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RESEARCH ARTICLE

EXPLORATION OF PLANT GALLS IN CAMPUS FLORA

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ABSTRACT

Plant Galls are external expression of mysterious interaction between two biological entities namely, the insects and the plants. It is abnormal, uncontrolled, largely independent growth of the host tissues which arise under the influence of an external stimulus. The growth of the host tissues by means of *hyperplasy*, *hypertrophy* and *hypoplasy*. Guru Nanak College is a semi arid dry Scrub Jungle harbours a few curious morphologically diversified plant galls on different plant species with specific plant organs. The present study deals with the enumeration of plant galls in the campus of Guru Nanak College with special reference to morphological, anatomical and biochemical compounds. In our preliminary survey we have find out the Eight different plant galls namely, *Ficus bengalensis*, *Lannea coromandelica*, *Madhuca longifolia*, *Mimusops elengi*, *Morinda pubescens*, *Pongamia pinnata*, *Syzygium cumini* and *Tectona grandis*. This paper proves that the new report of plant galls in the campus of Guru Nanak College for the first time.

INTRODUCTION

Plant Galls are external outburst of plant tissues due to the stimulus incited by certain phytophagous insects. The ultimate result of the gall inducing insects is to secure nutrition and safer domain for a short span of time during their life-style. In certain instances, these needs are fulfilled by the development of a simple outgrowth of the Plant Organ, structure termed 'Gall'. In many cases, the galls induced by the parasites attain phenomenal structural complexity and architectural design which have allured by the naturalists. Our knowledge of plant galls dates back to 17th century, and Marcello Malphigi seems to have held the foundation for the scientific perspectives of the plant galls. Development and anatomy of several insect induced galls on certain plant species have been worked out by many workers (Kostoff and Kendall, 1929; Lewis and Walton, 1947; Meyer, 1965; Ananthakrishnan and Raman, 1988; Kant and Archana Karnawat, 1989; Kant *et al*., 1994; Amerjothy and Jayaraman, 2001). Different research centers have been contemplating on the various aspects of cecidogenetic studies and striving to reach solution for resolving certain intrigue queries involved in the cecidogenetic mechanism. Presently this research paper concerned with the some plant galls in the campus of Guru Nanak College with special reference to semiarid zones of Chennai. About eight different plant galls are so for recorded from this campus. Guru Nanak College is the one of the prestigious institute located along the road side of Velachery, nearby Centre of the city about 15 km from Chennai, surrounded by Indian Institute of Technology, Tamil Nadu Reserve Forest Department, Raj Bhavan. The vegetation of this area covers about 20 acres with varied vegetational profile (Gopi *et al.,* 2008; S. Natarajan and M. Gopi, 2010) with different morphologically alluring structural dynamics of plant galls. The research findings highlight the insect plant interaction, seasonal variation, morphological architecture, histopathological and biochemical analysis etc.

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MATERIALS AND METHODS

Galls and normal plant materials were collected from heavily galled on plants like *Ficus bengalensis, Lannea coromandelica, Madhuca longifolia, Mimosops elengi, Morinda pubesens, Pongamia pinnata, Syzygium cumini* and *Tectona grandis* growing in the Guru Nanak College Campus and fixed in FAA (Formalin 5 ml, Acetic Acid 5 ml and 70 % Ethyl Alcohol 90 ml). Dehydration, clearing, embedding were done by following the Tertiary Butyl Alcohol method as recommended by Johanson (1940). Microtome sections were cut at a thickness of 8 – 12 µm and stained with Toluidine Blue (O' Brien *et al.,* 1964) and Tannin acid Ferric Chloride combination (Johansen's, 1940, Foster, 1934). The galls were examined under the stereoscopic microscope while still attached to the leaf. They were also studied in both fresh and preserved conditions using hand cut sections and also evaluated the physicochemical constants and preliminary phytochemical analysis of the galled portion as well as normal plant organs (Kokate, 1989). The plants were identified with the help of Flora of Madras, Presidency (Gamble, 1935); Flora of Madras city and its neighbourhood (Mayuranathan, 1929) and Flora of Tamil Nadu (Henry *et al*., 1987). Latest

nomenclatures of the plants were studied as per, "The Plant Book, by Mabberley (2005). The selected plants for the present investigation is tabulated in Table 1. The galls and their causative insects were identified by comparing the description given by Mani (Plant Galls of India – 2000) and introduction of Indian Plant Galls by Amerjothy (2006).

