

Effects of Mites infestation on foliar galls

Gopi M

Assistant Professor & Head, Department of Plant Biology and Plant Biotechnology, Guru Nanak College (Autonomous), Velachery, Chennai, India.

Email: gopilmk74@gmail.com

Manuscript details:

Available online on <http://www.ijlsci.in>
ISSN: 2320-964X (Online)
ISSN: 2320-7817 (Print)

Cite this article as:

Gopi M (2022) Effects of Mites infestation on foliar galls, *Int. J. of Life Sciences*, Special Issue, A19: 25-32.



Article published in Special issue of Darwin - 2021: An international Conference (2nd one of the India's Biggest evolutionary Movements in Biology organized by Somaiya Vidyavihar & Riidl on 2nd to 5th December 2021.



Open Access This article is licensed under a Creative Commons Attribution 4.0

International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third-party material in this article are included in the article's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this license, visit <http://creativecommons.org/licenses/by/4.0/>

ABSTRACT

Plant Galls are exomorphically varied in size and outline and also vary in their topography on the plant body. The gall forming agents are called *Cecidophyta* (Bacteria, Fungi, algae, seed plants) or *Cecidozoa* (insects, mites, nematodes worms etc.). The present study pertains to a preliminary survey of certain mite galls in different parts of Kavalur Hills at Thirupatur District, Tamil Nadu, India, namely, *Acacia caesia* W. & A., *Alangium salvifolium* (L. f.) Wang. and *Commiphora caudata* Engl. The causative agents of these galls were belonging to mites. Mites have for long escaped detection because of their minute size, despite their occurrence for well over 50 million years. Mites are the most diverse and abundant of all arachnids belonging to the order Acarina. The eriophid mites occupy a significant place and produce galls of different complexities. Mites may infect any aerial organ of the plant leading to felty outgrowths, witches brooms, pouches and covering growth galls. Phytophagous mites not only damage food crops and fruits but also induce galls on plants. The organ of the host plants involved in galling is leaves only. Of the different plant organs which undergo galling, the leaves are the most susceptible organ, whereas the buds, veins and petioles are less affected. These various types of galls have been vividly described and compared, with normal plant organs in the observational part of this research paper. With over 5,00,000 species of insects and 2,50,000 species of plants and over 300 million years of evolutionary history on insect plant interactions.

Keywords: *Acacia caesia* W. & A., *Alangium salvifolium* (L. f.) Wang. and *Commiphora caudata* Engl., Foliar galls, Mites

INTRODUCTION

Man's knowledge of plant galls dates back to the seventeenth century. Marcello Malpighi seems to have initiated the scientific inquire of these neo-plastic outgrowths (Gopi, 2018). Cecidology as a separate discipline of biological significance was first founded by Prof. M. S. Mani.

Mites are the most diverse and abundant of all arachnids belonging to the order Acari. They are very small, microscopic (usually less than 1 mm) arthropods (Gopi, M, 2021) with oval or elongated body; unsegmented abdomen which is often attached to the cephalothorax. The adult has four pairs of legs, although some have only two or three pairs. The mouthparts, called chelicera are adapted for piercing, sucking and lacerating (Channabasavanna, 1981). The present study pertains to a preliminary survey of certain mite galls in different parts of Kavalur Hills at Thirupatur District, namely, *Acacia caesia*, *Alangium salvifolium* and *Commiphora caudata*.

MATERIAL AND METHODS

The materials for the present investigation were collected from Kavalur District at different seasons of the year. The leaves with galls and requisite normal leaf were fixed in FAA (Formalin-Acetic Acid-Alcohol) separately. For morphological study, fresh materials were used, besides some of them for photographed. The host plant was identified with the help of 'The Plant Book' by Mabberley (2005) and 'The Flora of the Presidency of Madras' by Gamble (1957). The gall causing organism was identified with the help of the previous literature 'Plant Galls of India', by Mani (2000). The requisite materials were passed through customary methods (Johanson, 1940) of dehydration and embedding with the help of a rotary microtome, sections were cut at 10 – 15 μ m thickness. The sections were stained with tannic acid and ferric chloride schedule (Foster, 1934); Toluidine blue is a polychromatic stain, the staining results were remarkably good; and some cytochemical reactions were also obtained. The dye render pink colour to the cellulose walls, blue to the lignified to the lignified to the lignified cells, dark green in to suberin, violet to the mucilage, blue to the protein molecules etc. Wherever necessary, sections were also stained with safranin, fast green and IKI (for starch). Descriptive terms of the anatomical features are as given the standard Anatomy books (Esau, 1964).

