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Galls on Medicinal Plants and Medicinal Plant Galls

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ABSTRACT: All about environment it's about Plant gall. Plant Gall is truly a pathological structure it comes under environmental factors. Gall shows special accent towards ecological relationship and also their impacts towards economic and medicinal field and even parasitic, symbiotic system is recorded in galls towards environment. They play a key role in ecological balance. The gamut of variation of the insect-plant interactions ranges from simple phytophagism to the most complex system of balanced parasitism on the insect side and self-defence adaptive strategies on the host-plant side. The evolutionary culmination of insect-plant interactions is manifested by the morbid outgrowths or the Galls. The plants of scrub forest are found to possess many medicinal properties almost all the gall plants have some use or the other there are some highly reputed herbals recognized in the system of medicine important properties found among gall is towards food values, neutraceutics of galls and its important towards mankind.

Key words- *Garuga pinnata* Roxb., Medicinal Plant Galls, *Morinda pubescence* J.E. Smith, *Ziziphus mauritiana* Lam.

INTRODUCTION

Plant galls are outburst of repulsive reactions of the plant tissues to the stimulus incited by certain guild of phytophagous insects. The ultimate effort of the gall inducing insects is to secure nutrition and safe domain for a short span of time during their life-cycle. In certain instances, these needs are fulfilled by the development of a simple outgrowth of the plant organ, a structure termed 'gall', which provides the food and shelter to the gall-inducing insects and mites. In many cases, the galls induced by the parasites attain phenomenal structural complexity and architectural design which have allured the naturalists. Our knowledge of plant-galls dates back to 17th century, and Marcello Malpighi seems to have held the foundation for the scientific perspectives of the plant galls. Different research centers have been contemplating on the various aspects of cecidogenetic studies and striving to reach solutions for resolving certain intrique queries involved in the cecidogenetic mechanism. Many practical applications may be attributed to ratiocinate the study of plant galls. Certain fungal galls are said to be edible[1] and some galls are also claimed to be traditionally used as drugs. Furthermore, to understand the mechanism involved in the morphogenesis and histogenesis in the normal growth of plant, cecidogenetic studies, similar to tissue culture and experimental methods, may also provide useful information and throw light on our perception of growth and development of plant galls. Every gall is associated with diverse organisms like insect, fungi, bacteria and nematode. The fungal growth found in certain galls is mere inquilines. The mater about galls involves broad based ecological approach and it synthesis knowledge into unified ecological problems. Thus, gall which comes under biodiversity and its conservation [2]. The plant galls have not gained as much of popularity as other vegetables in the food and neutraceutics arena. Many galls, especially certain smut fungal galls have folklore claims for food values of the galls. Scientific evaluations have also affirmed the food and neutraceutical potentials of galls. Thus, the study of plant-galls forms a thrust area in biological sciences. Prof. Mani (Father of Indian Cecidology) has recorded nearly 1100 galls all over India. Surprisingly, not even single percentages of these galls have been studied for their medicinal value. In the present investigation the following aspects have been identified for comprehensive study of folklore claims of medicinal value of galls as well as galls on medicinal plants.

MATERIALS AND METHODS

The different forests from Scrub forest to Deciduous – Evergreen forests were visited at least thrice in a year at an interval of 4 months almost throughout Tamil Nadu. Most of the areas are true scrub forests. A few places are the foot-hills of the Hills and Higher elevation of mountain, exhibit all essential features of the varied habitats of different forests.The specimens of the galls and corresponding normal organs bearing the galls were fixed in FAA (Formalin-Acetic Acid-Ethyl alcohol) for further studies. The galls were photographed mostly in the field in order to preserve their colour and external features. A few mature galls were put in plastic covers with proper aeration for rearing the insects. Galls which were available in sufficient quantities were collected for preliminary phytochemical studies. Identification of the insects was done with the help of the monograph, **Plant galls of India** (Mani, 2000) [3]. For those galls which were the first records, the insects were reared wherever possible. Some insects have been sent to the competent entomologists for determination of the identity. The plants of various forests have been identified and referred with the help of standard books of Gamble Flora (Vol. I, II & III) [4] as well as medicinal properties of the plants and galls were identified with the help of Medicinal Plant of India, 2000 by Yoganarasimhan, S.N.[5] and Indian Medicinal Plants by Dey, A.C. 1998 [6], Wealth of India by J. D. Hooker [7], British Flora.

