ISSN No:-2456-2165

A Survey on Insect Gall Diversity in Two Different Areas at Kozhikode District, Kerala

Aneesha P.
M.Sc., PG and Research Department of Zoology, Nirmala College for Women, Coimbatore -18

Dr. J. Roopavathy
Assistant Professor, PG and Research Department of Zoology, Nirmala College for Women, Coimbatore-18

Abstract:- A study investigated to explore the distribution of insect gall in two different areas at Kozhikode district, Kerala (Vatakara and Koyilandi). Galled and ungalled plants were collected from these two study areas. These galls bearing plant parts were dissected and observed under the stereomicroscope. Followed by observation sorting and phenolic test was done up to family level and the possible galls were photographed. So the present study revealed that the galled leaf show higher phenolic content when compared to its ungalled leaf.

Keywords:- *Galls, Ungalls, Stereomicroscope*

I. INTRODUCTION

Insects are highly specialized group of invertebrates belonging to the largest phyla, arthropoda. They appeared on the scene from 350 million years ago, during Mississippian period of Paleozoic era and now they constitute the most dominant class of animal kingdom. The estimated 1.35 million living species of animals, more than 9 lacks are insects. The class insect is further divided in to 29 orders which can be broadly grouped as winged and wingless insects. A large number of insect species are adapted to feed over a variety of plants ruthlessly causing severe damage to our economy; such destructive insects are called as pests. Whenever the population of any insects increases significantly so as to cause appreciable economic loss then it attains a status of the pest.

Galls are plant structures formed by abnormal growth of cells, tissues or organs in response to stimuli caused by other organisms (Carneiro *et al*., 2009, Rohfritsch & Shorthouse 1982). The insect stimulus may be the saliva of the gall inducing insects, the secretion during oviposition or larval feeding (Raman 2007). This abnormal growth is due to increase in cell volume (hypertrophy) and/or cell number (hyperplasia). They can be caused by viruses, fungi, bacteria, insects and mites. A rich insect fauna is associated with the galls and includes predators, parasitoids, tenants and successors, so galls represent a true micro habitat where several tri-trophic relations are established (Maia 2001). A recent study estimated the richness of insect galls in about 120,000 species (Espirito Santo & Fernandes 2007), making knowledge of this group essential for ecological studies.Recently, outbreak of some gall including insects have been reported as invasive exotic species causing severe damage and serious threat to commercially important plants (Faizal *et,al*., 2006; Jacob *et, al*., 2007). Galls are rich in resins and tannic acid have been used in the manufacture of permanent inks, in dyeing and in tanning. The gall tissue produced by the same plant in response to species of gall formers differed in chemical composition from that of un galled tissue. This is tested using Folin-Ciocalteu assay for total phenolic study. Phenols, the aromatic compounds with hydroxyl groups react with phosphomolybdic acid in Folin-Ciocalteu reagent in alkaline medium and produce blue coloured complex.

The present study aimed to investigate the diversity of gall inducing insect and insect induced plant gall from two sites in Kozhikode district, Kerala. The total phenolic content of galled and ungalled leaves of *Tectona grandis* is also focused inorder to analyze how gall effect plant metabolism.

II. MATERIALS AND METHODS

A. Study Area

Present work was done in Kozhikode district in the state of Kerala. Two sites were selected from the district, which belongs to two Taluks – Vadakara (11◦36’30.5820N) and Koyilandy (11◦26’17’N). The study areas have highly humid tropical climate with high temperature recorded from October to November.

B. Collection of Galls

Leaf galls in different developmental stages were collected along with some part of the plant organ. Pertinent details, such as the binomial name of the host – plant species, date of collection, name of collection site and other relevant plant data were recorded. The vegetative as well as reproductive parts (in some plants) of the host plant were also collected for the identification of the host plant. The collected host plant specimens were taxonomically determined by Mr. Pramod, Department of Botany, Govt. Brennen College.