Photomicrographs

Microscopic descriptions of tissues are supplemented with micrographs wherever necessary. Photographs of different magnifications were taken with Nikon Labphot-2 microscopic unit. For normal observation bright field was used. For the study of crystals, starch grains and lignified

cells, polarized light was employed. Since these structures have birefringent property under polarized light they appear bright against dark background. Magnifications of the figures are indicated by the scale-bars.

RESULTS

1. *Acacia caesia* W.& A. (Mimosaceae) – It is a large shrub, armed, leaves bispinnate, leaflets, small 15 – 25 pairs, stipules spinescent with terminal panicles; flowers pentamerous; pods stipulate, lanceolate, grey, glabrous, apex obtuse, horned, seed – 6. Now commercially raised by the Forest Department especially around the Mettur dam.

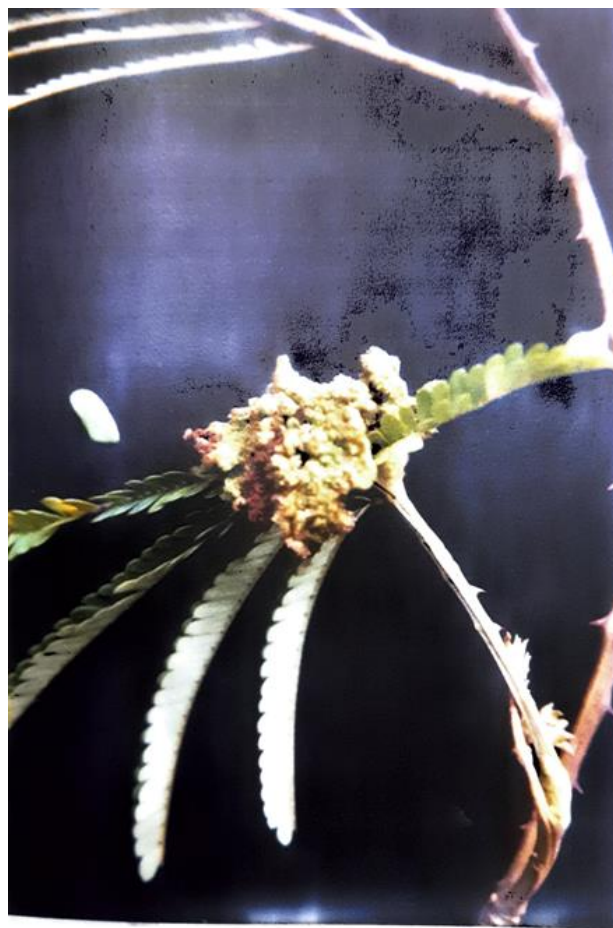


Fig. 1. *Acacia caesia* W.& A. (Mimosaceae) - 'Caulifourous gall' Exomorphic features of normal leaf and Galled leaf

Exomorphic features of the Gall (Fig. 1) 'Caulifourous gall' - Foliar gall several leaflets of a pinna or entire leaf with almost of leaflets are infested and turned into

irregular, tuberculate, highly convoluted irregular mass; the gall, when young is pale green and turns brick red when old; the leaflets lose their identity and get agglomerated into a mass. The gall mass is a fusion of several deformed leaf lets.

Anatomy of the Normal leaflet – Lamina – The normal leaf is 100 μm to 150 μm in width in cross sectional view. The lamina is dorsiventral and distinctly differentiated into adaxial palisade and abaxial spongy parenchyma. Two rows of palisade parenchyma occupies the major portion in the lamina where the cells are long, narrow and compact. The spongy constitute three to four layers of irregular parenchyma with large intercellular spaces. The adaxial epidermis is of tabular or circular in outline with thick peripheral cuticle, whereas the abaxial epidermis is poor in stomatal distribution but abaxial epidermis is densely distribution.