RESULTS

Galls are mini ecosystems or mini food webs and gall induction is a major specialized type of herbivory, providing adequate information on insect-plant interactions. In these interactions, nutrition and environmental protectants are essential criteria shedding

light on their adaptive nature and ecological significance. They are phenotypic entities that develop under the influence of both plant and insect genotypes and being developmental abnormalities induced by environmental stimuli, galls are considered as 'extended phenotypes' (Weis, *et al*., 1988) [8].

EFFECTS OF GALLING ON MEDICINAL PLANTS

In the present investigation of forests galls, two aspects of economic considerations were analysed. 1. How many medicinally important plants were affected by galling and the severity of the galls? 2. Whether the galls are of any use to the society? The plants of the forests are found to possess many medicinal properties. Almost all the plants have some use or the other. So, it is difficult to list out the medicinal plants from the non-medicinal ones. However, there are some highly reputed herbals recognized in the Indian system of Medicine that are affected by the gall insects. A few medicinal plants of the forests bearing galls are given below (Table – I) :-

1. ***Boerhaavia diffusa*** Linn. (Fig. 1) - The plant is used for oedema, spleenic disorder, urinary disorders, Piles, anaemia, cardiac diseases and Hydrocele. The plant produces shoot apical gall and flower gall soon after rains and disappears during hot seasons. The galls are caused by ***Punarnavomyia boerhaavifoliae*** Mani. Since the gall is seasonal, it does not affect the plant severely.

Fig. 1: ***Boerhaavia diffusa*** Linn. Flower Bud Gall

2. ***Clausena dentata*** (Willd.) M. Roem. (Fig. 2) - It is aromatic shrub; a weed. The plant is used for antimicrobial activities and mosquito repellent. The plant produces *Vermiform covering growth* leaf gall by ***Cecidomyiidae*** (Diptera). The gall is epiphyllous, vermiform, shortly cylindrical, green or pale yellow; mostly along the veins; indehiscent soft and glabrous.

Fig. 2: *Clausena dentate* (Willd.) M. Roem. Leaf Gall

3. ***Cynodon dactylon*** Pers. (Fig. 3) - Barmuda grass, used for ant diabetic, anti-inflammatory, antiviral, brain and heart tonic. This grass bears terminal bud gall formed by a cluster leaf-sheath and terminal part of the culm. The gall is reddish brown. The gall is not common, even though the plant is a common weed. The gall is caused by ***Orseoliella cynodontis*** Kieff. & *Drs Van Leeuwan –Reijnvaan*. The damage due to galling seems to be insignificant.

Fig. 3: *Cynodon dactylon* Pers. Terminal Bud Gall

4. ***Ficus bengalensis*** Linn. - It is used for curing diabetes, diarrhea, and dysentery. It produces Leaf gall by *Nesomyia echinata* Mani (Hymenoptera) - hypophyllous, subglobose, reddish, solid, uni / bicolour, 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.
5. ***Ficus glomerata*** Roxb. - It is used for diabetes, liver disorder and urinal diseases. It is caused by ***Pauropsylla depressa*** Crasf. (Psyllidae) produces *Perfoliate obpyriform* foliar gall and it is predominant one and infesting the leaves in dense agglomerate masses. The gall is epiphyllous sessile, growing as spherical mass on the adaxial side and as conical fistular outgrowth with obliterated ostiole on the abaxial side. The gall is reddish brown with membranous flakes on the surface. The gall is soft, fleshy, indehiscent.
6. ***Ficus religiosa*** L. (Fig. 4) - It cures gastrointestinal issues, respiratory disorders and pain and inflammation. It produces Spindle form vein gall by ***Pipaldiplosis pipaldisplsis*** Mani (Diptera) - hypophyllous, localised or extensively fusiform continuously extending along the midrib as well as lateral veins; hard, indehiscent, reddish brown, longitudinally fissured; gall persists even after leaf fall.

