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Studies on Psyllidgall of two selected plants

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Abstract

Objectives: The mechanism underlying the morphological and structural specificity of galls attributable to particular insect species is very little understood. The present study is a fragment of the galls found in the Nilgris and Courtallum Hills in India and the study has offered some interesting results and conclusions.
Methods / Statistical Analysis: A comprehensive study on two leaf galls exhibiting evidently different ontogenetic sequences is attempted in the present investigation.
Findings: We studied histology of maturefoliar galls on two host plants caused by different insect species. The pit-gall on *Mallotusphilippensis* is simple in structure with homogeneous parenchymatous tissue. The galls on *Alstoniascholaris* and *Magniferaindica* are more complex in structure.
Application / Improvements: Cecidological studies gain popularity nowadays as they form the most conspicuous elements of the terrestrial ecosystem. The role of the insect behavior is considered as the major factor in determining the form and structure of the gall that an insect incites.

***Keywords*:** Plant gall, Leaf gall, Psyllid, *Alstoniascholaris*, *Mallotusphilippensis*.

1. Introduction

The galls are externally visible expressions resulting from a series of biochemical and biophysical reactions occurring in plant tissues due to infection of parasitic organisms [1, 2].Galls occur on all parts of the plants. Among the aerial organs, leaves dominate over other organs in number, structural complexity and morphological diversity of galls as well as the association of so many diverse groups of gall organisms. On the basis of the morphological and anatomical features, the galls may be grouped into different types [3]. The distribution of galls in India presents some interesting features [4]. There are certain galls, which are countrywide in distribution, while others are restricted in their occurrence. The Western and Eastern Ghats, the vindhya and satpura regions, the chota-Nagpur plateau, Assam and the wooded slopes of the Himalayas represent the places of richest gall development [3]. The developments of the gall were described by [5]. The homoptera order includes many important gall insects which belong to the families *Chermidae (Psyllidae), Aphididae, Phylloxeridae, aleurodidae*and *Coccoidae.* Of all these groups, the psyllids constitute major group of insects responsible for the scrub forest galls. They induce galls on the leaves and the galls are mostly **pouch** type or **Pouch-cum-covering-growth** type. The Psyllids are major groups of cecidozoa and more than 350 psyllids have been reported to be cecidogeneous in the world [4]. A total of 41 gall-forming species belonging to various subfamilies of pshyllidae have so far been recorded from India [6]. They induce galls, mostly on leaves of different plants.

2. Materials and methods

The galls for the present study were collected from Courtrallam deciduous forest of Tamil Nadu. The plants were identified with the help of Flora of Madras Presidency [7]; Flora of Madras City and its neighborhood [8, 9]; Flora of Tamil Nadu [10, 11]. Latest nomenclature of the plants was followed as per "The Plant Book by [12]**".**Collections were made by visiting the above place during the following periods, June, August, September 2013 and June, July, August 2014.Both normal and affected plant parts were collected in the field. Herbaria of these plants were also prepared and used for further identification or reference. The leaves with mature galls and also those of normal ones were separately fixed in FAA (Formalin Acetic Acid-Alcohol). Fresh materials were used for morphological study and photography. The requisite materials were passed through the tertiary butyl alcohol series [13]-[16] for dehydration and embedded in paraffin wax. Serial sections were cut with the help of a rotary microtome, at 10-15 mm thickness.

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The slides were stained with different staining schedules like (I) tannic acid and ferric chloride with safranin[17], (ii) Safranin and fast green schedule [13], [18]. Photographs of both normal organs and different galls were taken with the help of "NIKON Lab Photo - 2 Microscopic unit and Motic microscopic unit [19].Mature galls and corresponding normal organs are observed under bright field and crystals under polarized light, were photographed. Magnification of the figures is indicated by scale-bars. The various Photographs, indicating the salient anatomical and morphological features are appended in plates.