The lateral veins and veinlets are poorly developed. The major veins are indistinct and donot project beyond surface level of lamina. The bundles are very small and collateral with few xylem elements and insignificant phloem elements.

Midrib – The midrib is 150 μm in width in cross section, slightly projecting below the lamina. On the adaxial side a slight hump id present. The adaxial epidermal cells are broad and tabular whereas the abaxial epidermal cells are small and narrow. The palisade tissue is continuous and cross across the vascular strand of the midrib i.e., trancurrent palisade. The vascular strand is ‘arc’ shaped comprising collateral vascular strands. The vascular bundles consist of radial parallel rows of xylem elements and narrow then bands of phloem. Towards the abaxial side of phloem a sclerenchymatous cap of 3 to 4 layers are seen.

Anatomy of Gall (Fig. 2.1, 2.2) – The mite infects the meristemetic axillary bud of the plant; the bud consists of apical meristem, leaf primordial and bud scales. The anatomy of the gall is typical leaf. The mites are usually dispersed by wind and when deposited on the young axillary buds, they feed on the surface cells of the young organs. The feeding stimulus causes proliferation of the epidermal and subepidermal cells, which develop into tuberculate tissue masses provide a conducive domicile

for feed and to live. Though the gall appears to be cauliflorous masses, microscopic observation reveals that there are several ‘Meristemetic apices’ (Fig. 3.1, 3.2) with distinct apical cells and lateral cell segments. Due to puncturing of the cells and feeding impacts of the mites, the apical cell-system gets converted into tumourous mass. Increasing mite population coupled with indefinite proliferation of the plant tissue is a curious biological phenomenon.

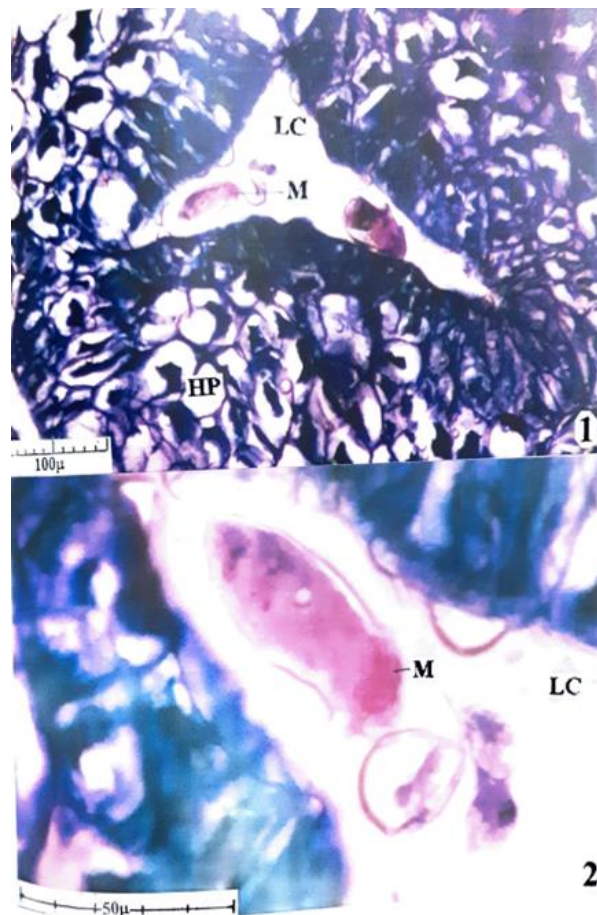


Fig. 2. *Acacia caesia* W.& A. (Mimosaceae)

1. Transectional view of leaf gall showing gall cavity and hypertrophied parenchyma cells
2. Larval cavity magnified showing mites (HP – Hypertrophied parenchyma; LC – Larval Cavity; M – Mite)

2. *Alangium salvifolium* (L. f.) Wang. – Alangiaceae – It is a small tree or shrubs with spinescent branches and pale brown bark. Flowers in fascicles, white, berry fleshy. Almost all districts. Indo Malaysia, China, Sri Lanka, East Asia.