Fig. 4: *Ficus religiosa* Linn. Leaf Vein Gall

7. ***Gymnema sylvestre*** (Retz.) R. Br. ex Schult. - Used for diabetes and glycosuria. **Apical bud gall**: The terminal part of the shoot along with the leaf primordia fuse and swell into a pyriform gall with many larval chambers. The galls are not abundant and not widespread. The gall is caused by a member of **cecidomyiidae** *Punarnavomia* sp.(Gall midge).
8. ***Leptadenia reticulata*** (Retz.) Wight & Arn. - Twining shrub, leaves of economic importance. It cures respiratory disorders, cough, dehydration, tuberculosis and chicken pox. It produces Leaf curl gall *by* **Thysanoptera** (Thrips), one or two margins of a leaf roll adaxially or entire leaf curls and rolls into an irregular shape. Affected leaves as green, wrinkled, glabrous and soft.
9. ***Memecylon edule*** Roxb. - Small tree with edible fruits. It protects skin disorders, menstrual disorders and burning urination. It produces *Double margin leaf roll gall by* ***Brachythrips dantahasta*** Ramkr. (Thysanoptera). Two margins of a leaf roll adaxially up to the midrib forming a thick hollow cylinder. Gall surface is nodulated; gall is thin and coriaceous, light yellow.
10. ***Mitragyna parviflora*** (Roxb.) Korth. (Fig. 5) - Small tree, wood useful. It prevents jaundice, rheumatic pain and muscular pain. It produces Utricular terminal bud gall *by* ***Cecidomyiidae*** (Diptera); Pyriform, ovoid or spherical subterminal shoot apical gall; the galled shoot apex bears malformed leaves at the tip, gall yellow or red, soft, smooth, fleshy.

Fig. 5: *Mitragyna parviflora* (Roxb.) Korth. Shoot Apex Gall

11. ***Piper nigrum*** L. - Liana; cultivated for the fruits. It is useful for Antioxidant, antidiabetic, antimicrobial and others. It produces Leaf margin roll gall by ***Gynaikothrips chavicae*** Zimmermann (Thysanoptera). Two margins of the entire leaf roll abaxially forming thick, crinkled yellow rind long the margins.
12. ***Syzygium cumini*** (L.) Skeels. – It cures digestive issues, cardiovascular problem and inflammation. It produces Blister gall on leaf by ***Trioza*** sp. (Psyllidae) - Foliar gall, aliform, blister like epiphyllous slightly raised pouch with flat or concave 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.
13. ***Tectona grandis*** Linn. – It is useful anti-inflammatory, antimicrobial and antitumor activities. The tree bears densely crowded woolly galls on the leaf and large, woody agglomerate galls on the young stem. The galls are caused by ***Asphondylia tectonae*** Mani (Diptera). The foliar and stem galls are perennial severely affecting the growth of the plant.
14. ***Terminalia arjuna*** W. & A. - Large tree near river banks and lakes. It is useful for antioxidant, anticarsinogenic, antimutagenic and gastro protective. It produces Leaf margin roll gall by **Thysanoptera** (Thrips). Leaf margins of limited distance roll adaxially forming thick, fleshy, smooth, reddish blisters galls; gall is solitary or continuous for some distance with uneven thickness.
15. ***Tinospora cordifolia*** (Willd.) Miers ex Hook. f. & Thoms. Twining shrub of medicinal importance. It cures stomach upset, jaundice, constipation and vomiting. It produces Terminal bud gall by **Cecidomyiidae** (Diptera). Vegetative bud gall formed by fusion of leaf primordial of a terminal bud, soft, glabrous, smooth, spherical or other shapes indehiscent, amorphous mass gall on the axillary shoot tip.

