexton and Hall (1978) respectively. The qualitative increase or decrease in the enzymes and other compounds was assessed in terms of the intensity of colouration and the relative degree of distribution in the host tissues.

To assess the role of thrips in gall induction, experiments involving the feeding of thrips on the lower side (abaxial side) of the leaf as against the natural conditions with *Mimusops elengi—Arrhenothrips ramakrishnae* system as a model were made. This system was used in view of the continued availability of the host plant material locally, and of existing knowledge about the biological details of *Arrhenothrips* (Varadarasan and Ananthakrishnan 1982). On identified young leaves of specific age, vaseline was smeared on the adaxial sides to restrict thrips feeding on the abaxial side which is not the conventional and natural site of feeding. Adequate controls were also maintained. In one of the experiments, the leaf tips (upto 3 mm) were cut and allowed to develop by restricting the feeding by thrips to the lower epidermis to find out any change in polarity. A minimum of 10 replicates of each experiment was conducted.

3. Observations

Gall development results from periclinal divisions of the primordial palisade cells and anticlinal divisions of the spongy mesophyll cells which later undergo expansion in the anticlinal axis. Concomitant with the feeding stimulus the galled leaves fail to open out and remain as fold-galls (figure 1A) harbouring *Arrhenothrips* in large numbers. The cecidogenetic process involves the inhibition of normal histogenesis followed by hypertrophy, hyperplasy and failure of laminar expansion (Raman and Ananthakrishnan 1983a).

Naturally developed *Mimusops* galls with varying populations revealed different levels of morphological alterations in the gall-forms (figure 2). Under unusual circumstances, as a result of the continuous feeding on the lower epidermis in the folded galls, another hypophyllous fold of one of the laminar margins became manifest (figures 1B and 2F,G), resulting in significant anatomical variations as compared with the naturally developed galls. The initial feeding stimulus on the adaxial side (upper epidermal cells) of young leaf primordia (figure 1C,D) resulted in the first folding of the lamina; simultaneous feeding on the lower epidermis constituted the second folding along the margin. Thus the tissue reactions were found to be different with the changes in the feeding sites: (i) on the upper epidermis—periclinal and anticlinal divisions of the palisade and spongy mesophyll cells together with the linear elongation of the cells (figure 3A–D,F), (ii) on the lower epidermis—a pattern of division exactly contrary to feeding along the upper epidermis (figure 3H), and (iii) on both the lower and upper epidermises—periclinal divisions in palisade as well as spongy mesophyll cells coupled with an elongation of the cells along the vertical axis (figure 3E,G,I).