C. Identification of Galls

The collected galls were photographed by using a good clarity camera. Cross section of the galls were taken to determine the shape of the gall chamber to observe the developing insects. The external gall morphology has been used for insect species identification (DregerJauffret&Shorthouse1992). The collected galls were compared with descriptions of galls by Mani (2000) and other relevant. Every visibly different gall types were kept separately. The gall bearing plant parts were observed regularly and the emerged gall associated insects were collected using an aspirator and killed using ethyl acetate.

Gall materials were dissected in laboratory to expose their internal structure. The collected insects were observed under stereo Microscope, and sorted up to family level and photographs of the possible ones were taken(plate 2,3,4&5).

D. Phenolic Study

In the present study galled and ungalled leafs of same plant *Tectona grandis* were taken. It is a tropical hardwood tree species placed in the flowering plant family Lamiaceae. *Tectona grandis* is a large, deciduous tree that occurs in mixed hardwood forests. It has small, fragrant white flowers and large papery leaves that are often hairy on the lower surface. It is sometimes known as the "Burmese teak". Plant used for phenolic study is depicted in plate 1.

E. Phenolic Assay

Gall induced on *Tectona grandis* was taken for testing total phenolic content. The extraction of total phenolics was performed using the Folin – Ciocalteu assay. The total phenolic content of leaf was determined using the Folin – Ciocalteu reagent (Singleton and Rossi Jr, 1965; Osawa and Namiki, 1981). The results were expressed as mg catechol/g of fresh weight of the material. The reaction was conducted in triplicate and results were averaged (plate 5).

III. RESULT

Present study was carried out with 17 morphotypes of galls in 15 plant species from 13 families. Some of the insects were identified. Most of plant species had only one type of gall. One host plant support more than one gall morphotype – *Piper nigrum* (Piperaceae). One is a globose gall induced by gall midge and the other one is marginal leaf roll gall induced by gall thrips. The insect induced plant galls collected from the study area depicted in table 1.

A. Gall Inducers

The gall inducers of the collected plant galls include gall midges (Diptera :Cecidomyidae), psyllids (Hemiptera: Psyllidae), thrips (Thysanoptera : Phlaeothripidae), gall wasp (Hymenoptera: Eulophidae) and leaf moth (Lepidoptera: Thyrididae). Off all the insects identified ,7 are Diptera (41%) ,5 Hemiptera (29%), 3 are Thysanoptera (18%), 1 Hyenoptera (6%), 1 Lepidoptera(6%).Cecidomyidae are the most dominant gall inducers including 6 of the 16 galls studied, followed by Hemiptera (psyllids), Thysanoptera (thrips), Hymenoptera (gall wasp) and Lepidoptera(fig 1).

B. Composition of Galls

Among the collected galls, its composition can be stated as leaf galls and stem galls.In the present study we got 13 leaf galls and 4 stem galls(fig 2).

C. Phenolic Assay Using Folin-Ciocalteu

The total phenol content of the gall on *Tectona grandis*, which is induced by Gynaikothrips javicae was determined using Folin - Ciocalteu assay. The results showed that galled leaf contain more phenol when compared to that of ungalled leaf. This clearly depicts that the gall insect alter plant metabolism and hence reduces herbivory. So the increase in phenolic content act as an indicator of altered plant metabolism. Out of the four samples taken, all of them showed increased phenolic content in galled leaf and a reduced value in ungalled leaf (table 2: fig 3).