Table - I

Galls on Medicinal Plants				
S. No.	**Host Binomial**	**Causative Organism**	**Gall Type**	**Plant Organ**
1.	*Boerhaavia diffusa* Linn. (Nyctaginaceae)	*Punarnavomyia boerhaavifoliae* Mani	Leaf fold gall	Shoot apical and flower
2.	*Clausena dentata* (Willd.) M. Roem. (Rutaceae)	*Cecidomyiidae* (Diptera)	Vermiform covering growth gall	Leaf
3.	*Cynodon dactylon* Pers. (Poaceae)	*Orseoliella cynodontis* Kieff. & *Drs Van Leeuwan –Reijnvaan*	Terminal bud gall	Shoot apex
4.	*Ficus bengalensis* Linn. (Moraceae)	Nesomyia echinata Mani (Hymenoptera)	Erupting Gall	Leaf Gall
5.	*Ficus glomerata* Roxb. (Moraceae)	Pauropsylla depressa Crasf.	Pouch Gall	Leaf Gall
6.	*Ficus religiosa* Linn. (Moraceae)	Pipaldiplosis pipaldiplosis Mani (Diptra)	Fusiform Gall	Leaf Gall
7.	*Gymnema sylvestre* (Retz.) R. Br. ex Schult. (Asclepiadaceae)	Cecidomyiidae *Punarnavomia* sp.(Gall midge)	Apical bud gall	Shoot apical
8.	Leptadenia reticulata(Retz.) Wight & Arn. Asclepiadaceae	Thrips (Thysanoptera)	Leaf roll gall	Leaf
9.	*Memecylon edule* Roxb. (Melastomaceae)	Unknown Cecidomyiidae (Diptera)	Pouch gall	Leaf
10.	*Mitragyna parviflora* (Roxb.) Korth. (Rubiaceae)	*Cecidomyiidae* (Diptera)	*Utricular terminal bud gall*	Shoot apex gall
11.	*Piper nigrum* L. (Piperaceae)	*Gynaikothrips chavicae* Zimmermann (Thysanoptera)	*Leaf margin roll*	Leaf
12.	*Syzygium cumini* (L.) Skeels. (Myrtaceae**)**	*Trioza* sp. (Psyllidae)	*Blister gall*	Leaf
13.	*Tectona grandis* Linn. (Verbenaceae)	Cecidomyiid	Pouch Gall	Leaf
14.	*Terminalia arjuna* W. & A. (Combretaceae)	Unknown Cecidomyiidae (Diptera)	Blister Gall	Leaf
15.	*Tinoapora cordifolia* Miers. *(*Menispermaceae)	Unknown Cecidomyiidae (Diptera)	Rinden gall	Shoot Axis

GALLS OCCUR ON PLANTS IRRESPECTIVE OF THEIR MEDICINAL PROPERTIES. THE BIOACTIVE COMPOUNDS PRESENT IN THE HERBALS DO NOT SEEM TO PREVENT THE INSECTS FROM GALLING THEM. MANY PHYTOPHAGOUS INSECTS ARE MERELY PESTS AND FEED ON THE HERBALS CAUSING HEAVY DAMAGE TO THE PLANT[9]. THERE ARE ALSO INSECTS WHICH INCITE GALLS ON THE MEDICINAL PLANTS THAT ARE HIGHLY REPUTED IN THE HERBAL FORMULATIONS.

