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CONTRIBUTION TO KNOWLEDGE OF THE GALL INSECTS AND MITES ASSOCIATED WITH PLANTS IN SOUTHERN ROMANIA

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Abstract

Many phytophagous insect and mite species induce galls to plant leaves, either by lying eggs or feeding activity. Some of them attack forest and fruit trees in different environments, and can became serious pests where heavy infestation occurred. The paper presents the results regarding on the presence of galls and gall insects and mites detected in 2013 on various plant species in different sites from northern part of Bucharest city (the South part of Romania). A total of 15 species of insects and 3 species of mites causing gall on plants were evaluated according to their galls type and host plant information. The gall insects belonged to Aphididae, Psyllidae, Cecidomyiidae, Cynipidae families and gall mites belonged to Eriophyidae family. The galls were encountered on the buds, leaves and twigs of plants, as ornamental oak and elm trees, walnut, apple, pear and plum fruit trees and dog-rose, raspberry and goji plants. The damages caused were of aesthetic or economic importance, depending on the purpose for which the investigated plants were used.

Key words: *galls, gall insects and eriophyd mites.*

INTRODUCTION

Organisms producing plant galls are an important group of pests on which numerous research studies have been directed worldwide. The galls are described as abnormal growths of plant tissues caused by increase of some plant growth hormones (auxins, cytokinins, gibberellins, etc.) under the influence of parasite organism species (Neacşu, 2006). Egg laying and feeding activity of numerous phytophagous insects and mites as well as infections of bacteria, fungi or nematodes are among the factors that can induce the galls formation. Many parts of plants (buds, flowers, leaves, stems, twigs or roots) can be affected by galls. Aphids, midges, psyllids and eriophyid mites are among the common arthropod species with abilities to produce different types of galls to a wide range of plant species.

The researches devoted on this subject have been achieved in Romania still in the earliest times by Borcea (1912) and Borza et al. (1938), who brought the first important contributions to the knowledge of the galls in Romanian fauna, which remained applicable nowadays, too.

The extended presence in high density of galls and gall inflicting organisms to a great range of plants and areas in Romania, stimulate many researches and an increased numbers of published studies and new records have occurred recently (Ianovici et al., 2010; Gutue et. al., 2012). From one area to another, the gall types and gall-making organism species are different depending on composition of the host plant species and local climatic conditions, as well as invasion of alien species in new environmental conditions.

In this paper we described the results of investigation on the presence of the galls, and insects and mites associated with them, found on different plant species in sites from various habitats in green spaces, orchards and private gardens located in the Northern part of Bucharest city in 2013. This area has experienced a rapid and profound development in terms of building of people houses and company offices, with promotion of large green areas that become a very complex environment with various vegetation structures and reach flora and fauna diversity.

MATERIALS AND METHODS

The investigation was undertaken in 2013 in sites from the Northern part of Bucharest city, which is located in the Romanian Plain, the South part of Romania. This part of the city benefits from areas with large green spaces including different categories of urban and spontaneous vegetation which created very favourable conditions for the pests and diseases development. For our research purposes, the samples of plants together with their galls and associated arthropods were collected in the field and processed in laboratory conditions. The species of plants and associated gall types and arthropod fauna inside galls were determined based on the descriptions available in relevant publications. The pictures were achieved by photographic techniques.

RESULTS AND DISCUSSIONS

During this research, we recorded various types of galls on plants caused by 15 insect and 3 mite species, belonging to the families Aphididae, Psyllidae, Cecidomyiidae, Cynipidae and Eriophyidae from Hymenoptera, Diptera, Homoptera and Acari orders. The gall arthropods associated with the galls on plant species in Northern part of the Bucharest city detected in 2013 are listed in Table 1.