ISSN No:-2456-2165

HOST PLANT	PLANT FAMILY	GALL BEARING ORGAN	GALL INDUCING INSECT	ORDER	FAMILY	GALL MORPHOLOGY
Alstonia scholaris	Apocyanaceae	Leaf	*Pauropsylla* sp.	Hemiptera	Triozidae	Globose
Coccinia indica	Cucurbitaceae	Stem	*Lasioptera cephalandra*	Diptera	Cecidomyiidae	-
Ficus racemosa	Moraceae	Leaf	*Pauropsylla* sp.	Hemiptera	Triozidae	globose
Ficus benghalensis	Moraceae	Leaf	*Chrysocharis echinata*	hymenoptera	Eulophidae	Echinate
Garuga pinnata	Burseraceae	Leaf	*Phacopteran lentiginosum*	Hemiptera	Phacopteronidae	-
Hopea ponga	Dipterocarpaeae	Stem	*Mangalorea hopea*	Hemiptera	Beesonidae	Sea urchin shaped
Helicanthes elastic	Loranthaceae	Leaf	*Phorinothrips loranthi*	Thysanoptera	Phlaeothripidae	Leaf roll
Jasminum malabaricum	Oleaceae	Leaf	Unnamed	Diptera	Cecidomyiidae	Spindle shaped
Leea indica	Vitaceae	Leaf	*Lasioptera* sp.	Diptera	Cecidomyiidae	-
Mallotus philippensis	Euphorbiaceae	Leaf	*Trioza malloticola*	Hemiptera	Triozidae	-
Mangifera indica	Anacardiaceae	Leaf	Unnamed	Diptera	Cecidomydiae	Globose
Pavetta indica	Rubiaceae	Leaf	*Teuchothrips sp.*	Thysanoptera	Phlaeothripidae	Leaf marginal roll
Phyllanthus embilica	Euphorbiaceae	Stem	*Hypolamprus stylophora*	Lepidoptera	Thyrididae	-
Piper nigrum	Piperaceae	Leaf	Un identified	Diptera	Cecidomydiae	Globose
Piper nigrum	Piperaceae	Leaf	*Gynaikothrips chavicae*	Thysanoptera	Phlaeothripidae	Marginal leaf roll
Tectona grandis	Verbenaceae	Stem	*Asphondyla tectonae*	Diptera	Cecidomydiae	-
Tectona grandis	Verbenaceae	Leaf	Unnamed	Diptera	Cecidomydiae	Discoid

Table 1:- Insect Induced Plant Galls Collected From Study Area

SAMPLE SOLUTION	GALLED LEAF (mg/ml_)	UNGALLED LEAF (mg/ml)
SAMPLE 1	0.043	0.011
SAMPLE 2	0.055	0.014
SAMPLE 3	0.037	0.006
SAMPLE 4	0.026	0.005

Table 2:- The Values Obtained For the Phenolic Test (Galled and Ungalled Leaf)

