

## Diversity of insect induced plant galls in two sites of Kannur District, Kerala, India and phenolic analysis in the leaf gall of *Garuga pinnata*

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### Abstract

Plant cells that grow abnormally in response to different insect stimuli are called insect galls. Insects in the Thysanoptera, Hemiptera, Hymenoptera, Coleoptera, Diptera, and Lepidoptera taxa have the ability to induce galls. Insect gall diversity of two locations in Kannur District, Kerala, India are examined. Galls of various shapes, colour and size was observed. To examine the impact of gall on plant metabolism, the total phenolic content of *Garuga pinnata* leaves, both galled and ungalled, is also examined. Phenols react with phosphomolybdic acid in the Folin-Ciocalteu reagent in an alkaline medium to form a blue-colored complex. Comparing galled leaf to its counterpart, the results revealed a higher phenolic content. The secondary metabolite phenol's relationship to potential biological activities and as a source of naturally occurring bioactive chemicals is vividly correlated.

**Keywords:** Insect galls, ungalled, galled, phenolic analysis, *Garuga pinnata*, galls of Kannur, midge galls

### Introduction

Insect galls are the aberrant growth of plant cells, that emerges due to insect stimulus. The secretion during oviposition, larval feeding, or the saliva of gall-inducing insects can all serve as insect stimuli, the inducing agent of galls. Approximately 2000 distinct plant galls have been documented in India (Raman 2007) <sup>[3]</sup>. There have been reports of striking morphological differences in insect-induced plant galls from the Indian subcontinent (Mani 2000) <sup>[2]</sup>. Extreme host specificity and extreme monophagy are characteristics of gall-inducing insects. They are regarded as extremely advanced herbivores (Mani 2000) <sup>[2]</sup>. When a host plant and the inducer insect form an interspecific association, there arises a gall (Rohfritsch 1992) <sup>[4]</sup>.

Insects in the Orders Thysanoptera, Hemiptera, Hymenoptera, Coleoptera, Diptera, and Lepidoptera taxa are the ones who have the ability to induce galls. Infact, not every species in this group has the capacity to induce galls (Raman 2007) <sup>[3]</sup>.

The chemical makeup of the gall tissue that the same plant produced in response to different species of gall inducers, was different from that of the tissue that was not galled. The Folin-Ciocalteu assay for total phenolic analysis is used to test this. In an alkaline medium, phenols, which are aromatic compounds with hydroxyl groups, react with phosphomolybdic acid in the Folin-Ciocalteu reagent to form a blue-coloured complex.

The goal of the current study is to examine the variety of gall-inducing insects and insect-induced plant gall from two locations in Kannur district, Kerala, India. To examine the impact of gall on plant metabolism, the total phenolic content of *Garuga pinnata* leaves, both galled and ungalled, is also examined.

### Materials and Methods

The current work was completed in two locations of Kannur district, Kerala, that belongs to two Taluks - Kayyilakathu

Kaavu, Chalad (11°52'0"N) and Govt. Brennen College, Dharmadam (11°46'31"N). The study areas experience high temperatures between March and May due to their extremely humid tropical climate. Monthly visits were made to collect and study the galls.

The leaf galls were collected in polythene zip-lock bags and the inducer insects in separate small bottles. All the necessary scientific details of the gall, host and insect were noted, routinely observed and tabulated accordingly.

Insects associated with galls were collected using an aspirator and killed with ethyl acetate. Under a stereo microscope, the gathered insects were examined, arranged by family, and photos of the potential ones were taken. Identification of insect species has been done using the external gall morphology and its comparison with the gall description by Mani (2000) <sup>[2]</sup>.

The leaf gall of *Garuga pinnata* was removed in order to measure the total phenolic content by Folin-Ciocalteu assay and same was done with that of its ungalled counterparts. The findings were reported as mg catechol/g of the material's fresh weight. Three duplicates of the reaction were carried out, and the outcomes were averaged.

### Result and Discussion

Morphologically different kinds of insect-induced plant galls were gathered from two locations in Kannur district Kerala for the current study. The galls were 16 various types from 15 plant species belonging to 13 plant families. Most of the plant species had only one type of gall.