Table 1. The gall arthropods associated with plant species in Northern part of Bucharest city, 2013

Order	Family	Species	Common name	Host plant of galls
Hemiptera	Aphididae	*Dysaphis devecta*	Apple rosy leaf-curling aphid	*Malus domestica* (Rosaceae)
		Myzus varians	Peach leaf-roll aphid	*Prunus persica* (Rosaceae)
		Tetraneura ulmi	Elm sack gall aphid	*Ulmus sp.* (Ulmaceae)
		Eriosoma lanuginosum	Elm balloon-gall aphid	*Ulmus sp.* (Ulmaceae)
	Psyllidae	*Cacopsylla pyrisuga*	Great pear sucker psyllid	*Pyrus communis* (Rosaceae)
Diptera	Cecidomyiidae	*Dasineura pyri*	Pear leaf midge	*Pyrus communis* (Rosaceae)
		Dryomyia circinans	Oak gall midge	*Quercus sp.* (Fagaceae)
		Asphondylia pruniperda	Gall midge of plum buds	*Prunus domestica* (Rosaceae)
		Lasioptera rubi	Raspberry stem gall midge	*Rubus sp. (*Rosaceae*)*
Hymenoptera	Cynipidae	*Aphelonyx cerricola*	Oak bud gall wasp	*Quercus sp.* (Fagaceae)
		Andricus kollari	Oak marble gall wasp	*Quercus sp.* (Fagaceae)
		Andricus hungaricus	Oak bud gall wasp	*Quercus sp.* (Fagaceae)
		Andricus quercustozae	Oak bud gall wasp	*Quercus sp.* (Fagaceae)
		Cynips quercusfolii	Oak leaf gall wasp	*Quercus sp.* (Fagaceae)
		Diplolepis rosae	Mossy rose gall wasp	*Rosa canina* (Rosaceae)
Acari	Eriophyidae	*Aceria tristriata*	Walnut gall mite	*Juglans regia* (Juglandaceae)
		A. erinea	Walnut leaf blister mite	*Juglans regia* (Juglandaceae)
		A. kuko	Goji gall mite	*Lycium barbarum* (Solanaceae)

The galls were encountered on buds, leaves, and on shoots having various shapes, colour and consistence.

The galls on oak species were the most commonly found. Four important gall maker insects were found associated with fruit trees, apple, pear, peach and plum species, and 2 gall mites on walnut trees. The elm trees were affected by two species of gall aphids.

The insect and mite species causing galls on plants and the type of galls are presented as follows:

***Dysaphis devecta* Walker 1849 (Hemiptera: Aphididae) - the apple rosy leaf-curling aphid** This aphid is widespread on apple trees in Europe, and it is considered an important pest producing galls on leaves of *Malus* species. Damage caused by *D. devecta* appeared in many localities in Romania (Feraru, 2004; Trandafirescu et al., 2004; Ianovici et al., 2010). In this research, it was found feeding on apple trees in orchards and in house backyards from early spring to summer. Characteristic symptoms of rosy aphid infestation are the downward curl of the margins of apple leaves, which gradually transform into galls of shiny red colour (Figure 1). These types of galls are called pseudogalls. The leaf rolling and red colour of galls are caused by a toxin present in the saliva of aphids, which is injected into leaf tissues

during their feeding from phloem. Large colonies of aphid develop several generations inside galls, sucking sap under protection of curled leaves. Aphid damages include loss of sap, decrease of the foliage surface of apple trees by coating with honeydew on which the fungal diseases develop.

Figure 1. Red galls of rosy leaf curling aphid

***Myzus varians* Davidson 1912 (Hemiptera: Aphididae) - the peach leaf-roll aphid** This is spread in Europe, Minor Asia and North America, and is considered a sever pest for peach in Italy (Manachini et al., 2004). Aphid damage on peach was reported in the Southern part of Romania (Chireceanu 2006; Sivu, 2011). The biological cycle of *M. varians* occurs on peach *Prunus persica* (primary host) and on species of *Clematis* (secondary host). Under the influence of the *M. varians* attack, the peach leaves roll backwards along the midrib, the galls being of cigar shapes (Figure 2). Additional to direct damage, *M. varians* is an efficient vector of the Plum Pox Virus, causing significant losses in peach crop, on which the aphid can transmit from infected *Clematis* plants to peach trees (Manachini et al., 2004). In 2013, ooccasional attacks of *M. varians*, visible through the curled young leaves of the annual shoots were notated on peach trees in orchards and house backyards.

Figure 2. Peach leaves rolled caused by *M. varians*

***Tetraneura ulmi* L. 1758 (Hemiptera: Aphididae) – the elm sack gall aphid** It is a cosmopolitan species found in Europe, Asia and North America and Romania as well. This aphid galls (Figure 3) have a bean shape with peduncle and are smooth and shiny, of reddish, green or yellow colour. They are produced on the leaves of elm tree species (*Ulmus spp.*). The winged aphids emerge from elm galls in June-July and colonize the grasses roots from the *Poaceae* family. In autumn, they return to elm. The galls of *T. ulmi* were collected from the leaves of massively attacked elm trees in June in a private garden.