3. Observations

(A) *Alstoniascholaris* R.Br. (Apocynaceae)
Gall Incitant: *Pauropsyllatuberculata*Crawf. (Homoptera)
Occurrence:Nilgiris, Common.
Gall type : Covering growth pouch gall

(i) **Morphological description**is shownin figure 1.

The gall is **covering growth pouch gall**. Semi-globose, conical or blunt, rounded on one side of the leaf and truncated conical on the other side. About 2.5 mm at the tip and 3 mm at the base; the conical part beneath the leaf is 5 – 6 mm long. Mature galls are yellow, younger galls are pale green; glabrous, hard, scattered all over the lamina; sometimes found as a covering growth on the petiole and stem. Ostiole narrow in young galls; wide open as a circular hole at the summit of a truncated cone.

Figure 1. Alstoniascholaris(L.) R.Br. (Apocynaceae)

1. Adaxial view of the galls showing hemispherical part, 2. Abaxial view of the gall showing the ostiole

(ii) **Anatomy of the gallis** shown in figure 2.

(a) Normal Leaf lamina T.S: The leaf has fairly thick adaxial epidermis with squarish thick walled epidermal cells; the cuticle is also thick. The abaxial epidermis is thin; the outer tangential walls have prominent knob-like tubercles. The mesophyll consists of upper zone of palisade cells and lower zone of spongy parenchyma. The palisade cells are vertically high and cylindrical; the vascular bundles of the lateral veins are situated in the median part of the mesophyll; they have a whorl of parenchymatous bundle sheath cells.

(b) Gall Portion: The gall consists of partly pouch and partly covering growth. The palisade tissue has undergone extensive *hyperplasia* and *hypertrophy* and contributed to the bulk of the gall. The palisade cells, which are single layered in the leaf, has undergone repeated periclinal divisions giving rise to nearly 15 – 20 radially aligned oblong cells. The derivatives of the palisade tissue form compact outer zone of the hemispherical part of the gall. The epidermis does not undergo same rate of proliferation as the palisade cells; due to surface expansion, the epidermal cells of the upper face of the gall get collapsed forming a thin dark line on the outer surface of the gall. The sub-epidermal cells beneath the obliterated epidermis divide by periclinal walls forming a narrow zone of periderm like outer boundary.

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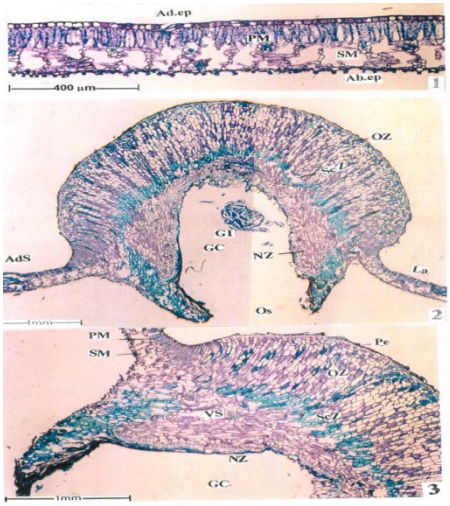
(Ab.ep-Abaxial epidermis; Ad.ep-Adaxial epidermis; AdS-Adaxial side; GC:Gall chamber; GI-Gall insect; La-Lamina; NZ-Nutritive zone; OS-Ostiole; OZ-Outer zone (Parenchyma); Pe-Periderm; PM-Palisade mesophyll; ScZ-Sclderotic zone; VS-Vascular strand)

Figure 2. Alstoniascholaris(L.) R.Br. (Apocynaceae)