Observation

The characteristic features of galls and normal organs of different plant species were studied.

1. *Ficus bengalensis* Linn. - Moraceae

Gall Type – Leaf gall, hypophyllous, subglobose, reddish, solid, uni or biloular, sclerenchymatous, sessile gall, with very peculiar fleshy but hard, obtusely conical echinate processes on the surface, these processes are parenchyma emergences which turn almost black when old and may break into small fragments. The larval cavities usually double, with conspicuous sclerenchyma walls in the centre of the fleshy mass, size 5 – 8 mm in diameter. Anatomical observations show that this gall is an eruptive gall, beginning from the lower palisade and breaking through the spongy parenchyma and lower epidermis.

2. *Lannea coromandelica* (Houtt.) Merr. (Syn: *Odina wodier* Roxb.) – Anacardiaceae

Gall Type – Radially cylindrical symmetry gall. It is a large tree often planted in avenues. The plant has compound leaves 4 – 5 pairs of leaflets. According to Mani (1973) has reported 25 different types of galls on different plant species belonging to the family Anacardiaceae, and one gall has been reported on this plant. Galls on veins and rachis are very common on this plant and this gall is widely distributed in India and it extends up to outer Himalayan Hills (Mani, 1973).

Normal Vein – The unaffected midrib of Lannea coromandelica has a ring of vascular bundles ranging from 10 – 14 in number. The palisade tissue extends upto middle part of the vein on the adaxial side. The epidermal cells are cubical in transaction. The cortex consists of nearly 7 layers of parenchyma cells, some of which are filled with tannin. The vascular bundles are collateral with inner xylem and outer phloem and a large resin canal occurring at the centre of the latter. The pith is made up of large compact thin walled parenchyma cells.

The Gall – Gall develops on the rachis, midrib and large lateral veins. The shape of the gall may be globose, oval, fusiform or moniliform. It is brown and the surface is covered by reddish-brown membranous scales. The galls on the veins are fleshy and soft ranging from 5 to 20 cm in diameter. When the gall is cut longitudinally, there is an 'L' shaped larval cavity enclosing a single larva. The mature gall may project either on the adaxial side or on the abaxial side. In transactional view it is perfectly circular in outline. In the centre of the gall, there is a larval cavity which is surrounded by 3 – 4 layers of small thin-walled cells and broad excentric zone of sclereids. The vascular bundles are scattered in the form of small irregular strands. The resin canals are larger in size and are scattered throughout the gall tissue. The ground tissue of the gall is large thin walled parenchyma, which diminishes in size towards the larval cavity. The outer part of the mature gall is represented by 4 – 5 layers of laterally stretched thin walled cells resembling periderm.

3. *Madhuca longifolia* (Koenig) Marbr. (Syn.: *Bassia longifolia* Linn.) – Sapotaceae

Crown gall on stem caused by *Agrobacterium tumifacient* (Bacteria), the bacterial gall can be recognized into stem and root gall. Former it is usually crown gall latter it is nodules. In Madhuca longifolia plant bears a large globose or circular bacterial crown gall on the stem, surface is wavy, ridges and furrows, irregular outgrowth on the pheripheral region.

4. *Mimusops elengi* L. (Sapotaceae)

Leaf fold gall caused by *Arrhenothrips ramakrishnae* Hood (Thysanoptera). A small tree, fruits edible. Entire leaf folded adaxially along the midrib. The midrib region of the folded gall has small crinkles. No tissues fusion is evident. Structure of the lamina not affected much and it is very common. Other associated organisms like inquilines, predators are *Rhynchothrips vichitravarna* Ramakr. and *Androthrips flavipes* Schmutz (Thysanoptera); *Montandiola thripdes* Berg. and *Septicus* sp. (Anthocoridae: Heteroptera). It is commonly distributed in South India (Mani, 1973).

