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Epidermal Morphology of Five Leaf Galls Caused by Thrips (Insecta: Thysanoptera)

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Stomatal abnormalities of five leaf galls studied, induced by thrips, fall under two categories: (i) in the number of stomata per unit area, and (ii) in individual stomata.

Key Words: Thrips galls, Stomata, Epidermal morphology, Insecta, Thysanoptera

Introduction

Information pertaining to morphology of stomata under abnormal conditions like galls induced by fungi (Akai 1951, Meyer 1955) and insects (Kuster 1930, Meyer 1959, Schmidt & Meyer 1966, Raman & Devadas 1976) is available. Although internal organization and development of thrips galls have been extensively investigated (Krishnamurthy et al. 1975, 1977, Raman et al. 1978, Raman & Ananthakrishnan 1979), morphology of stomata has been discussed only with reference to galls on the leaflets of *Schefflera racemosa* Harms. induced by *Liothrips associatus* Ananthakrishnan and Jagadish, and *Liothrips ramakrishnae* Ananthakrishnan and Jagadish (Krishnamurthy et al. 1975). The present study describes the stomatal abnormalities of five leaf galls induced by thrips.

Material and Methods

Small pieces of normal and gall-leaves of *Casearia tomentosa* Roxb., (*Gynaikothrips flaviantennatus** Moulton), *Memecylon edule* Roxb., (*Crotonothrips dantahasta** (Ramk.)), *Mimusops elengi* Linn., (*Arrhenothrips ramakrishnae** Hood), *Pavetta hispidula* Linn.,(*Teuchothrips longus** Schmutz), and *Ventilago maderaspatana* Gaertn., (*Schedothrips orientalis** Ananthakrishnan) were treated in Jeffrey's macerating fluid and the epidermal peelings obtained were stained with aqueous safranin and mounted in glycerine.

*Gall Maker

Observations

In all the plant species studied the stomata on normal leaves occur restricted to the lower epidermis. *Casearia tomentosa*, *Memecylon edule*, and *Ventilago maderaspatana* showed anomocytic stomata with two guard cells (figures 1A, 2A, 3F) while *Pavetta hispidula* and *Mimusops elengi* exhibited paracytic and anisocytic stomata respectively (figures 3A,

4A). In *V. maderaspatana* two types of stomata were present in normal epidermis (figure 3F), one smaller than the other, perhaps giant stomata, although less frequent.

In galled epidermis both epidermal cells and stomata showed abnormalities in that the former showed stretching and hypertrophy, and the stomata were not uniformly distributed. With the concentration of stomata at specific regions, the stomatal index (table 1)