1. TS of normal leaf.2. Vertical Section of the gall.3. A Sector of the gall enlarged.

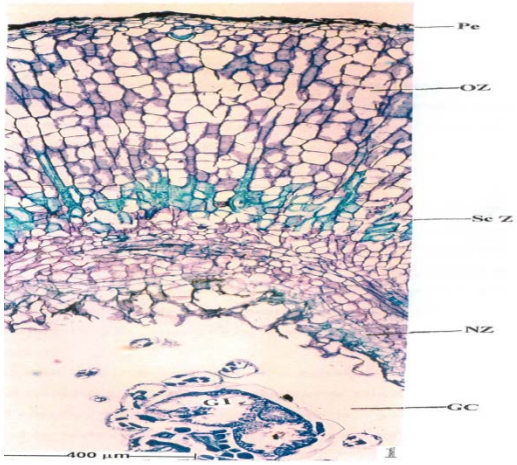
The spongy parenchyma cells have undergone divisions by anticlinal walls followed by vertical stretching. As a result, the spongy parenchyma tissue becomes compact and the cells are vertically oriented forming the cover-cone part of the gall as shown in figure 3. The larva, which is invariably single per gall, feeds on the cells bordering the gall cavity. The surface cells of the gall cavity develop a less conspicuous *meristematic zone*. Broken cells are seen all around the gall cavity. The cells of the ostiole are disintegrated and **form a dark** zone at the ostiolar passage shows in figure. 3.

Comparative measurements of leaf and gall tissues:

Lamina total thickness – 250µm; Palisade tissue thickness -150 µm; Spongy Gall – Total thickness -1.5 mm; Thickness of tissues formed by the palisade tissue -1 mm; Thickness of tissue formed by the spongy parenchyma - 0.5 mm.

The zone at the junction of the palisade derivatives and the spongy cells derivatives differentiate into rectangular to cubical sclerenchyma cells and forms the sclerotic zone. The tissue overarching the gall cavity is rich in cell contents and it provides the nutrition to the insect. The nutritive zone shrivels as the insect leaves the gall.

Figure 3. Alstoniascholaris(L.) R.Br. (Apocynaceae)



A sector of vertical section of the gall.
(GC-Gall chamber; GI-Gall insect; NZ-Nutritive zone: OZ-Outer zone (Parenchyma); Pe-Periderm; ScZ- Sclerotic zone)

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(B) ***Mallotusphilippensis***Muell. (Euphorbiaceae)
Gall Incitant:*Phylloplectasp*.Homoptera(Psyllid)
Occurrence:Courtallum Hills.
Gall type:Pit gall

(i) **Morphological descriptionis** shown in figure 4.

Pit gall; epiphyllous, circular, dot-like raised above the adaxial surface; pale yellow; on the abaxial side the gall appears as shallow pits filled with same type of trichome as on the lamina. About hundred galls occur per leaf; mostly solitary, also crowded together shown in figure4, but not agglomerate. The injested plants are rare in occurrence.

Figure 4. Mallotusphilippensis (Lam.) Muell. (Euphorbiaceae)

Leaf showing irregular pit gall.

(ii) **Anatomy of the gall**

(a) Normal Leaf lamina T.S:

Dorsiventral, adaxially flat, abaxially ridged and furrowed; stellate or dendroid type of epidermal trichomes abundant all over the abaxial surface is shown in figure5. Adaxial epidermal cells broad and tabular; abaxial epidermal cells small and squarish. Mesophyll tissue less differentiated, mostly of vertically elongated compact cells; **vascular bundles** situated in the ridges; each bundle has parenchymatous bundle sheath and extensions.

(b) Gall Portion.

Adaxial epidermal cells slightly increased in thickness; mesophyll tissues have undergone divisions at random, producing fairly large, compact parenchyma cells. Vascular elements scattered; bundle sheath cells have also undergone proliferation loosing their identity. Epidermal trichomes are less in density, but well developed.