5. *Morinda pubescens* J.E. Smith (Rubiaceae)

This plant bears abundant galls on fruit call it is as agglomerate inflorescence gall, caused by *Asphondylia morinda* – Ditera (Midge).

Gall Morphology – The galls are solid, fleshy, soft, indehiscent, smooth and green after falling, the gall mass becomes black and start decaying. The true gall natue of the agglomerate masses can be detected from the complete absence of seeds, and the conspicuous highly enlarged pericarp of the ovaries. The galls also bear aborted and under developed corolla as conical stump on the surface.

Gall Anatomy – The usual three zones of the drupe, namely epicarp, mesocarp and endocarp are suppressed in the gall. The carpellary chambers and the ovules are obliterated. The gall consists of a thin, less conspicuous epidermis and homogeneous parenchymatous ground tissue. The cells are small, thin walled and compact. The vascular strands are scattered into small, diffuse unorganized islands. No specific ergastic inclusions are recognizable in all gall tissue. The entire gall is massive parenchymatous tissue. The vessels and phloem elements are highly reduced and cleaved.

6. *Pongamia pinnata* (L.) Pierre (Papilionaceae) bears leaf galls commonly call it as cephalonean pouch gall incited by Eriopyes cheriani Massee (Acarina). Epiphyllous, very rarely hypophyllous, subcylindrical, clavately-cylindrical or obliquely obpyriform, pedicellate cephaloneon pouch gall, more or less lopsided, usually simple and free and only rarely 2 – 3 agglomerate, glabrous, green, unusually pubescent or very rarely tomentose, hard, unilocular, indehiscent, ostiole hypophyllous and minute and obstructed by the downwardly directed erineal hairs, gall cavity large, with numerous irregularly projecting, smaller or larger fleshy emergences,

Table 1. List of Plant Galls for the Present Investigation

Sl.No.	Name of the Host Plant with Families with Gall location	Gall inciter	Plant Organs
1.	*Ficus bengalensis* L. Moraceae – Epidermal tissue	Nesomyia echinata Mani (Hymenoptera)	Eruptive Leaf gall
2.	*Lannea coromandelica* (Houtt.) Merr. Annacardiaceae – Ground tissue	Odinadiplosis odinae – Diptera	Sphaeroidal – Vein gall
3.	*Madhuca longifolia* (Koenig) Marbr. Sapotaceae – Cortex	Agrobacterium tumifacient – Bacteria	Crown gall – Stem
4.	*Mimusops elengi* L. Sapotaceae – Adaxial Epidermis	Arrhenothrips ramakrishnae Hood (Thysanoptera)	Leaf fold gall
5.	*Morinda pubescens* J.E. Smith Rubiaceae – Ground Tissue	Asphondylia morinda – Diptera (Midge)	Agglomerate inflorescence gall (Fruit)
6.	*Pongamia pinnata* (L.) Pierre Papilionaceae – Upper Epidermis	Eriophyes cheriani Massee (Acarina)	Cephalonean leaf pouch gall
7.	*Syzygium cumini* (L.) Skeels Myrtaceae – Mesophyll Tissue	Trioza sp. (Psyllidae)	Blister leaf gall
8.	*Tectona grandis* L. Verbenaceae – Lower Epidermis	Cecidomyiidae (Diptera)	Furry leaf gall

Table 2. Phytochemical Analysis

No.	Binomial	Saponin		Alkaloids		Steriods		Coumarin		Tannin		Quinones		Phenol	
		N	G	N	G	N	G	N	G	N	G	N	G	N	G
1.	*Lannea*	+	+	-	+	-	-	-	+	+	+	-	-	+	+
2.	*Morinda*	0	+	0	+	0	-	0	+	0	+	0	-	0	+
3.	*Pongamia*	+	+	-	-	+	-	-	+	+	+	-	-	+	+
4.	*Syzygium*	+	+	-	-	-	-	-	-	+	+	-	-	-	-