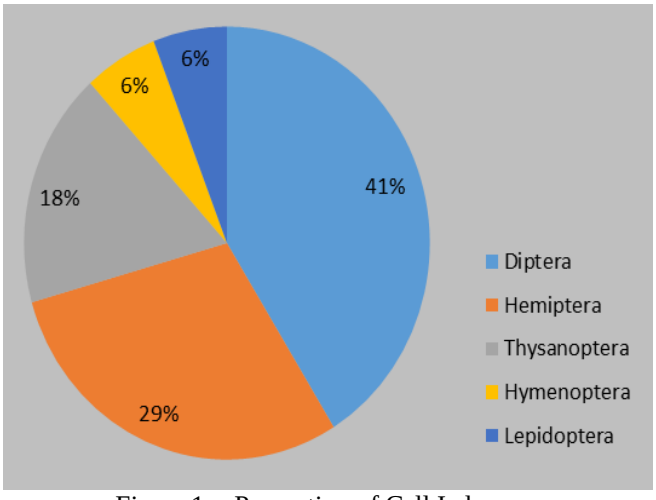


Figure 1:- Proportion of Gall Inducers

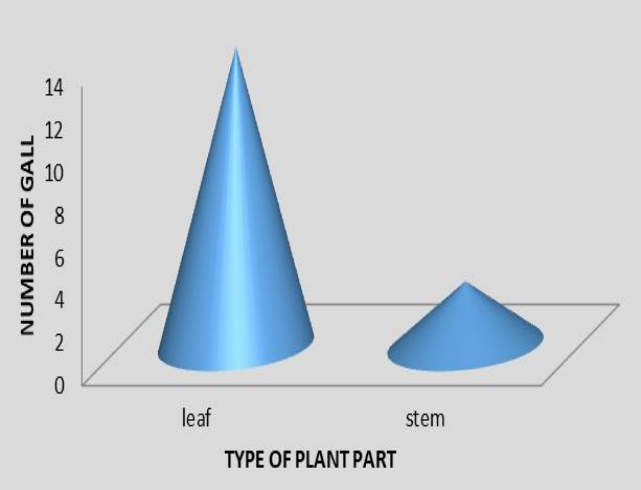


Fig 2:- Composition of Galls

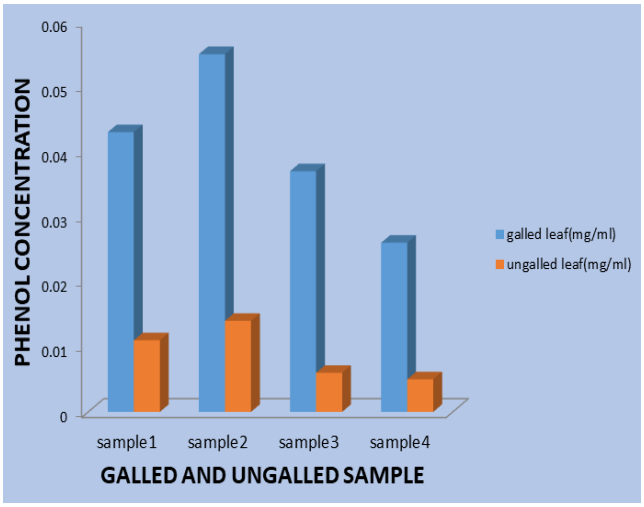
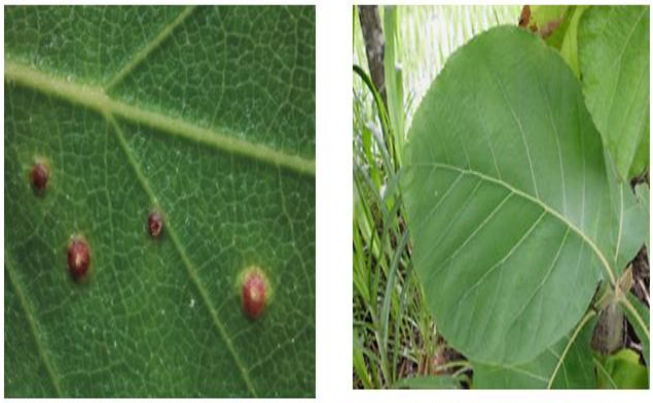


Fig 3:- Total Phenoli Content (Mg/Ml) In 0.1g Tissue



GALLED LEAF UNGALLED LEAF

PLATE 1:- GALLED AND UNGALLED LEAF FOR PHENOLIC STUDY

Phyllanthus embilica

Lepidopteran larva from *phyllanthus embilica*

Coccinia indica

Tectona grandis

PLATE 2:- STEM GALLS

Ficus racemosa

Psyllid nymph from *Ficus racemosa*

Leea indica

Midge Larva from *leea indica*

Alstonia scholaris

piper nigrum - globosegall

ISSN No:-2456-2165

Mallotus philippensis

Psyllid from *Mallotus philippensis*

Garuga pinnata

Psyllid nymph from *Garuga pinnata*

Ficus racemosa

ficus racemosa

PLATE 3:- LEAF GALLS

Sea urchin shaped stem gall from *Hopea ponga*

Gall opened (*Hopea ponga*)

Piper nigrum-marginal leaf roll

Cinnamomum malabatrum leaf gall

PLATE 4:- OTHER GALLS

Galled and ungalled leaf extract

Extract kept for evaporation

Folin-ciocalteu test

PLATE 5:- PHENOLIC ESTIMATION IN THE LEAF GALL OF *Tectona grandis*

IV. DISCUSSION

Indian sub continent displays a rich diversity of gall flora (Raman 2007a) with about 2000 different galls and almost the same number of gall inducing insect species. Hemipterans are one of the dominant gall inducing insect groups with about 350 species (Hodkinson 1984).The insect is not only specific to the host plant, but also specific to the plant organ as the galls are found only on leaves. The result of the study shows that Dipterans are one of the most common gall inducers.

Many workers (Araújo *et al*., 2010; Lebel *et al*., 2008) have reported different morphotypes of galls induced by different gall inducing insects on same host plant. But in *Garuga pinnata* only one type of gall was observed. But in the present study most of the plant species have one type of gall, and one host plant supported more than one gall morphotype.