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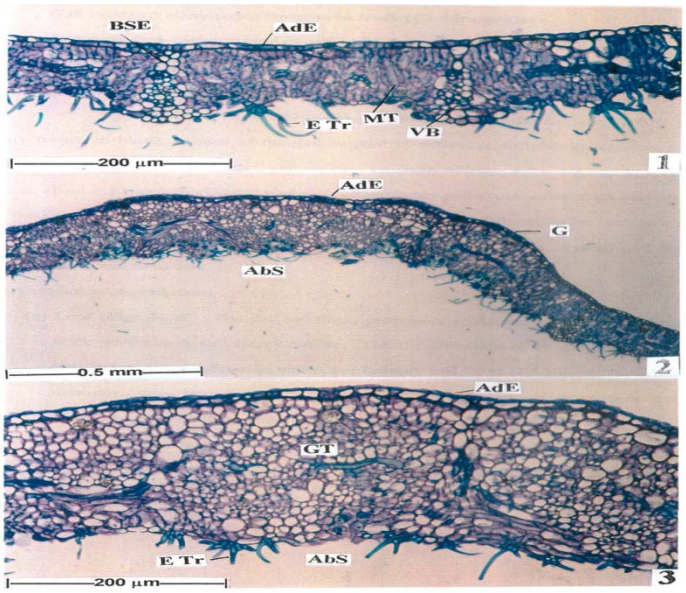
Figure 5. Mallotusphilippensis (Lam.) Muell. (Euphorbiaceae)



1. TS of normal leaf.2. TS of gall showing proliferated bundle sheath parenchyma.
3. TS of gall – a sector enlarged showing well developed trichomes.

(AbS-abaxial side; AdE-Adaxial epidermis; BSE-Bundle sheath extension; ETr-Epidermal trichome; G-Gall; GT-Ground tissue; MT-Mesophyll tissue; VB-Vascular bundle)

Comparative measurements of leaf and gall tissues:

Normal Lamina	:	Adaxial epidermis – 10 µm; Abaxial epidermis – 1µm;Mesophyll tissue – 100 µm.
Gall	:	Adaxial epidermis – 20 µm; abaxial epidermis – 12µm; Mesophyll tissue – 240 µm.

4. Discussion

The present study is made on the foliar galls deals with the histology of mature galls on two host plants caused by different insect species. The pit-gall on *Mallotusphilippensis* is simple in structure with homogeneous parenchymatous tissue. The galls on *Alstoniascholaris* and *Magniferaindica* are more complex in structure. They have inner nutritive zone surrounding the gall cavity, middle sclerotic zone and outer parenchyma zone. Calcium oxalate crystals in some galls observed under polarized light appear to be more abundant in the gall tissue than in the normal tissue. The physiological nature of the insect stimulus and of the plant response is still an open question. It is here that further investigation is required. Because of regulated growth and also because a large part of insect life cycle is completed within, galls are useful as ideal laboratory models for both ecologist and evolutionary biologists to creatively interpret and even manipulate plant strategies [20]-[24].The increasing diversification of defense mechanism in plants tends to promote new exploitation strategies in insects, and a lot of research needs to be done in this direction. The mechanism underlying the morphological and structural specificity of galls attributable to particular insect species is very little understood. The role of the insect behavior is considered as the major factor in determining the form and structure of the gall that an insect incites. The chemical nature of the carcinogenetic stimulus and the inbuilt responsive potentials of the host plant at molecular and sub cellular levels do play equally significant role in determining the specific morphology of the gall. Even if the Cecidogentic factors are understood, the mechanism that operates during cecidogenesis is beyond our present state of understanding. As in puts it, 'It would seem that we are on the threshold of deeper understanding not only of the mechanism of gall formation but also plant processes of much broader implication'.

5. Conclusion

The mechanism underlying the morphological and structural specificity of galls attributable to particular insect species is very little understood. The role of the insect behavior is considered as the major factor in determining the form and structure of the gall that an insect incites. The chemical nature of the cecidogenetic stimulus and the adult responsive potentials of the host plant at molecular and sub cellular levels do play equally significant role in determining the specific morphology of the gall.

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