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GALLS INDUCED BY INSECTS ON OAKS AND ELMS IN THE LUBLIN REGION, POLAND

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ABSTRACT

The aim of the present study was to evaluate, qualitatively and quantitatively, the galls forming by wasps (Hymenoptera, Cynipidae) on oaks and aphids (Hemiptera, Aphididae, Eriosomatinae) on elms in the Lublin region. Besides, a state of knowledge on galls formation as an effect of insect feeding and their effect on host plants are presented. The studies were carried out during three vegetation seasons in 2009–2011 in the habitats of different anthropopressure. As a result of the study the occurrence of galls induced by 11 cynipid species on oaks and 2 aphid species on elms was examined. On oaks high intensity of occurrence was in the case of galls caused by both generations of *Neuroterus quercusbaccarum* (L.) and by asexual generation of *N. numismalis* (Fourc.) as well as *Cynips quercusfolii* (L.). Relatively medium intensity of occurrence was observed for galls of the sexual generation of *A. inflator* (Hartig) on *Q. robur* 'Fastigiata'. So far this gall-forming wasp has not been observed in the Lublin region. On elms high abundance of *Tetraneura ulmi* (L.) galls was noted.

Key words: galls, Cynipidae, Aphididae, gall formation, elm, oak.

INTRODUCTION

Elm (*Ulmus* spp.) and oak (*Quercus* spp.) trees constitute an important element of the landscape. In natural stands of Poland three elm species and five oak species occur. On the other hand, the assortment of tree nurseries comprise a lot of cultivars of the aforementioned plants which are used in urban planting and in private gardens. In the course of the last 200 years changes in the healthiness of these plants have taken place. It was caused by a number of biotic, abiotic and antropogenic factors [24]. In the 18th and 19th centuries elms belonged to the most popular ornamental alley trees in Europe. However, the outbreak of World War I and then the fast spreading Dutch elm disease (DED) caused that within a short time more than half of the European elm population disappeared [18]. However, cultivation of the resistant to DED varieties and the so-called Habitats Directive (Council Directive 97/62/WE) contributed to a systematic increase in the elm population. The first observations on the decreased health condition of oak stands were noticed in the 18th century. Since the 1980's this process has been increasingly deeper, comprising all European countries. Oaks are very important forest and field trees representing high natural and economic values [24]. They constitute pure stands (oak forests), they are an element in riparian and dry-ground forests as well as being a part of landscape plantings [2, 12]. Elm trees, on the other hand, do not make pure stands, growing singly or in small groups in riparian forests, on the edges of mixed and leafy forests, on the banks of streams and rivers and in landscape plantings [12].

The feeding of phytophagous species is one of the biotic factors affecting the condition of plants. In this context, gall forming insects that numerously colonize oak and elm trees, are of particular interest. Cecidogenesis, considered to be the most complex system in the world of nature, is a unique group of interactions between the insect and the host plant. The insect changes the plant's normal development, causing the formation of a new organ by this plant where the growing offspring find shelter and food [22]. The formation of galls is stimulated by arthropods from various orders. Nevertheless, the plant's response to the attack by a phytophagous species is similar, namely the formation of a gall. Their morphological and anatomical structure is characteristic of a given species of the gall-maker even on the same host plant. However, the factors stimulating the plant's response to the attack by a phytophagous species are not known [5].

The purpose of the present paper was to evaluate, qualitatively and quantitatively, the galls induced by wasps (Hymenoptera,

Cynipidae) on oaks and aphids (Hemiptera, Aphididae, Eriosomatinae) on elms in the Lublin region. Such an analysis would make it possible to verify and update the data in this field. Studies of this type were conducted in a fragmentary manner several dozen years ago. Besides, the paper presents the knowledge on the gall formation as an effect of insect feeding and their influence on host plants.

MATERIALS AND METHODS

The studies were carried out during three vegetation seasons in 2009–2011 in habitats of different anthropopressure. Observations comprised elm (*Ulmus* spp.) and oak (*Quercus* spp.) trees growing in natural stands and in the urbanized environment of Lublin and its vicinity. Forest stands were situated in the area of the forests division of Świdnik, Puławy and Lubartów. In addition, observations were conducted in the field plantings in the vicinity of Lublin and in an urban trees in Lublin and Świdnik. In each type of stand, weekly, throughout the vegetation period 10 elm and 10 oak trees were monitored. The qualitative and quantitative evaluation of 200 leaves and 100 shoots randomly taken from each plant (one sample) was made. In the laboratory (Department of Entomology, University of Life Science in Lublin) the collected material was subjected to determine the percentage of leaves and shoots with galls of particular insect species as well as the number of galls on the leaf blades and on the shoots. Three abundance classes were defined as: high intensity (in one sample more than 60% of leaves and shoots with galls of the given insect species), medium intensity (in one sample 30–60% of leaves and shoots with galls of the given insect species) and small intensity (in one sample less than 30% of leaves and shoots with galls of the given insect species).