Gall infestation is widespread among all types of forests in India. Albeit wide prevalence of galls on all growth habits of plants, no effort is made to estimate their economic utility[10]. Since the galls are conceived to be of pathological in nature, they have not been given consideration for their uses[11]. During the survey of literature on the uses of galls, a few galls have been reported to be medicinally useful. Eg: the pouch gall on ***Terminalia chebula*** (Combretaceae) by *Thrips* (Fig. 12); horn-shaped galls on ***Pistacia integirrima*** (Anacardiaceae, Fig. 9 & 10) and ***Quercus infectoria*** (Fagaceae), the gall nut on *Quercus* sp., (Fig. 11) both caused by *cynipids* (Table – II).

Table – II

Medicinal Plant Galls						
S. No.	**Host Binomial**	**Causative Organism**	**Gall Type**	**Plant Organ**	**Medicinal Uses**	**References**
1.	*Morinda pubescence* J.E. Smith (Rubiaceae)	Asphondylia morindae Mani	Agglomerate inflorescence gall	Compound Fruit Gall	Eczema, fever, ulcer, Glandular swelling.	Yoganarasimhan, S.N. Medicinal Plant of India, 2000.

2.	*Pistacia integirrima* J. L. Steward (Anacardiaceae)	*Dasia aedifactor*	Leaf let roll gall	Foliar gall (Karkata shringi)	Appetiser, expectorant and tonic, asthma, cough, dysentery, dyspepsia.	Dey, A.C. 1998. Indian Medicinal Plants. Wealth of India, J. D. Hooker, British Flora.
3.	*Quercus infectoria* Oliv. (Fagaceae)	*Cynipid wasps*	Hard covering growth	Nut gall (Mayaphal)	Antidote, astringent, expectorant and styptic, cough.	Dey, A.C. 1998. Indian Medicinal Plants.
4.	*Tamarix aphylla (L.) S. Karst (Tamaricaceae)*	(*Eriophyes tlaie*) gall midge	Covering gall	Flower gall	Used in gargles	Yoganarasimhan, S.N. Medicinal Plant of India, 2000.
5.	*Tamarix ericoides Rottler & Willd. and Tamarix troupii Hole //* (*Tamarix gallica* L.) (Tamaricaceae)	ERIOPHYES TLAIAE (ARACHNIDA: ERIOPHYIDAE)	Covering and rinden gall	Young shoot apex, Leaf gall (Jhabuka)	Astringent, diarrhoea, dysentery, Disorders of spleen, oedema, bleeding, wounds, diarrhoea, haemorrhage, spermatorrhoea, ulcers and piles.	Yoganarasimhan, S.N. Medicinal Plant of India, 2000.
6.	*Terminalia chebula* (Combretaceae)	*Dixothrips onerosus*	Hypophyllous huge pouch gall	Foliar gall (Haritaki)	Alterative, astringent, dentifrice, purgative, tonic.	Dey, A.C. 1998. Indian Medicinal Plants.

In the forests of South India, a few galls which were found in abundance have been subjected to analyses of medicinal properties. A few plant-galls were recognized as potential drugs in the Indian system of Medicine. This prompted us to analyse the medicinal properties of the galls. Those galls that are available in large quantities were subjected to pharmacological screening. The mite gall on ***Zizyphus jujube*** (Fig. 13 & 14), fruit gall on ***Morinda tinctoria*** (Fig. 6) and leaf gall on ***Garuga pinnata*** (Fig. 7 & 8) were among the galls to be studied for the medicinal properties.