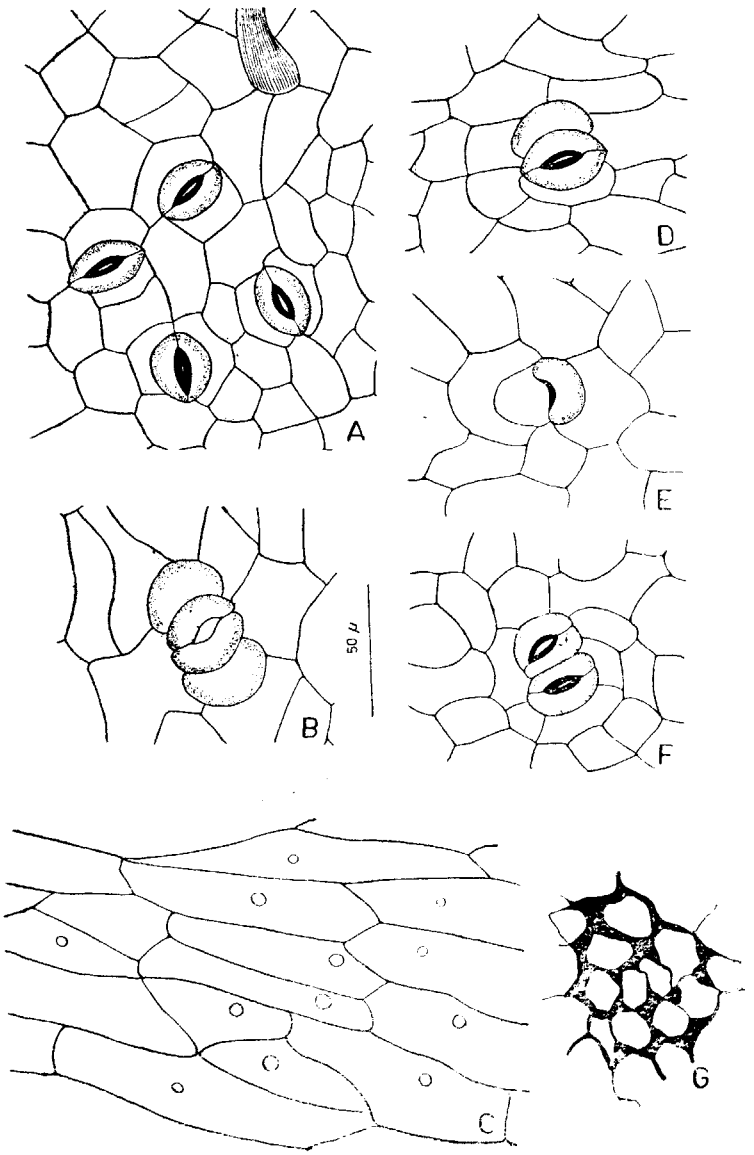

Figure 1A—G *Casearia tomentosa*. *A*, Normal epidermis; *B*, Stoma with two guard cells on each side; *C*, Epidermal hypertrophy; *D*, Stoma with two guard cells on one side; *E*, Stoma with single guard cell; *F*, Agglomerated stomata; *G*, Epidermal wall thickening

was low in gall epidermises. The stomata were shorter on the linear axis in galls of *Memecylon edule*, *Mimusops elengi*, and *Pavetta hispidula*, while it was the reverse in the galls of *Casearia tomentosa* and *Ventilago maderaspatana* (table 1). Except in *C. tomentosa*, in all the galls studied the stomata were narrower than those of the normal leaves (table 1). The giant stomata found in the normal leaves of *V. maderaspatana* were absent in the galled leaves.

Galls of *C. tomentosa* and *M. edule* revealed hypertrophy in epidermal cells suggesting the possible cause for the reduction of stomatal number. The stomatal abnormalities in thysanopterocecidia ranged from generally degenerated condition to stomata having more number of guard cells and subsidiary cells (figures 1 to 4). In all the thrips galls studied, the presence of stomata with single guard cell was a common phenomenon, although this abnormality was rare. In the case of *C. tomentosa* and *V. maderaspatana* there were abnormal thickenings on the walls of both epidermal and guard cells. Absence of ledge formation in guard cells was also evident during galling as in *P. hispidula* (figure 4D) and *V. maderaspatana* (figure 3E); on the other hand, unequal-sized guard cells were frequently observed in *M. edule* (figure 2B). In the normal leaves of *P. hispidula* the paracytic stomata were supported on one or both sides with a subsidiary cell, although the former was less frequent (figure 4A & E). But in gall leaves of this species the total absence of subsidiary cells leading to anomocytic condition (figure 4C) and presence of more than one subsidiary cell on one side (figure 4B) were also observed. Stomata with single guard cell as in *P. hispidula* existed with or without subsidiary cells (figure 4 F& G). In *M. edule* many of the stomata of gall leaves were reduced in size, without any pore. Besides, at certain places the undifferentiated guard mother cells and the

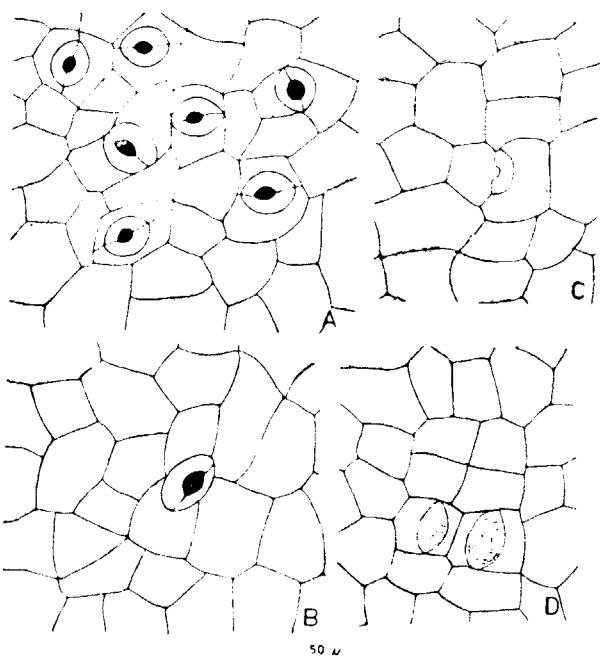

Figure 2A—D *Memecylon edule*. *A*, Normal epidermis; *B*, Stoma with unequal guard cells; *C*, Stoma with single guard cell; *D*, Degenerated Stomata

Table 1 *Stomatal index and dimensions* (*all measurements in* μ)