RESULTS AND DISCUSSION

The presence of 112 cynipid species (Hymenoptera, Cynipidae) in Poland was found. Most of them (47%) colonize oaks, their main host plant (Figure 1). They can also feed on different plant species, mainly from the Asteraceae and Rosaceae family (Figure 2) [8]. Aphids causing galls belong first of all to Eriosomatinae subfamily. Among 23 species forming galls, 7 are trophic related to elms [1, 23].

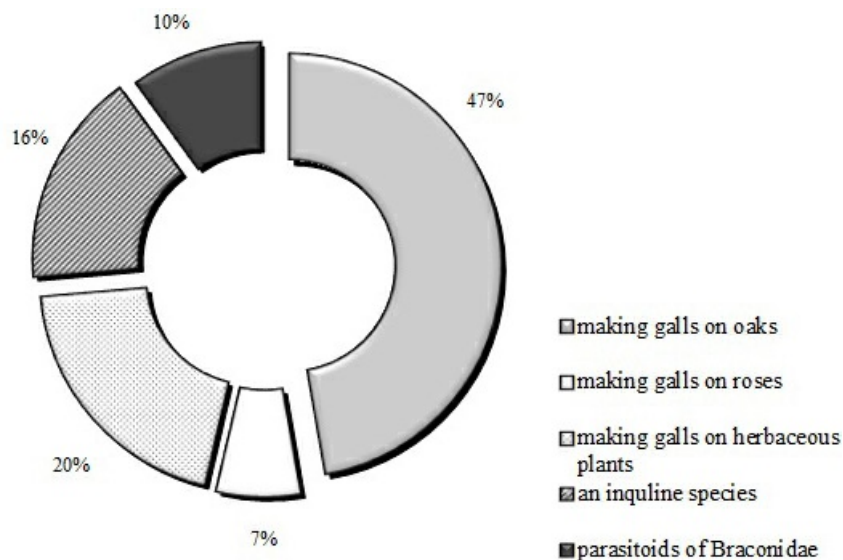


Fig. 1. The trophic relation of Cynipidae species in Poland

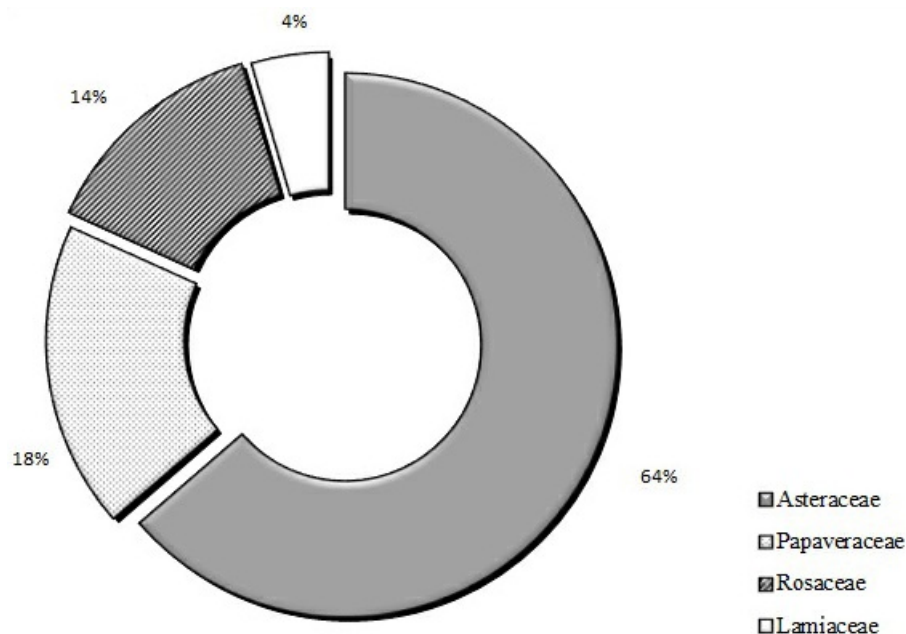


Fig. 2. The percentage of herbaceous-plant families inhabited by gall-forming wasps (Hymenoptera, Cynipidae) in Poland