Several insect orders are found to be the gall inducers. Out of which the Midge-induced galls (Diptera - Cecidomyiidae), was the most prevalent type of gall inducers, being isolated from six host plants. Lepidoptera and Hymenopteran insects contribute the least amount of gall inducers, whereas Thysanoptera and Hemiptera have the fewest. Despite being the largest insect order, no members of the Coleoptera order have been identified as gall inducers. Table 1 describes the specifics of the insect induced plant galls that were gathered from the study site.

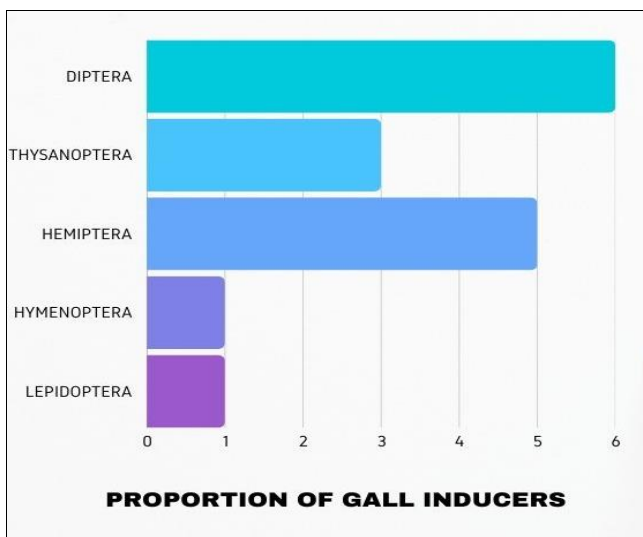
**Table 1:** insect induced plant galls collected from two sites in Kannur district, Kerala, India

Plant Family	Host Plant	Gall-bearing organ	Gall inducing insect	Order: Family	Gall morphology
Anacardiaceae	<i>Mangifera indica</i> Linn.	leaf	Unnamed	Diptera: Cecidomyiidae	globose
Apocyanaceae	<i>Alstonia scholaris</i>	Leaf	Pauropsylla sp.	Hemiptera: Triozidae	Globose
Burseraceae	<i>Garuga pinnata</i>	leaf	Phacopteron lentiginosum	Hemiptera, phacopteronidae	
Cucurbitaceae	<i>Coccinia indica</i>	stem	Lasioptera cephalandra	DIPTERA Cecidomyiidae	
Dipterocarpaceae	<i>Hopea ponga</i>	stem	Mangalorea hopea	Hemiptera Beesonidae:	Sea urchin like
Euphorbiaceae	<i>Phyllanthus emblica</i>	stem	Hypolamprus stylophora	Lepidoptera; Thyrididae	
	<i>Mallotus philippensis</i>	Leaf	Trioza mallotica	Hemiptera: Triozidae	
Loranthaceae	<i>Helicanthes elastica</i>	leaf	Phorinothrips loranthi	Thysanoptera: Phlaeothripidae	Leaf roll
Moraceae	<i>Ficus racemosa</i>	Leaf	Pauropsylla sp.	Hemiptera: Triozidae	Globose
	<i>Ficus benghalensis</i> Linn	leaf	Chrysocharis echinata	Hymenoptera: Eulophidae	echinate
Plant Family	Host Plant	Gall-bearing organ	Gall inducing insect	Order: Family	Gall morphology
Oleaceae	<i>Jasminum malabaricum</i>	leaf	Unnamed	Diptera: Cecidomyiidae	Spindle shaped
Piperaceae	<i>Piper nigrum</i>	Leaf	Un identified	Diptera: Cecidomyiidae	Globose
	<i>Piper nigrum</i>	leaf	Gynaikothrips chavicae	Thysanoptera: Phlaeothripidae	Marginal leaf roll
Rubiaceae	<i>Pavetta indica</i> L.	leaf	Teuchothrips sp.	Thysanoptera: Phlaeothripidae	Leaf marginal roll
Verbenaceae	<i>Tectona grandis</i>	stem	Asphondyla tectonae	Diptera: Cecidomyiidae	
Vitaceae	<i>Leea indica</i>	leaf	Lasioptera sp.	Diptera Cecidomyiidae	

