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Histological study of anomalous growth in the stem of *Momordica charantia* infested with *Lasioptera bryoniae* Schiner

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Abstract
Gall formation due to attack of the larvae of *Lasioptera bryoniae* Schiner is common on the stem of *Momordica charantia.* Histological changes have been studied. Isolated patches of secondary meristematic centres develop throughout the proliferated tissue and they often differentiate into vascular tissues (either xylem or phloem or both). The larvae bore through the stem and live in lysigenous cavities in the ground tissue. Proliferation of cells of the secondary meristematic centres results in gall formation and the normal vascular pattern is disturbed and vascular bundles crushed. Development of mechanical tissues in the affected region is suppressed.

Keywords: anomalous growth, *Lasioptera bryoniae* Schiner

Introduction
Vegetables are major constituents of human diet but are more prone to pest attack mainly due to their tenderness and softness than other crops. In India, vegetable productivity is limited mainly by pests and insect pests inflicting crop losses up to 40 % (Srinivasan, 1993) [5]. Bitter gourd is an important vegetable crop because of both nutritional as well as medicinal properties. It was infested by many insect pests which affect the yield among that recently bitter gourd gall midge became major pest in Coimbatore (Muthukumar *et al*., 2017) [2] and natural enemies have been reported by (Muthukumar *et al*., 2018) [3]. The mosquito like fly lays its egg inside the tender shoots. The developing maggots inducing sophisticated gall by producing long, tubular galls at the distal end of young shoots affecting the growth of the plant (Muthukumar *et al*., 2019) [4]. The anatomy of the of the gall induced by the gall midge has not studied. The present study aims at an analysis of the histological changes which accompany gall formation.

Materials and Methods
Anatomy of galled shoots
The galls induced by the *L. bryoniae* in different parts of the plant (Plate 1) was collected from the field. The galled shoots were preserved in formalin-acetic acid- alcohol mixture (9 parts 70% ethyl alcohol, 0.5 parts 40% formalin and 0.5 parts glacial acetic acid). Hand sections of wax embedded galls were made at different loci using a razor blade. Sections that were ~50–60 µm thick were stained with safranin, mounted on microscopic slides in glycerol and captured the structure of galled shoots through image analyser (Model - LEICA M205 A, Made in Germany). The observation on number of vascular bundles, its measurement of length and width was carried out both in galls and ungalled shoots for comparison. In addition, the size of the parenchymatous cells covering the life stages of gall midge was also measured (Plate 2).

Results & Discussions
Anatomical sections of gall
The number of vascular bundles in ungalled stem was high (9) whereas in galled shoots the number of vascular bundles was lower which ranged 8 – 6 with different gall ages 5 DAGI (Days after Gall Initiation), 10 DAGI and gall after the emergence of adult. The leaf petiole gall possessed seven vascular bundles. The linear measurement of vascular bundles in µm of ungalled shoots, 5 DAGI, 10 DAGI, gall after emergence of adult midge, leaf petiole gall and ungalled leaf petiole was 0.150, 0.254, 0.220, 0.214, 0.320 and 0.349 respectively. The width of the vascular bundles in µm in ungalled shoots, 5 DAGI, 10 DAGI, gall after emergence of

gall midge, leaf petiole and ungalled leaf petiole was 0.125, 0.093, 0.090, 0.082, 0.200 and 0.190 respectively (Table 1).

Likewise the distribution and size of the vascular bundles in a fully developed gall at three different loci were observed. Gall at the proximal end contain nine vascular bundles which was 0.148 µm long and 0.127 µm wide, middle portion had 7 vascular bundles with length of 0.240 µm and width of 0.085 µm. The top portion of gall at distal end recorded six vascular bundles measuring length of 0.240 µm and a width of 0.090 mm (Table 2).