Fig. 6: *Morinda pubescence* J.E. Smith Compound Fruit Gall

Fig. 7: *Garuga pinnata* Roxb. Leaf Gall

Fig. 8: *Garuga pinnata* Roxb. Leaf Gall After the exit of insect larvae

Fig. 9: *Pistacia integirrima* Leaf Petiole Gall

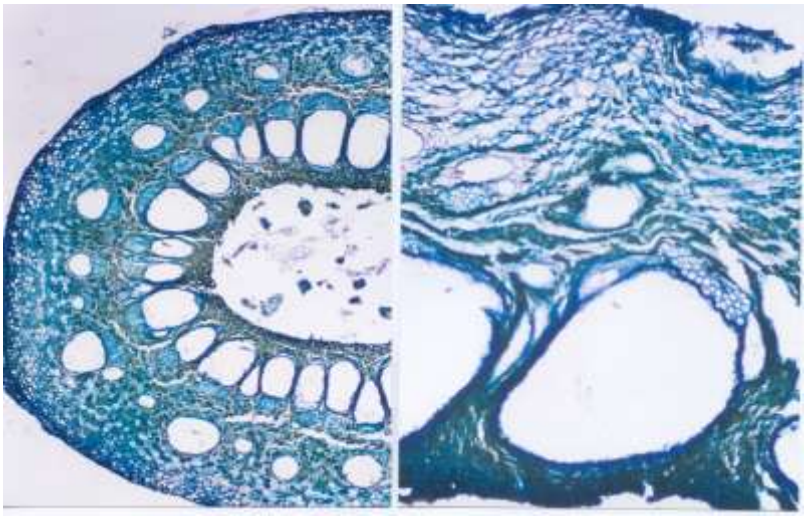

Fig. 10: *Pistacia integirrima* Leaf Petiole Gall T. S. View

Fig. 11: *Quercus infectoria* Nut Gall

Fig. 12: *Terminalia chebula* Leaf Gall

Fig. 13: *Ziziphus mauritiana* Lam. Leaf Gall

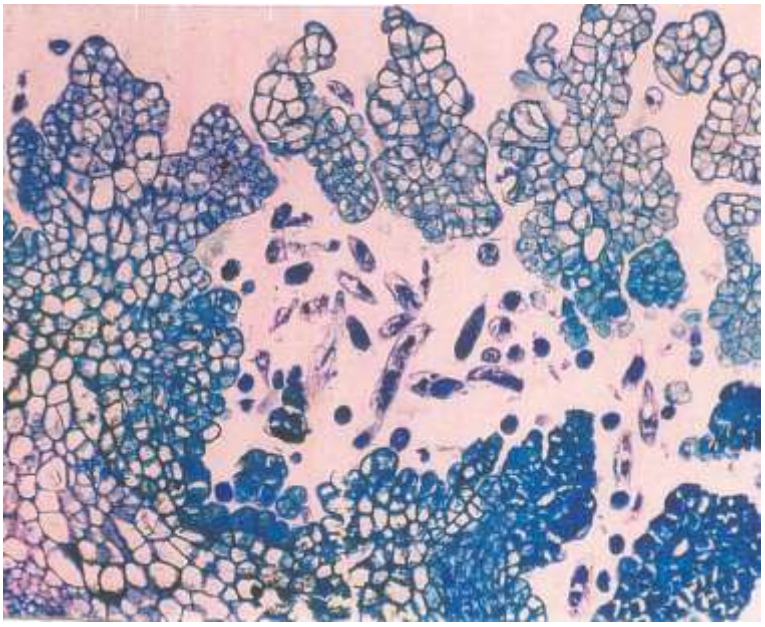

Fig. 14: *Ziziphus mauritiana* Lam. Leaf Gall T. S. View

Table - III

Present Investigation of Medicinal Plant Galls					
S. No.	**Host Binomial**	**Causative Organism**	**Gall Type**	**Plant Organ**	**Medicinal Uses**
1.	*Garuga pinnata* Roxb. Burseraceae	*Phacopteron lentiginosum* Buckton (Homoptera)	*Cupular covering growth rostrate pouch*	Leaf	Diarrhea, ulcers, hemorrhoids, and hyperhidrosis, Cardioprotective
2.	*Ziziphus mauritiana* Lam. (Rhamnaceae)	*Eriophyes cernuus* Massee (Acarina)	*Tuberculate callus like gall*	Stem, Leaf	Pellagra disease

Garuga pinnata Roxb. - Large deciduous tree. Leaf gall, a remarkably curious gall, alluring in size, shape and colour. Gall occurs mostly at the basal part of the leaflet, near the veins. Epiphyllous, densely clustered or solitary, ovoid, or sub-cylindrical, smooth, soft, hollow and apically nipple-like mucronate. The gall consists of a basal cuplike covering growth; from the basal cup arises the erect cylindrical part, which is constricted into neck at the place of insertion. Gall is yellow when young, turns reddish and finally brightly reddish brown. Wide gall contains Psyllid nymphs and adults; mature gall dehisces along the vertical cylinder. Mature galls are 2 cm high and 1 cm thick.