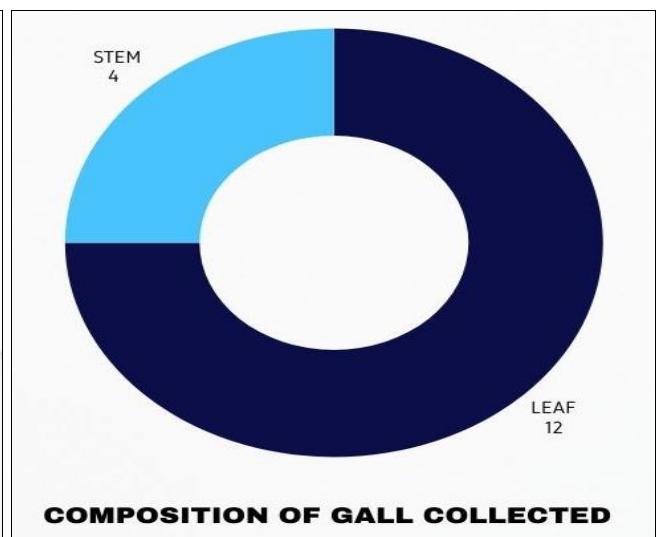
**Gall inducers**

Gall midges (Diptera: Cecidomyiidae), Psyllids (Hemiptera: Psyllidae), Thrips (Thysanoptera: Phlaeothripidae), gall wasps (Hymenoptera: Eulophidae), and leaf moths (Lepidoptera: Thyrididae) are among the gall inducers of the insect galls that were collected.

Six of the 16 galls examined belong to the Cecidomyiidae family, which is the most common gall inducer. Hemiptera (psyllids), Thysanoptera (thrips), Hymenoptera (gall wasps), and Lepidoptera are next in line. Figure 1 illustrates the proportion of gall inducers.



**Fig 1:** Proportion of gall inducers



**Fig 2:** composition of galls

**Composition of galls**

The galls that were collected can be divided into two categories: leaf galls and stem galls. Four among the sixteen falls under stem galls and the rest being leaf galls. The gall composition proportion of the collected galls is displayed in Figure 2.

**Phenolic assay using Folin Ciocalteu method**

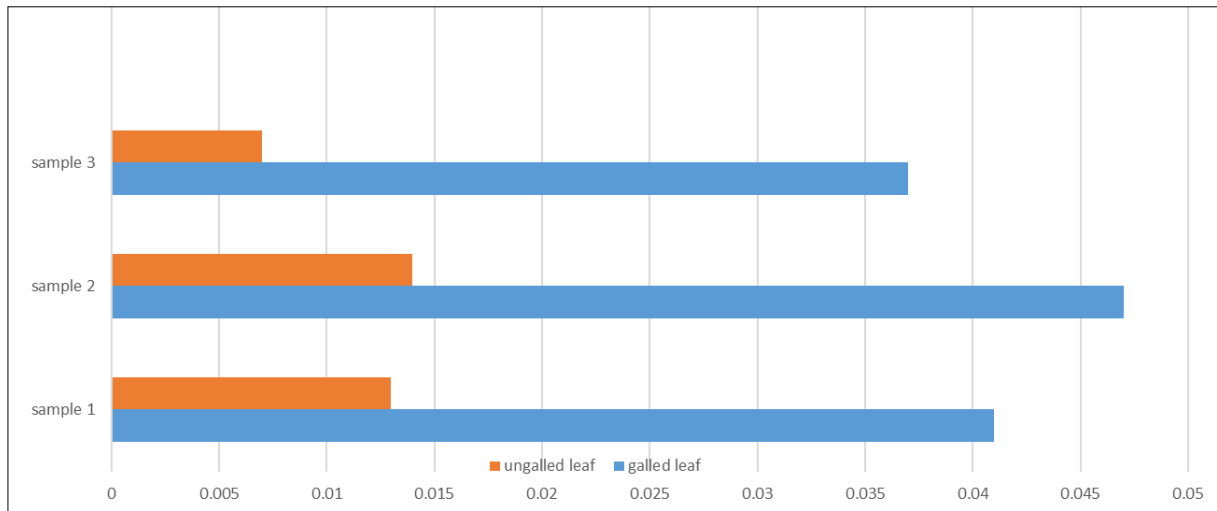
The Folin Ciocalteu assay was used to measure the total phenol content of the galls on *Garuga pinnata*, which is