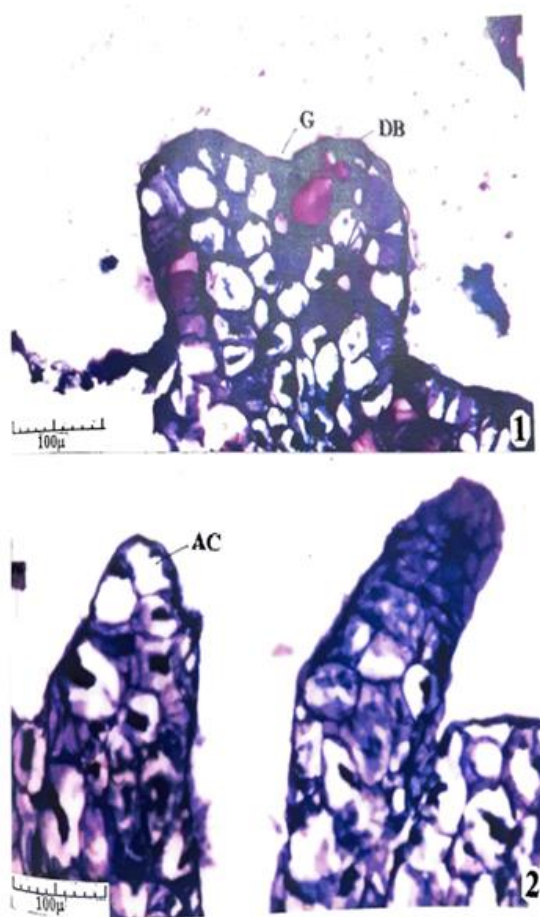


Fig. 3. *Acacia caesia* W.& A. (Mimosaceae)
 1. Proliferated gall tissue showing dichotomous branching
 2. Transectional view of gall showing Meristamatic Apex (AC – Apical Cell; DB Dichotomous Branch; G – Groove)

Uses – Root bark used in cutaneous troubles; astringents, anthelmintic, purgative, emetic and diaphoretic. Also used in biliousness. Leaves hypoglycaemic. Fruits acidic and astringent, laxative, tonic. Seeds used in haemorrhages.

Exomorphic features of the gall – It were incited by the mite *Eriophyes alangii* Nalea (Acarina).

Shallow Pouch Gall (Fig. 4.1, 4.2) – Leaf gall epiphyllous, irregularly subglobose, verrucose, sessile, free or sometimes also a few agglomerates, pale yellow or yellowish green pouch gall, with large wide open ostiole on the lower side, gall cavity filled with fine, short, rusty-brown erineum. Size 2 – 15 mm in diameter; distributed in northern coromandal coast.

Anatomy of Normal Leaf Lamina – The normal leaf is 110 to 150 µm in width in sectional view. The leaf is dorsiventral and the mesophyll 75 to 100 µm in thickness differentiated into upper palisade and lower spongy tissue. The adaxial epidermis made up of rectangular / tubular cells.



Fig. 4. *Alangium salvifolium* (L. f.) Wang. – Alangiaceae
 1. Exomorphic features of the leaf gall
 2. Exomorphic fetures of leaf gall – Adaxial view and Abaxial view (A – Mite Gall; B – Infected Region)

The abaxial epidermis is thinner and made up of small narrow somewhat squarish cells. Peripherally a thin cutin is seen. Palisade cells are very narrow long cells occupying one-third the mesophyll tissue. Spongy cells are angular / irregular enclosing very small intercellular spaces. The abaxial epidermis is densely stomatiferous while the adaxial epidermis has sparse stomata. The lateral veins and veinlets are well differentiated. The

major veins slightly project the surface level of the lamina. The vascular bundles of the major lateral vein are collateral with a small core of xylem elements and small groups of phloem elements; the vascular strand is surrounded by single layer of dilated hyaline bundle-sheath cells which extend adaxially and abaxially into one cell thick bundle sheath extension. The vascular strand has a single layer of dilated, hyaline bundle sheath cells with unistratose adaxial and abaxial extensions.