Anatomical section of the gall owing to the development of *L. bryoniae* indicated the reduction in the number of vascular bundles in the galled shoots as compared to ungalled shoots and also in leaf petiole. In addition, the derangement of the vascular bundles in galled shoots was also observed due to extension of length and compression of width as against the normal ungalled shoots. These histopathological happenings might have arrested the nutrient flow to the growing meristem resulting in the arrestment of further growth of galled shoots. Similar disturbances in the vascular pattern and cellular differentiation was also noted in *Coccinia indica* by the *Neolasioptera cephalandrae* (Unni *et al*., 1991) [6]. The formation of larval cavity due to the lysis of the ground tissue by cellulose degrading enzymes present in the saliva of the insect also diffuse into the plant tissue during feeding leading to the derangement of vascular bundles. In addition, the growth of developing immatures in the central cavity push the outer layer of cells outward leading to compression of cells around the nutritive tissue. This development leads to the compression of vascular bundles resulting in elongated galls measuring longer and thinner vascular bundle tissues. The reports of Mani (1964) [1] on the disturbances of vascular bundles in gall shoots of cucurbitacea supports the present finding.

Acknowledgement

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Conflict of Interest

Authors declare that there is no conflict of interest

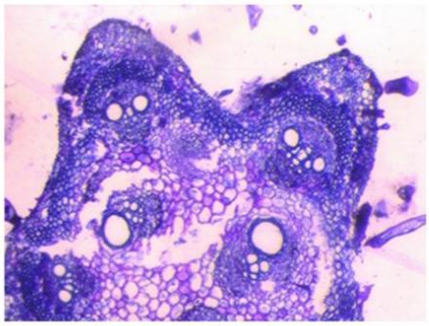
Table 1: Anatomical study of the gall sections (Single gall)

Stage (10 days old gall)	No of vascular bundles	Length (µm)	Width (µm)
Stem			
Lower	9	0.148	0.127
Middle	7	0.240	0.085
Top	6	0.240	0.090
Leaf Petiole			
Lower	8	0.310	0.190
Middle	7	0.245	0.218
Top	7	0.222	0.194

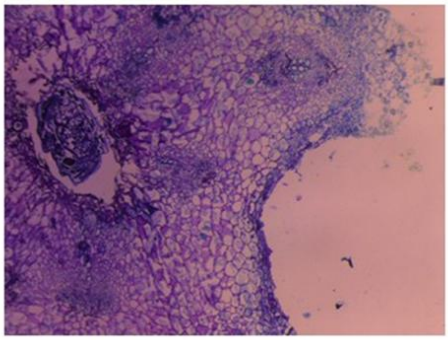
Table 2: Anatomical study of the gall sections (Different gall)

Stage	No of vascular bundles	Length (µm)	Width (µm)
Ungalled	9	0.150	0.125
5 days after gall formation	8	0.254	0.093
10 days after gall formation	7	0.220	0.090
Adult emerged gall	6	0.214	0.082
Ungalled leaf petiole	8	0.320	0.200
Leaf petiole	7	0.349	0.190

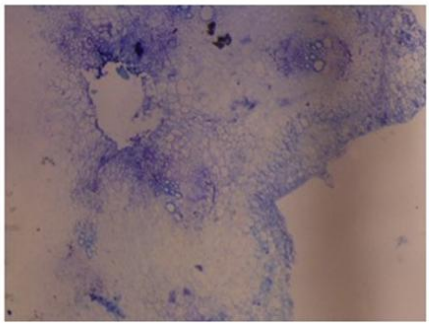
Damage Symptoms of *Lasioptera bryoniae*



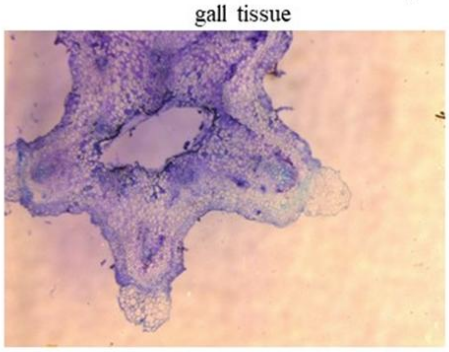
Vascular bundles in normal ungalled tissue



Reduced size of vascular bundle in 5 day old gall tissue



Derangement of vascular bundle in 10 days old gall tissue



Reduced size of vascular bundle in matured gall tissue

Anatomical study of gall

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