Figure 3. Elm leaf galls of *Tetraneura ulmi*

***Eriosoma lanuginosum* Hartig 1839 (Hemiptera: Aphididae) - the elm balloon-gall aphid** The galls form on elm branches (Figure 4). They are bag-shaped and have variable sizes. The abandoned galls are hard and dry with various numbers of holes, where the aphids exited. The abandoned galls may

host various organisms as caterpillars. Samples of balloon-galls were sampled from one elm tree in a street alignment in autumn.

Figure 4. *Eriosoma lanuginosum* galls

***Cacopsylla pyrisuga* Foerster 1848 (Hemiptera: Psyllidae) – the great pear sucker psyllid** It is a phloem feeding insect important pest of pear in Europe, where is widely distributed. *C. pyrisuga* develops only a single generation per year from March to May (Chireceanu, 2001). The damage to pear trees is produced by deposition of a great number of eggs along the midrib on the upper surface of leaves. The attack results in the rolling up of leaves (Figure 5), stunting of shoots and covering of the trees foliage with sooty mould that develop on the honeydew secreted by the nymphs. Usually, *C. pyrisuga* is present together with *C. pyri*, *C. pyricola* or *C. bidens* which compose the pear psyllids group. In addition, this species, similar to others psyllids is vectors for phytoplasmas causing the *pear decline* disease (Lethmayer et al., 2011).

Figure 5. The rolling up of pear leaves under *C. pyrisuga* egg lying action

***Asphondylia pruniperda* Rondani 1867 (Diptera: Cecidomyiidae) – the gall midge of plum buds** This species is widely spread in Europe (Gagné and Jaschhof, 2014). It is regarded as a potential pest for the plum trees in Serbia, Italy and Moldova (Simova-Tošić et al., 2000; Timuş et al., 2014). In Romania, the pest damage is not yet estimated. Only the species of *Prunus domestica* and *P. spinosa* are attacked. *A. pruniperda* has a single generation each year. Adults appear in June and July and females insert the eggs into young buds where the larvae develop onwards. A single larva occurs inside a gall and the pupation completes in the next year (Skuhravá et al., 2007). We found galls midges of plum buds (Figure 6) in a private garden in a residential area. The wasp attack was sporadic.

Figure 6. Galls midge of plum buds

***Dasineura pyri* Bouché 1847 (Diptera: Cecidomyiidae) – the pear leaf midge** *D. pyri* is a European species, present in Europe and North America (Skuhravá and Skuhravý, 2010). In Romania it is present in most pear growing regions. This causes galls exclusively on the leaves of trees in *Pyrus* genus. Females emerged in May and lay their eggs on the leaves growing in the top of annual shoots. By feeding on leaves, the larvae cause galls by rolling upwards and inwards of the margins along the main vine. They develop inside the galls, sucking sap. Two generations are developed annually, May-June and July-May. The infested leaves gradually blacken, dry and early fall from the tree. Great infestations of the gall midge can cause important damage to pear young nurseries. The galls of pear leaf midge

were found on young leaves of vegetative shoots tip, during the summer months, in the house gardens and orchards of some research institutions. The pest attack was limited to 2-10 gall shoots per tree.

***Dryomyia circinans* Giraud 1861 (Diptera: Cecidomyiidae) - the oak gall midge** The species is a forest gall midge developing on trees of genera *Quercus* (Fagaceae), frequently on *Q. cerris*. It is present all over the territory of Romania (Fodor et al., 2011). The larvae cause circular galls affecting both leaf sides of the oak trees (Figure 7): the pubescent discs on the lower side (Figure 7a, b) correspond with round openings on the upper side of the leaf (Figure 7c). The insect has one generation per year; adults fly from April to May; larvae overwinter in the soil after leaving the galls (in the Mediterranean regions) or remain in galls where they pupate. *D. circinans* has economic importance especially in the forest areas.