Midrib – It is 200 μm width in cross section, well projecting below the lamina. On the adaxial side it is flat or shallow and abaxial side in broadly semicircular. The adaxial epidermal layer of squarish cells followed an arc of 2 to 3 layers of collenchyma, the remaining part being circular and thin walled parenchyma cells. The palisade zone of lamina does not cross across the adaxial midrib. The abaxial midrib has an epidermis similar to the adaxial layer has an epidermis similar to the adaxial layer 2 to 3 layers of collenchyma and the remaining ground tissue being thin walled, circular parenchyma cells. The midrib has an ‘arc’ shaped vascular bundles. The vascular bundle has radial parallel rows of xylem elements and a narrow band of phloem.

Trichomes – The trichomes are broad, uniseriate and multicellular with basal radiating bulbous foot cells and pointed triangular terminal cell.

Leaf Gall Anatomy (Fig.5) – The gall has simple undifferentiated mesophyll tissue not much thicker than the lamina. On the lower concave surface of the gall dense erineal hairs develop from the abaxial epidermis. The trichomes of the unaffected lamina are uni or multicellular, unbranched and thick walled with pointed tips. The trichomes are modified in the gall into wide, thin walled, unicellular or multicellular, trichomes with terminal cluster of lobes or branches.

Erineal hairs (Trichomes) – The foliar erineal hairs of gall are hypophyllous, dense patches white cottony hairs occur in circular or irregular spots. Erineum becomes brown when old. The erineal hairs arise from the abaxial epidermis. The erineal hairs are of two types. The first type is unbranched, unicellular and thin walled; while the other is branched, unicellular and thin walled. The erineal

hairs are multinucleate. These cells have rich cell contents.

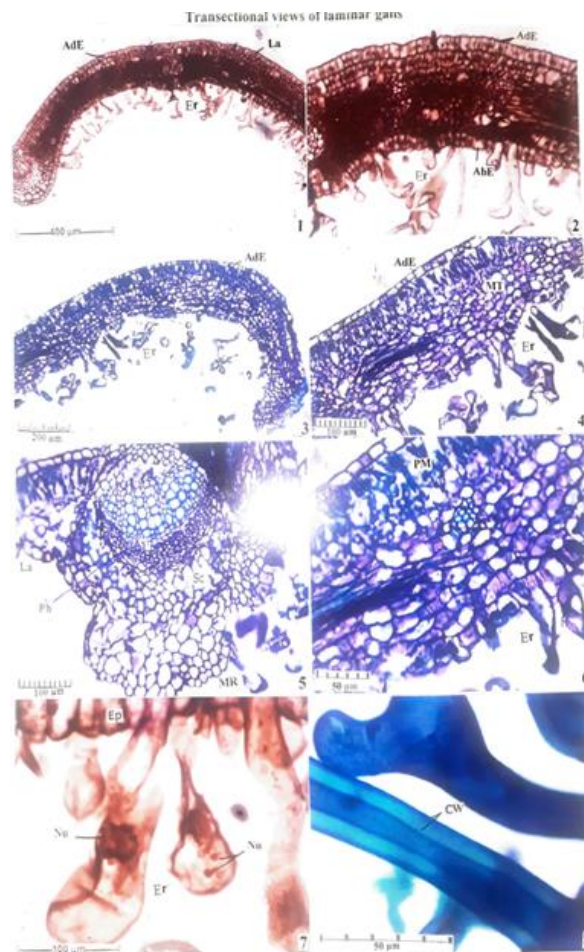


Fig. 5. *Alangium salvifolium* (L. f.) Wang. – Alangiaceae (AdE – Abaxial Epidermis; AdE – Adaxial Epidermis; CW – Cell Wall; Ep – Epidermis; Er – Erineal Hairs; GP – Gall pouch; La – Lamina; MR – Midrib; Nu – Nucleus; Ph – Phloem; PM – Palisade Mesophyll)

3. *Commiphora caudata* Engl. (Burseraceae) (Fig. 6.1) – It is a deciduous tree with papery bark and greyish soft wood. Leaves alternate, 3 to 7 foliar leaflets sessile or shortly petioled, entire, crenate, lateral ones often small, flowers polygamous in paniculate dichasia. Petals four stamens 8 – 10 inserted on the margin the disc, fruit a fleshy drupe. Very abundant in the deciduous belt. Stout thorns on old wood are seen.