Name of the gall	Stomatal index		Stomatal length		Stomatal width	
	Normal	Gall	Normal	Gall	Normal	Gall
Casearia tomentosa	15.29±2.57	6.74±6.7	24.59±3.66	31.78±3.95	17.40±1.64	24.36±5.8
Memecylon edule	21.82±2.82	10.23±6.47	22.74±3.42	20.65±2.55	18.33±1.71	17.40±2.26
Mimusops elengi	12.28±2.64	6.69±2.56	24.59±3.66	18.10±4.99	17.40±1.22	12.76±5.5
Pavetta hispidula	20.71±5.38	13.94±4.1	26.68±2.73	23.20±2.68	15.54±1.12	14.62±1.12
Ventilago maderaspatana	16.22±2.94	6.86±3.58	16.94±1.57 25.29±2.3*.	18.56±2.68	12.99±1.2 18.56±1.55*	10.44±1.97

*Giant stomata (*V. maderaspatana*)

subsidiary cells were greatly enlarged (figure 3B). Among all the thrips galls studied, *C. tomentosa* showed the maximum abnormality (figure 1). In the gall-epidermis the stomata showed both reduction and increase in the number of guard cells, from one guard cell organising ½ stomata, to stomata with two guard cells as that of normal epidermis, as well as with two guard cells restricted to one side developing a 1½ stomatal condition, and with two guard cells on each side of the stomatal pore. Further, agglomeration of stomata was also evident in *C. tomentosa* (figure 1F). At certain regions of the gall epidermis there was a distinct thickening of the cell wall (figure 1G), while in certain other regions, there was extensive stretching of the epidermal cells (figure 1C). In *C. tomentosa* alone the epidermis occurred with trichomes. No marked change with reference to the length and number of cells of trichomes between galled and normal epidermises was evident, while the frequency of trichomes in normal and galled epidermises did show variations; in the former the number/0.88 sq mm was 46.3 ± 4.88 while in the latter it was 27.3 ± 5.83.

Discussion

In thrips galls, the abnormalities in relation to stomata caused by the cecidozoan are manifested in two levels: (i) in the number of stomata per unit area, and (ii) in individual stomata. In all the thrips galls studied, there is a reduction in the stomatal index and

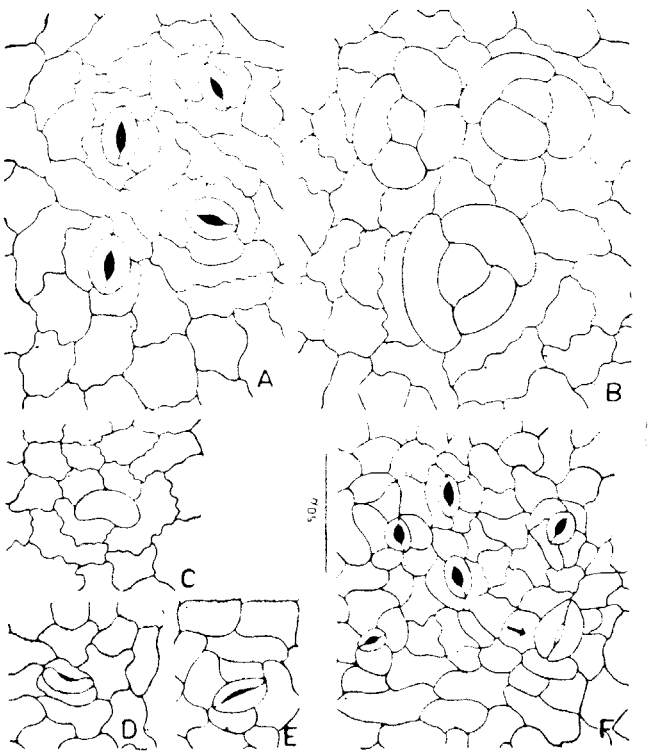

Figure 3A—F A—C *Mimusops elengi*; D—F *Ventilago maderaspatana*. *A & F*, Normal epidermises; *B*, Hypertrophied stomatal initials, *C & D*, Stomata with single guard cell; *E*, Absence of ledge formation in one guard cell (arrow—giant stoma)

the concentration of stomata at specific areas; similarly, in the leaf galls of *Rivea hypocrateriformis* Choisy caused by *Asphondylia riveae* Mani, the sparse occurrence of stomata with reduced stomatal index was reported (Raman & Devadas 1976). Hypertrophy of the epidermal cells could have resulted in the sparse distribution of stomata with consequent reduction in the stomatal number per unit area. But in the rugose zones of the gall epidermis, the stomatal concentration is especially significant. Degenerated and underdeve-