Ziziphus mauritiana Lam. Small tree yielding edible fruits. The gall occurs mostly in the axillary buds or sometimes on the tender leaves and petiole. The gall is bright reddish callus like mass of tuberculate surface. The mites feed on the surface cells of the callus mass and punctured cells develop into a "shoot-apical cell" which produces lateral vegetation producing again new lateral primordial. Thus, several masses with individual apical organization are repeatedly produced forming mass of tissues.

DISCUSSION

An aquatic grass, *Zizania latifolia*, when infected by a smut fungus, *Ustilago esculenta* develop a fleshy edible gall possessing unique flavour and delicacy. This gall is used as vegetable in Taiwan, S. Korea and Manipal in India. A wild reed, *Narenga porphyrocoma* infected by *Ustilago consimilis* and *Rumex maritimus* infected by *Ustilago parlatoreii* give rise to edible galls which serve as palable food for Manipuri community. Paddy grains infested by *Ustilago* sp. give rise to swollen brightly coloured pod-like galls, which are called "*paddy-fruits*", are eaten by farmers in Tamil Nadu. A rust fungus, *Ravenelia esculenta* causes edible gall on *Acacia eburnea* in Maharashtra, India. The afore said galls are only a few to mention. Many more edible galls are yet to be discovered from different parts of India. The results of the present investigation have wide applications both in biological curriculum and in nation's welfare schemes. The research will benefit the Forest ecologists, Insect taxonomists, Plant pathologists, Plant morphologists, Pharmacologists and Natural scientists.

The hills and foot hills are geologically similar in a number of ways and share many species of endemic plants and animals as well as insect induced plant galls. The eastern hills of Southern India have lost much of their original plant gall flora and fauna due to progressively drier conditions. However, similarities in the biodiversity of the Western Ghats, Eastern Ghats and Srilanka have long drawn the attention of biogeographers particularly the gall hunters. Varying altitude, changing aspect, and the resultant variations in rainfall have together rendered these hills as one of the world's most unique biogeographical position, India has been considered as a treasure house of plant galls. Many plant feeding insects have evolved as generalists, living and feeding on plants.

Vegetables constitute important components of a balanced diet for man. They supply important vitamins and minerals that the human body needs for a healthy and active life. Vegetables like carrot, beet root, ladies finger etc. provides normal diet for all human beings, and we have another alternate source of food as well as medicine called plant galls. However, some medicinal plants never affected by galls in any of the plants organs, like Azadirachta indica, Cassia auriculata and Ocimum sanctum still now. The secondary metabolites of these plants strongly protect to fight against the entry of insects in to the plant organs[12].

CONCLUSION

Insect- plant interactions and their relationships have always fascinated the Natural Scientists. Cecidology provides unique opportunity to understand the intrisinic process of morphogenesis and histogenesis which operates during cecidogenesis; these studies cannot be easily carried out in the laboratory conditions. So, galls represent natural products formulated in Nature's laboratory and provide enormous scope for research students of Natural Science. Galls also provide scope for the pathological studies dealing with host plant morbidity and biology of plant parasitic insects. Galls have potentials in bioactive compounds and pharmacological activities, which have not been tapped so far and the time is ripe for focusing attention towards these area. Since the study of galls involves several disciplines such as *plant morphogenesis, insect biology, taxonomy, ecology, phytochemistry* and *pharmacology,* it offers enormous source to pursue all these perspectives either independently or collectively.

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