Exomorphic features of the gall (Fig. 6.2) – ‘Tuberculated emergence gall’ – Galls are seen on the leaf, petiole and tender stem. On the leaf the gall occurs along

the midrib and lateral veins. Epiphyllous, solid, fleshy, tuberculated, yellow vermiform, longitudinally agglomerate, sometimes extensive on the entire lamina



Fig. 6. *Commiphora caudata* Engl. (Burseraceae)
1. External features of normal trifoliar leaf and Inflorescence
2. Exomorphic features of Galled Leaflets

turning the leaflet into folding and twisting. On the rachis, the gall appears small glandular, tuberculate cushions.

Anatomy of the normal leaf : Lamina – The normal leaf 150 μm to 210 μm in width in the cross-sectional view. The leaf is dorsiventral and differentiated into adaxial palisade and abaxial spongy parenchyma. The adaxial epidermis constitutes very broad fabular epidermal cells whereas the abaxial epidermis cells are very small and

narrow. Palisade cells are very narrow; two layered occupies the lamina 50 μm . Spongy parenchymas are irregular enclosing large intercellular spaces. The abaxial epidermis is densely stomatiferous while the adaxial epidermis has sparse stomata.

The lateral veins and vein let are well differentiated. The major veins were not project beyond the surface level of lamina. The bundles are collateral with few xylem elements and small patch of phloem elements. The vascular stands are surrounded by parenchymatous bundle sheath.

Midrib – It is 255 μm width in cross section slightly projective below the lamina. On the adaxial side it flat and the abaxial side is wide and semicircular. The adaxial epidermal layer of tubular cells followed by an arc of 2 to 5 layers of collenchyma and remaining ground tissue parenchyma. The palisade parenchyma slightly comes across the midrib. The abaxial midrib has an epidermis similar to the adaxial layer enclosing 5 to 6 layers of collenchyma and the remaining ground tissue is a circular thin wall parenchyma cell. The midrib has a 'c' shaped vascular strand comprising collateral vascular bundles. The vascular bundle constitutes radial, parallel rows of xylem elements and narrow thin bands of phloem.

Leaf Gall Anatomy (Fig. 7.1, 7.2) – The vein gall develops from the abaxial epidermis and ground tissue. The gall consists of fleshy, irregularly lobed masses of parenchymatous tissue simulating the callus mass of *in vitro* tissue culture. The cells are thin walled, compact and contain dense tannin masses. The emergence outgrowth shows a tendency of repeated branched due to the feeding stimulus of the mite.

Due to hypertrophy and hyperplasy a large amount of parenchyma cells formed. Proliferation of these parenchyma cells fuses to form larval cavities. The larval cavities are bordered with thick parenchyma cells followed by thin-walled nutritive cells. Tannin contents are abundantly seen in the parenchyma cells. In between the tannin content parenchyma cells and mites are seen. The gall lamina shows profusely branched vascular strands, vein terminations and vein islets when observed in para dermal sections. In between the meristematic cells the thrips stay and feed on the epidermal and sometimes

also on the sub epidermal cells. Repeated wounding and continued feeding on a large area of the host leaf seem to be essential for effective development of gall.