The plant part contain a wide variety of enzymes, presence of phenol is one type. Here we have investigate how insect galls affect the plant metabolism, and this work was similar to the work of Gupta which tested the amount of phenol in normal tissue of insect galls on some of the economically important plants in Rajasthan, India.

Phenolic compounds occur in a variety of simple and complex forms. During the present investigation of phenolic study the results showed that the phenol contents

were higher in gall tissues compared to the normal counterpart. The results are similar when comparing it to this project work. The galled leaf shows higher phenolic content when compared to its ungalled leaf. These results revealed that the galls are nutritionally beneficial to the insect larvae that grows within and since the defensive phenolics are high in them, they gets protected inside from the herbivore attack.

REFERENCES

[1]. **Araújo WS., Julião GR., Ribeiro BA, Portes I., Abraham Silva., Benedito Baptista dos Santos. (2010)** Diversity of galling insects in Styrax pohlii (Styracaceae): Edge effect and use as bioindicators. *International Journal of Tropical Biology and Conservation*. 59(4): 1589–1597.

[2]. **Carneiro, M.A.A.; Branco, C.S.A.; Braga, C.E.D.; Almada, E.D.; Costa, M.B.M.; et al. 2009.** Are gall midge species (Diptera: Cecidomyiidae) host plant specialists *Revista Brasileira de Entomologia*, 53: 365-378.

[3]. **Dreger-Jauffret, F., and J. D. Shorthouse. 1992**. Diversity of gall-inducing insects and their galls. In Biology of Insect-Induced Galls, ed. J. D. Shorthouse and O. Rohfritsch, *Oxford: Oxford University Press*. 8–33.

[4]. **Espírito-Santo, M. M., and G. W. Fernandes. 2007**. How many species of gall-inducing insects are there on earth, and where are they? *Ann. Entomol. Soc. Am*. 100:95–9.

[5]. **Faizal MH, Prathapan KD, Anitha KN, Mary CA, Lekha M, Rini CR. 2006.** Erythrina gall wasp Quadrastichus erythrinae, yet another invasive pest new to India. *Current Science* 90:1061–1062.

[6]. **Hodkinson ID. (1984)** The biology and ecology of gall forming PsyIloidea (Homoptera). In TN. Ananthakrishnan (Ed.). Biology of gall insects. Oxford and IBH. New Delhi. 59–77

[7]. **Jacob JP. (2007)** Outbreak of gall-inducing Leptocybe invasa (Hymenoptera: Eulophidae) in Eucalyptus plantations in India. Newsltr. *Asia-Pacific Forest Invasive Species Network*. 8: 4–5.

[8]. **Lebel P., Silva SCLD., Cortez JA. (2008)** Galling insect distribution on Psychotria barbiflora (Rubiaceae) in a fragment of Atlantic forest. *Ecotrópicos*. 21(1): 46–53.

[9]. **Maia, V. C. 2001a**. The gall midges (Diptera, Cecidomyiidae) from three restingas of Rio de Janeiro State, Brazil. *Rev. Bras. Zool*. 18:583–629.

[10]. **Mani MS (2000**).Plant Galls of India.(Second Edition), Science *Publishers, Inc., Enfield, New Hampshire. USA*. 477 pp.

[11]. **Raman A. (2007a)** Insect induced plant galls: unresolved questions. *Current Science*. 92(6): 748--756.

[12]. **Raman A., 2007.** Insect-induced galls of India: unsolved questions, *Current Science*. 92(6): 25

[13]. **Rohfritsch O. (1992)** Patterns in gall development. In: Shorthouse JD., Rohfritsch O. (Eds.) Biology of Insect induced Galls. *Oxford University Press*, New York. 60--86.

[14]. **Singleton, V.L. and Rossi, J.A. (1965)** Colorimetry of Total Phenolics with Phosphomolybdic-Phosphotungstic Acid Reagent. *American Journal of Enology and Viticulture*, 16, 144-158.

[15]. **Osawa, T and M. Namiki, (1981)** "A Novel Type of Antioxidant Isolated from Leaf Wax of Eucalyptus Leaves," *Agriculture Biology and Chemistry*, Vol. 45, No. 3