[G = Gall Portion; N = Normal organ; 0 = There is no normal organ]

bearing bundles of long, cylindrical, simple, unicellular, apically pointed and downwardly directed erineal hairs with packed parenchyma cells. On some plants the entire blade of leaflets are turned into dense clusters of conspicuously pubescent and yellowish brown galls, without a trace of free blade. Size 10 mm high, 1 – 2 mm thick at base and 5 mm thick apically. The midge *Microdiplosis pongamiae* Mani is predacious and the Chalcid *Tetrstichus* is parasitic. This is one of the commnest and perhaps also the most widely distributed plant galls in the orient and extends from Java, Sumatra, Sebesi, Salajar, Celebes through Burma to India, where it is found throughout.

7. *Syzygium cumini* (L.) Skeels (Myrtaceae)

This plant produce blister gall on leaves by *Trioza* sp. (Psyllidae). Foliar gall, aliform, blister like epiphyllous slightly raised pouch with flat or cancave hypophyllous region having a minute ostiole at the center. Gall hard, dehisces irregularly on ageing, young gall greenish yellow, mature one with reddish spot at the centre with yellow margin; entire gall turns dark brown during dehiscence. Gall abundant, mostly solitary but densely crowded and it is very common.

8. *Tectona grandis* Linn. (Verbenaceae)

Leaf gall produced by unknown Itonididae (Diptera), hypophyllous, depressed, circular, discoid, lenticular pouch gall, solitary, shortly stalked and conspicuously clothed with dense long, straight, simple, cottony-white, pointed villous hairs, thin walled and indehiscent. Ostiole minute and epiphyllous. The galls are usually crowded, often over 300 galls per leaf, giving the entire blade a cottony-woolly appearance. On the upper surface of the leaf, the site of the gall is inducted by a small fleshy tubercle. The gall is attached to a vein. Size 3 – 4 mm in horizontal diameter and 1 mm high, parasites numerous. It is distributed in Western Ghats. I also made preliminary phytochemical analysis of some galls and corresponding normal organs for the chemical evaluations (Table 2).

RESULTS AND DISCUSSION

In our preliminary survey, we have enumerated 8 different types of galls in the campus of Guru Nanak College. The plant galls of this area is quite interest with lot of variations. Among the 8 different types of plant galls, leaf gall is dominant in this area about 6 plant bears this type of gall, where as in stem and fruit gall show only one gall in each plant organs. The phonological distributions of insects are also varied widely. The majority of the gall caused by insect group likes Cecidomyiidae (Diptera), Thysanoptera (Thrips), Homoptera (Psyllidae) and one mite and a bacterium. Dipterian groups are dominant when compare to others. The leaf galls show variously shaped namely, furry gall, blister gall, leaf fold gall and sphaeroidal gall. The stem and fruit galls are rare in occurrence. In our present study reveals that Sapotaceae members have two galls and all other families are one gall in each. The leaf galls posses two galls from vein and three galls from lamina. The insects prefer mostly on the greenish portion of the leaves for feeding food materials and safer domain. There is no significant result of findings in fluorescence analysis and physicochemical analysis of the galls shows remarkable findings noted in *Pongamia* and *Lannea*. In *Pongamia*, coumarin present in gall tissue when compare to normal portion, where as steroid present only in normal portion. In *Lannea*, gall portion contain alkaloids and coumarin, but it is not present in normal organ. All other results of the comparative chemical compounds are more or less similar to both.

Conclusion

In our plant gall exploration, some of the basic ideas retrieved from the results of this research findings.

(i) The structural morphological and anatomical profile of galls based on the specific insect feeding stimulus and it is specific to specific plant species.

(ii) The phonological variations monitor the different types of galls on plants with alluring morphological structure.

(iii) The Cecidomyiidae (Diptera) is a dominant group of insects world wide. It is also true in our campus also.

(iv) The most of the plant galls are occurs in seasonal. The next season it will change and some other plant produce various other types of galls in this locality. So it is a dynamic and transient.

The preliminary phytochemical as well as physico chemical analysis proved that some pharmacological potentials and economic utility of the plant galls.

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