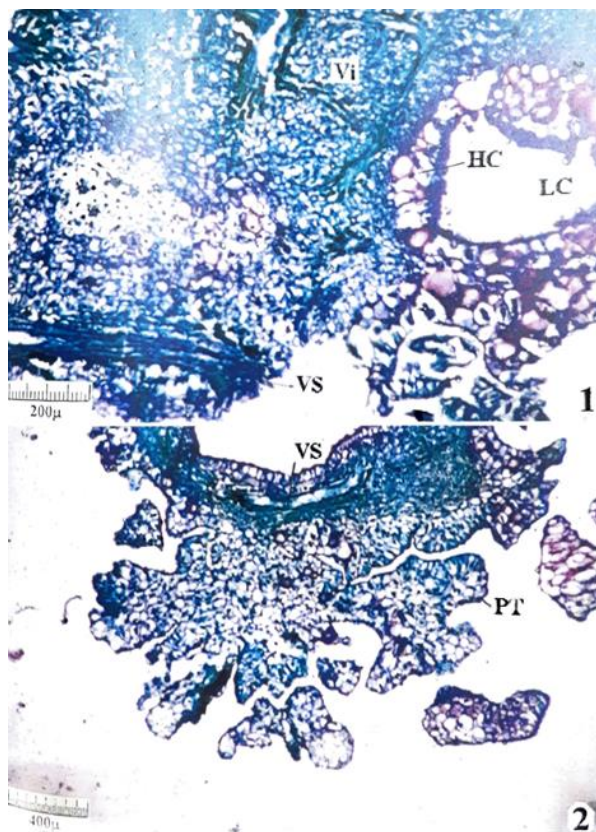


Fig. 7. *Commiphora caudata* Engl. (Burseraceae)

1. Galled leaf – Paradermal section showing larval cavity
2. Transectional view of leaf showing proliferated tissues

(HC – Hypertrophied Cells; LC – Larval Cavity; PT – Proliferated tissue; Vi – Vein islet; VS – Vascular strand)

DISCUSSION

The plant galls of Thirupathur district are induced by agents of diversified taxonomic groups. The bulk of the zoocecidia from their district are induced by mites (Eriophyes-Acarina). Of the different plant organs, which undergo galling, the leaves are the most susceptible organ, whereas the buds, veins and petioles are less affected. In the present investigation, three mite galls have been studied, out of which one has been reported for the first time. In many mite galls, the histology of the galls leaf

does not differ much from that of the normal leaf. The same trend has been observed in two galls i.e., *Alangium salvifolium* and *Commiphora caudata* but in the case of *Acacia caesia* the distinction between the two types of mesophylls is lost and the gall tissue is composed of ‘meristematic apices’ with distinct apical cells. The nature of symptoms that mites induce on the host plants is so diverse and varied that no other group of parasitic organisms can complete with them in this regard.

Conflicts Of Interest: The authors stated that no conflicts of interest.

REFERENCES

- Channabasavanna GP (1981) (ed.) Contributions to Acarology in India. Department of Entomology, University of Agricultural Sciences, Bangalore.
- Esau K (1964) Plant Anatomy Joyhn Wiley & Sons. New York p. 767.
- Foster AS 1934. The use of tannic acid and iron chloride for staining cell walls in meristematic tissue. Stain Technol. 99: 91 – 92.
- Gamble JS (1957) Flora of the Presidency of Madras, 3 Vol. Botanical Survey of India. Calcutta, India.
- Gopi M (2018) Utility of plant galls. Indian Journal of Economics and Development. Vol 6 (10), pp. 1 – 10.
- Gopi M (2021) Plant Galls: Hitherto untapped focus on positive approach. Book Chapter entitled ‘Gall-Inducing Arthropods on Forest Trees’. Scientific Publishers. Edited by John Prasanth Jacob. pp. 63 - 76.
- Johanson DA (1940) Plant Microtechnique. Mc Graw Hill Book company, New York.
- Mabberley DJ (2005) The Plant Book. Cambridge University Press.
- Mani MS (2000) Plant Galls of India. Second Edition Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.

Submit your manuscript to a IJLSCI journal and benefit from:

- ✓ Convenient online submission
- ✓ Rigorous peer review
- ✓ Immediate publication on acceptance
- ✓ Open access: articles freely available online
- ✓ High visibility within the field

Submit your next manuscript to IJLSCI through our manuscript management system uploading at the menu "**Make a Submission**" on journal website

Email your next manuscript to IJLSCI
editor@ijlsci.in