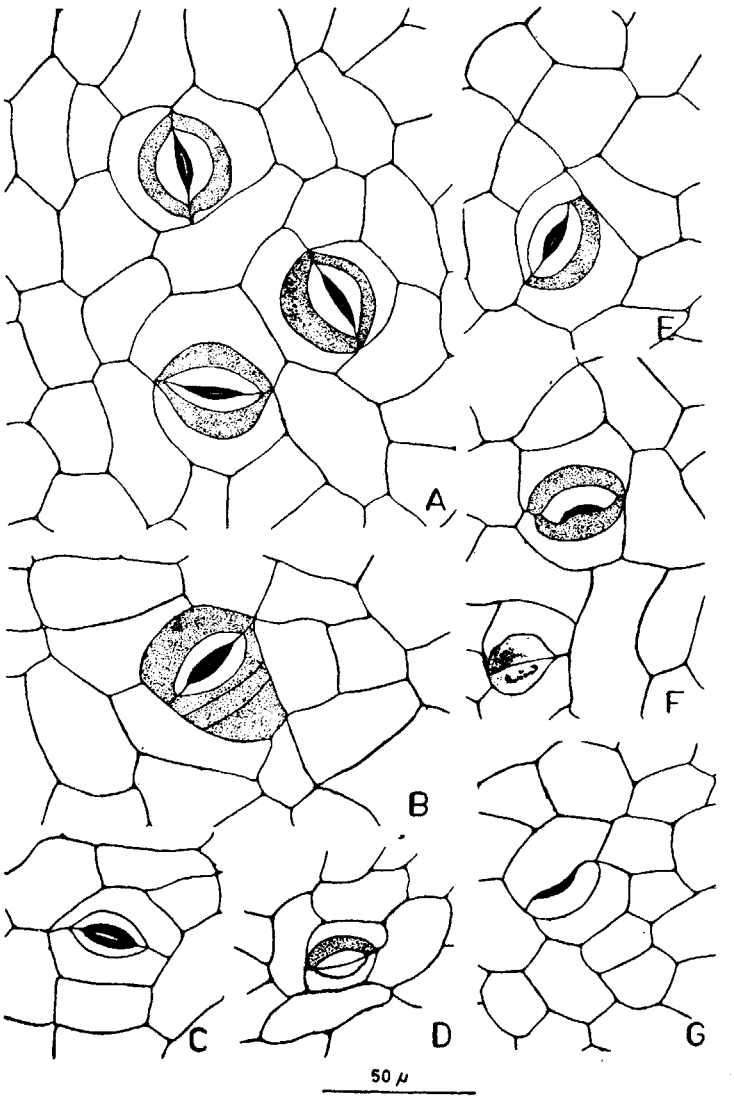

Figure 4 A—G *Pavetta hispidula*. *A & E*, Normal epidermises; *B*, Stoma with three subsidiary cells on one side; *C*, Anomocytic stoma; *D*, Stoma without ledge; *F*, Paracytic stoma with single guard cell and degenerated stoma; *G*, Anomocytic stoma with single guard cell

loped stomata, reduction and increase in number of component parts like guard cells and subsidiary cells, and variation in the dimensions of the stomata are the abnormalities met with in individual stomata, although dimensional variation of stomata in thrips galls does not seem to fall under definite pattern.

Degeneration of stomata, well-pronounced in *Memecylon edule* is possibly due to the infection after stomata have differentiated from the initials, while the underdeveloped stomata resulted from an early stage of infection as observed in *Mimusops elengi*, where the guard initials showed no differentiation but hypertrophied along with subsidiary cells. The presence of agglomerated stomata in the case of *Casearia tomentosa* indicates the possible isogenic origin of these stomata from a single stomatal mother initial as a result of infection at a very early stage of leaf differentiation which could have divided into two initials having the same potency to develop into separate stomata, since such an isogenic origin is not infrequent in gall-conditions. Meyer (1955) had observed isogenic origin of stomata resulting in multiplication in their number in galls caused by *Pernspoora parasitica*, and Schmidt and Meyer (1966) have observed in *Livia juncorum* galls caused on *Juncus articulatus* L., isogenic origin of adjacent stomata. The presence of more than one guard cell and subsidiary cell restricted to one of the sides is interesting and this is possibly due to infestation during later stages of stomatal development which has already developed guard and subsidiary cells and has lost the potential to become complete stomate. Occurrence of single guard cell in thrips galls may be due to the failure of the guard initial to divide into two before differentiating into guard cells.

Acknowledgement

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