In the study area, we observed a large number of characteristic galls induced by *D. circinans* on the leaves of *Quercus sp.* trees planted in street alignaments and in private gardens in residential sites. The significance of *D. circinans* attack was relevant for hardly attacked *Quercus* trees used in ornamental purposes. The gall midge attack created an unpleasant aspect for the people and the ornamental value of the trees was reduced.

Figure 7. *Dryomyia circinans* galls on oak leaves:
a) heavily attacked and deformed summer leaves; b) lower leaf side; c) upper leaf side of autumn leaf

From the galls that affected the oak leaves, adults of *D. circinans* (Figure 8) and other wasps (Figure 9) have resulted in laboratory conditions. On the basis of morphological characters of the wasps, compared with the descriptions found in the relevant literature (Graham and Gijswijt, 1998; Stojanova et al., 2012), they may be a natural enemy of the oak gal midge from the genus *Torymus* (Hymenoptera: Torymidae).

Figure 8. *Dryomya circinans* adults

Figure 9. Wasp parasites emerged from galls

***Lasioptera rubi* Schrank 1803 (Diptera: Cecidomyiidae) - the raspberry gall midge,** represents a major pest, mainly for untreated and ungroomed raspberry plantations (Milenković and Tanasković, 2008), widely distributed in Europe and Romania as well. It has one generation per year. In April-May, at temperatures over 14˚C, first adults emerge (Teodorescu, 1999). Females lay groups of 8-15 eggs at the base of flowering buds. White larvae penetrate the raspberry stem forming small bumps under epidermis, which later become galls where the larvae overwinter. The stem galls are asymmetric, globulous or elongated, of 3-4 cm long/1.5-2 cm wide (Anonymous 2007), with cracked and rough appearance (Neacsu, 2006). In our field observations, we collected numerous raspberry canes with galls of *L. rubi* (Figure 8) occurred in a private house garden during spring and summer.

Figure 10. Raspberry gall midge

***Aphelonyx cerricola* Giraud 1859 (Hymenoptera: Cynipidae) – the oak bud gall wasp** The gall wasp is native to countries from Central and Southern Europe, including Romania (Ionescu, 1973) and a recently established species in Britain (Schönrogge et al., 2011). It causes bud galls on *Quercus cerris*. It has a single generation in a year. The galls are round (1.5 - 1.8 cm), strung along the branch and pressed together, surrounding the branch partially or completely (Figure 11a), fixed with a short peduncle resulted from the laid egg of females. The mature galls are brown, glabrous and hard with one or two internal galls (Figure 11b) of oval shape and a thin wall. A high density of wasp galls was noted on many shoots of *Quercus* trees from street alignments and house gardens. White larvae of the gall wasp (Figure 11c) in various larval instars were found inside the galls in the autumn period.

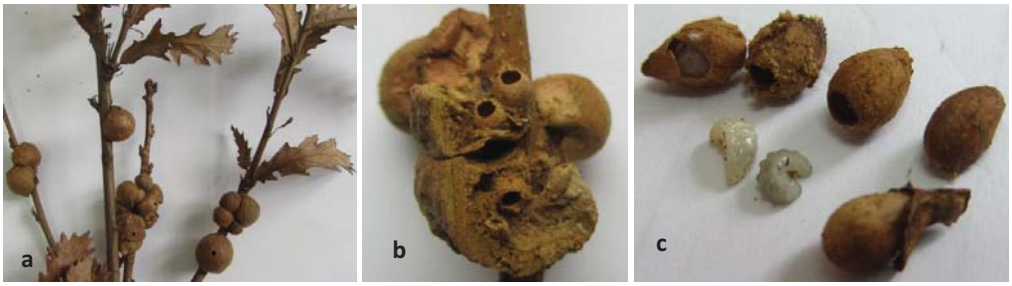

Figure 11. *Aphelonyx cerricola* oak bud galls: a) mature bud galls on shoots; b) section through the galls; c) internal galls and white larvae of oak gall-wasps

***Andricus kollari* Hartig 1843 (Hymenoptera: Cynipidae) – the oak marble gall wasp** The marble gall has alternating sexual and asexual generations. The galls form on terminal or lateral buds of host plants of *Quercus* genus. They are lignicolous, spherical in shape, of 3 cm in diameter (Figure 12). Sometimes they can be a little deformed, especially when commensal organisms develop inside. The galls are more frequent on young bushy trees. They are usually 2-3 together, rarely isolated. Inside the gall, there is the larval chamber, thin and slightly elongated. Galls of *A. kollari* were found during the summer and autumn on oak trees in street alignaments.