Study on galls induced by aphids and cynipids in the 20th century mainly concerned their distribution in the country [7, 8, 15, 23]. In recent years these observations have been extended to include some elements of selected species' bionomy and to estimate the number of galls on plants [9, 10, 19, 20, 26]. The Authors' own research conducted in 2009-2011 in different types of habitats proved the occurrence of galls formed by 11 cynipid species on oaks and 2 aphid species on elms (Table 1). High intensity of occurrence was in the case of galls caused by both generations of *Neuroterus quercusbaccarum* (L.) and by asexual generation of *N. numismalis* (Fourc.) and *Cynips quercusfolii* (L.) on oaks, while on elms high abundance of galls induced by *Tetraneura ulmi* (L.) was noted.

Table 1. List of the galls collected from oaks and elms in different habitats of the Lublin region in 2009–2011

Gall-making species	Habitat	Term of occurrence	Intensity of occurrence	Location of gall formation	Comments
Hymenoptera, Cynipidae					
<i>Neuroterus quercusbaccarum</i> (L.)	Forest (Dąbrowa)	May	+	leaves and petioles of <i>Quercus</i> spp.	caused by sexual generation
	Urban trees (Lublin – Czechów estate)		+++		
	Forest (Dąbrowa, Kaniwola, near Puławy, Świdnik, Uścimów)	August–September	+++	leaves of <i>Quercus</i> spp.	caused by asexual generation
	Field plantings (Motycz)		+++		
	Urban park (Lublin's Saxon Park)		+++		
	Urban trees (Lublin – Czechów estate, Świdnik)		+++		
<i>Neuroterus numismalis</i> (Fourc.)	Forest (Dąbrowa, near Puławy, Świdnik)	August–September	+++	leaves of <i>Quercus</i> spp.	caused by asexual generation
	Field plantings (Motycz)		+++		
	Urban park (Lublin's Saxon Park)		+++		
	Urban trees (Lublin- Czechów estate, Świdnik)		+++		
<i>Neuroterus tricolor</i> (Hartig)	Forest (near Puławy)	August	+	leaves of <i>Quercus</i> spp.	caused by asexual generation
<i>Neuroterus albipes</i> Schenck	Forest (Kaniwola, near Puławy)	August	+	leaves of <i>Quercus</i> spp.	caused by asexual generation
<i>Cynips quercusfolii</i> (L.)	Forest (Dąbrowa, Świdnik, Uścimów)	August–September	+++	leaves of <i>Quercus</i> spp.	caused by asexual generation
	Nursery of ornamental plants (near Puławy)		+++		
<i>Cynips longiventris</i>	Forest (Dąbrowa, Kaniwola, near	August–	++	leaves of <i>Quercus</i> spp.	caused by asexual

(Hartig)	Puławy Uścimów)	September			generation
<i>Cynips divisa</i> (Hartig)	Forest (near Puławy)	August	+	leaves of <i>Quercus</i> spp.	caused by asexual generation
<i>Andricus fecundatrix</i> (Hartig)	Forest (Dąbrowa)	August–September	+++	in the lateral and peak buds of <i>Quercus</i> spp.	caused by asexual generation
	Field plantings (Motycz)		++		
	Urban trees (Lublin- Czechów estate)		+		
<i>Andricus inflator</i> (Hartig)	Urban trees (Lublin- Czechów estate)	May	++	in the lateral and peak buds of <i>Quercus</i> spp. shoots	caused by sexual generation
<i>Andricus anthracina</i> (Curtis)	Field plantings (Motycz)	August–September	+	on the mid-rib of <i>Quercus</i> spp. leaves	caused by asexual generation
	Urban trees (Lublin- Czechów estate)		+++		
<i>Biorrhiza pallida</i> (Ol.)	Forest (Dąbrowa)	June	+	in the lateral and peak buds of <i>Quercus</i> spp.	caused by sexual generation
Hemiptera, Aphididae, Eriosomatinae					
<i>Tetraneura ulmi</i> (L.)	Urban park (Lublin's Saxon Park, Bronowice Park in Lublin)	May–June	+++	leaves of <i>Ulmus minor</i>	on elms as primary host
	Urban trees (Lublin – al. Warszawska)		+++		
<i>Colopha compressa</i> (Koch)	Urban trees (Lublin – LSM estate)	May–June	++	on the mid-rib of <i>Ulmus laevis</i> leaves	on elms as primary host