caused by Hemipteran psyllids. According to the findings, galled leaves have a higher phenol content than ungalled leaves. This demonstrates unequivocally how gall insects change plant metabolism, which in turn decreases herbivory. Therefore, the rise in phenolic content serves as a marker for changed plant metabolism. All three of the collected samples had higher phenolic content in galled leaves and lower levels in ungalled leaves.

The values obtained for the phenol test is given in table 2. The proportion of phenolic content is depicted in figure 3

**Table 2:** Values of the phenolic content present in galled and ungalled leaves of *Garuga pinnata*

Sample solution	Galled leaf (mg/ml)	Ungalled leaf (mg/ml)
Sample 1	0.041	0.013
Sample 2	0.047	0.014
Sample 3	0.037	0.007



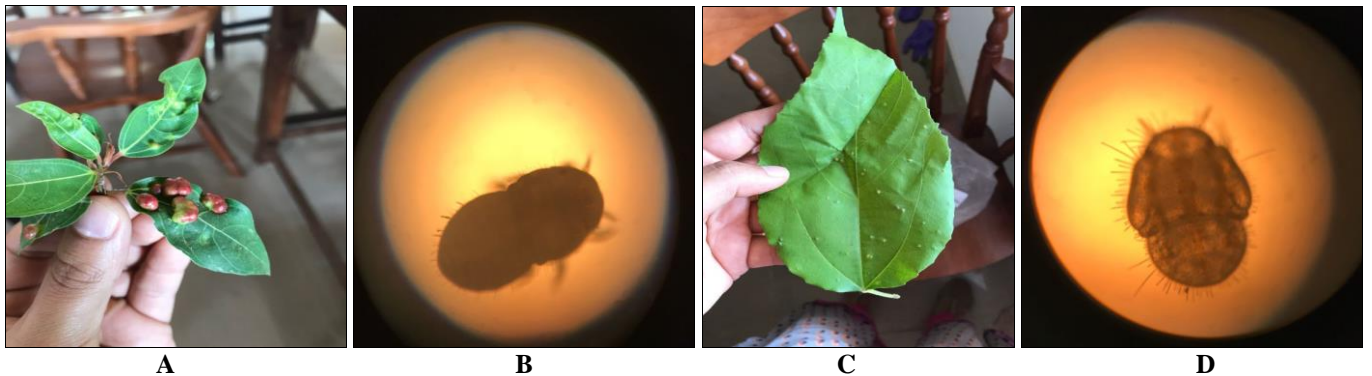
**Fig 3:** Proportion of phenolic content in galled and ungalled leaves of *Garuga pinnata*

**Conclusion**

Dicotyledons are the host of most gall inducers, and gall insects were very specific to their host plant species. Black pepper is frequently plagued by thrips, the marginal leaf rolls gall induced by *Gynaecothrips* sp, one of which is gathered as a major pest from *Piper nigrum*. (Visalakshi and Joseph 1967) [5].

Similar research was conducted by J.P. Gupta (2011) [1], who examined the levels of phenol in the normal tissue of insect-induced galls on a few economically significant

plants in Rajasthan, India. The findings demonstrated that gall tissues had higher phenol contents than their normal counterparts. When comparing it to this project work, the outcomes match perfectly good. The phenolic content of the galled leaf is higher than that of the ungalled leaf. According to these findings, the insect larvae that grow inside the galls benefit nutritionally from them, and because they contain a lot of defensive phenolics, they are shielded from herbivore attacks.



**Plate 1:** Leaf galls A. *Ficus racemosa* B. Psyllid nymph from *Ficus racemosa*



**Plate 2:** Stem gall A. *Phyllanthus emblica* B. Lepidopteran larva from *Phyllanthus emblica* C. *Garuga pinnata* – leaf gall

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