Figure 12. *Andricus kollari* oak marble galls

***Andricus hungaricus* Hartig 1843 (Hymenoptera: Cynipidae) – the oak bud gall wasp** It is common in Europe and Romania also, causing galls to oak trees of *Quercus robur* and *Q. pubescens*. The galls form in buds. Females deposit eggs inside the buds, afterwards the galls develop during spring and summer. They fall on the ground in autumn. A gall is large and spherical (20-25 mm) (Figure 13), being one of the greatest in the Western Palaearctic (Stone et al., 2008). It's hard, woody, brown, with angular swells on its surface, sharper or blunt. The gall wall is thick and spongy, containing about 11% tannin (Hac et al., 2013). Inside the gall, there is a large empty chamber with an oval and small internal gall in which the insects develop. Samples of galls were collected from the branches of oak trees during autumn.

Figure 13. *Andricus hungaricus* galls and larva inside the internal chamber

***Andricus quercustozae* Bosc 1792 (Hymenoptera: Cynipidae) - the oak bud gall wasp** The galls of this wasp appear on the oak trees of *Quercus spp.* They are spherical, slightly elongated. The top is bulged and has a small nodule in the middle (Figure 13). The gall is hard, woody, and yellow-brownish and on top it has a crown of nodules surrounding the gall. The gall's external wall is thick, spongy and hard. Inside the gall there is a horizontal cavity, where the internal gall is situated. The internal gall has an ellipsoidal shape situated horizontally and a very thin wall.

Figure 14. Oak bud gall of *Andricus quercustozae*

***Cynips quercusfolii* L. 1758 (Hymenoptera: Cynipidae) - the oak leaf gall wasp** It's a very common and widespread oak bud gall wasp. The galls are induced on *Quercus* oak trees. They are usually developed in groups on the same leaf, rarely isolated, more often on the leaves from the upper part of the oak canopy (Giertych et al., 2013). The medium height oak trees are more affected. They have a spherical shape and a diameter from 1-2 to 3 cm, and are attached in one spot on the main or secondary ribs on the down leaf face. The galls are smooth, glabrous and shiny. The gall's wall is soft, juicy, spongy and white-green in colour, later becoming brown. In the centre is found the larval chamber which is also spherical with a thin wall. Like many other types of oak galls, the *C. quercusfolii* galls (Figure 15) were sampled in almost all the oak trees.

Figure 15. The oak leaf gall of *Cynips quercusfolii*

***Diplolepis rosae* L. 1758 (Hymenoptera: Cynipidae) - the rose gall wasp** This is frequently found in Europe on species of *Rosa spp.*, mainly *R. canina*. Females lay their eggs into plant buds during spring and galls are fully developed in the late summer. Larvae feed upon the leaf bud tissue inside the galls and the pupae remain inside till next year in the spring. The galls have a complex internal structure, with one or many chambers, depending on the

clutch sizes of wasps (László and Tóthmérész, 2008). A multi-chambers gall consists of smaller galls which are spherical and tightly stuck together, having different sizes and each containing a larval chamber. Each gall is fully covered with dense, smooth and filamentous extensions, of greenish, yellowish or reddish colour, up to brown at the completed development in autumn (Ionescu, 1973). The galls are formed on branches, leaves and fruits as well. The galls sampling of rose gall wasp were done from dog-rose bushes in a neglected field between buildings. The galls (Figure 16a, b) were formed on branches and on fruits of the dog-rose plants. From two to seven mature galls per dog-rose bush were encountered in the autumn.