The galls of the sexual generation of *N. quercusbaccarum* are spherical, juicy, with a smooth surface and they were observed on the leaves and flower petioles between May and June. On the other hand, the lentoid-shaped galls of the asexual generation situated on the underside of the leaf blades were picked up from August till autumn. The galls caused by the asexual generation of this species occurred in a comparable and very high intensity on oak trees growing in the forest and city environments as well as in the field plantings. The galls of the sexual generation were found in high intensity only on oaks growing in the city area.

The asexual generation's galls of *N. numismalis* were button-shaped with a characteristic concavity of the upper surface and covered with silky hairs. They were observed on the underside of the leaves in all stands, in August and September. In the same period, big, spherical galls of the asexual generation of *C. quercusfolii* were also noticed (Table 1). However, those galls were found only on oaks in forest stands. Very high intensity of occurrence of this species galls were also observed on *Quercus robur* 'Fastigiata' in the ornamental plants nursery. It was localized in direct neighborhood of a mixed forest near Puławy.

In the examined forest communities no presence of *Andricus inflator* (Hartig), *Andricus anthracina* (Curtis), *T. ulmi* and *Colopha compressa* (Koch) galls was observed (Table 1). The galls caused by the aforementioned species were found only in the city environment. Relatively numerous galls of the sexual generation of *A. inflator*, in the form of dilated shoots, were observed on *Q. robur* 'Fastigiata' in spring. So far this gall-forming wasp has not been observed in the Lublin region [8].

Bean-shaped galls of *T. ulmi* were found on the upper side of the leaf. Galls appeared on elm trees at the beginning of May, and their maturation and opening fell on the second part of June. High intensity of occurrence of *C. compressa* galls were observed on *Ulmus laevis* Pall. Galls in the form of so-called rooster combs situated on the upper side of the leaf blade were observed in May and June. Data on the occurrence of this species on elm trees in the Lublin region come from the 1930's [14, 23].

The insect-plant interactions, considering the species causing closed galls, have not been studied in Poland. The stimuli triggering the formation of galls vary, depending on the group of insects causing them. In the case of aphids, it is saliva introduced into the tissues in the course of feeding by fundatrix, while for Cynipidae these are the larvae exudates of unknown origin. The character and manner in which these exudates act as well as the plants' reaction to them remain unclear [21]. It has not been established, either, in what degree the insect controls the development of the host plant [5, 6] and in what way the feeding of these insects affects the utility value of trees.

Views on the formation of galls underwent changes. Earlier, it was thought that they appeared as a defensive reaction of plants to insect feeding. According to the majority of the present theories, galls are formed as a result of the manipulation of a gall insect in the host plant [27]. Galls are the unique pattern of tissues differentiation that are not found in the normal morphogenesis of organs [16]. They are treated as sinks of assimilation products (carbohydrates, aminoacids) and they are compared to such plant organs as young leaves, flowers and seeds, which compete for them [13].

Information on the species found during the Authors' own studies is dispersed. In the case of *T. ulmi*, a detailed analysis on bionomy and infestation degree of elm trees were conducted [9, 10, 25]. As for *C. compressa*, the effect of insects' presence on the photosynthesis intensity was examined [17]. Observations on gall cynipids were performed in reference to their distribution in Europe [3]. The total content of carbohydrates, nitrogen and phenols in gall tissue of *N. quercusbaccarum* [5] and cytological changes in gall tissues of the sexual generation of *N. quercusbaccarum* [11] and the asexual generation of *C.*

quercusfolii [4] were also examined.

CONCLUSIONS

1. The occurrence of galls formed by 11 cynipid species (Hymenoptera, Cynipidae) on oaks and 2 aphid species (Hemiptera, Aphididae, Eriosomatinae) on elms was stated.
2. The galls of *Neuroterus quercusbaccarum* (L.), *N. numismalis* (Fourc.) and *Cynips quercusfolii* (L.) on oaks and *Tetraneura ulmi* (L.) on elms were the most numerous.
3. The presence of the sexual generation galls of *Andricus inflator* (Hartig) was found first time in the Lublin region.
4. Numerous occurrence of certain species indicate a need to carry out complex studies determining the effect of the feeding of these insects on the condition and utility value of trees.

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