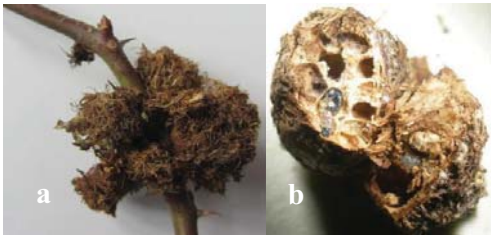

Figure 16a. Mature bud gall on dog-rose
Figure 16b. Dissection of a multi-chambers gall

***Aceria tristriata* Nalepa 1890 (Diptera: Eriophydae) - the walnut gall mite**
***Aceria erinea* Nalepa 1891 (Diptera: Eriophydae) - the walnut leaf blister mite**
Both gall midge species induce galls on the leaf of *Juglans regia* and are considered among the most important worldwide pests for the common walnut (Stojanovic et al., 2001). The two gall mites are originating from Asia, and have large world distribution. In our research, the high infestations of these gall pests on walnut trees were found in residential house gardens. The galls of *A. tristriata* have a round shape with 2 mm in diameter, brown colour, placed on the upper leaves surface of walnut trees (Figure 17). The galls of *A. erinea* form on the lower side of leaves inducing a characteristic discoloured blister like a swollen formation on the upper side of leaves (Figure 18). Later on, the blister zones turn brown (Neacşu 2006). The damage caused on walnut is mainly related to the aesthetic aspect of affected trees. Severe infestations may result from the malformations of young fruits.

Figure 17. *Aceria tristriata* galls on *Junglas* sp. leaves: a. upper leaf side; b. lower leaf side; c. opened gall

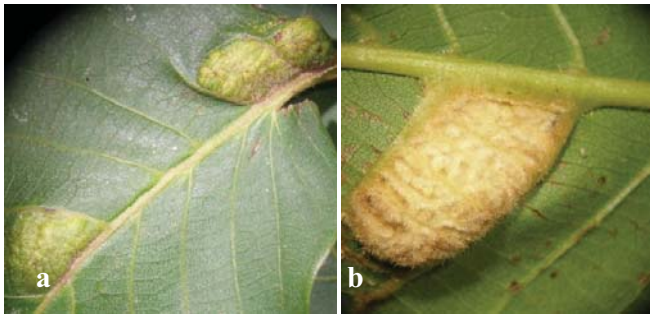

Figure 18. Galls on the leaves of *Junglas* sp. caused by the gall midge *Aceria erinea*, a. upper leaf side; b. lower leaf side

***Aceria kuko* Kishida 1927 (Acari: Eriophyidae) – the goji gall mite** *A. kuko* mite is native from the south-eastern Asia (Ostojá-Starzewski, 2009). It has recently been reported in some European countries, United Kingdom and Netherlands (EPPO 2008), Germany (EPPO 2011), Greece and Slovenia (European Commission, 2012) on planting material of *Lycium spp.* imported from China and other parts outside Europe. The mite develops on *L. chinense* and *L. barbarum*, the weed *Solanum nigrum* and *Capsicum anuum* (Anderson and Starzewski, 2010). Within our research, the presence of *A. kuko* was detected on plants of *Lycium barbarum L.* planted for research purposes in an experimental field. It was probably introduced with the infested plant material brought from China. The affected plants showed a strong attack of the mite. There were galls on buds, both the upper and lower surfaces of leaves (Figure 19). *L. barbarum* (Solanaceae) is a perennial ornamental plant, cultivated for its ornamental or commercial value in the West and South parts of Romania in the last years. At present, there is a commercial production of 'goji berries' in the country. The presence of *Lycium* plants in open field crops can acts as a primary reservoir for the mite, and that could be a threat to the cultures of economic interest from the Solanaceae family (e.g. pepper, tomato, potato, eggplant) cultivated in their vicinity. The weed *Solanum nigrum*, a common weed widely spread around the crops, could also be a potential source for the pest infection (EPPO, 2008).

Figure 19. Leaf galls of *Aceria kuko* on *Lycium sp*.

CONCLUSIONS

As a result of our investigation, a number of 18 types of galls have been collected and described on the plant species from the Northern area of Bucharest city (the South part of Romania) in 2013. Galls were induced on buds, leaves and stems, having various shapes, colour and consistence, on oak and elm trees, walnut, apple, pear and plum fruit trees and dog-rose, raspberry and goji plants.

Presence of 15 insect and 3 mite gall-making arthropod species belonging to 14 genera, 5 families and 4 orders have been recorded to be associated with collected galls.

Warming climatic conditions characteristic of the Bucharest region and environmental diversity in terms of wide range of plant species created a favorable context for presence of a considerable number of plant gall inducing arthropod species in this area just one year, possibly in the absence of adequated control measures.

Information gathered from our results show the importance of an intensive field survey concerning the galls and the galling species presence and identifying them based on their description and host plant information.

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