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Preliminary studies on the damage to the leaves of beech (*Fagus sylvatica* L.) caused by insects and mites in the Cisów-Orłowy Landscape Park

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Abstract

In Poland and most of the areas of Europe, the beech, that is, *Fagus sylvatica* L. is one of the most vital species found in the species composition of forests. A number of the species of foliophages tend to develop on the leaves, which may contribute to the dieback of the tree. The demonstrated results are the effects of the research conducted in 2018 in the Cisów-Orłowy Landscape Park. Subsequently, 11 species of foliophages were initially discovered there. Such species were inclined to form galls and the miner damages to the beech leaves. Among 4,000 of the analysed leaves, 398 galls and 498 leaf miner damages were found. They were caused by the representatives of insects and mites.

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1. INTRODUCTION

The common beech, that is, *Fagus sylvatica* L. is one of the most important forest-forming trees in Europe. In Poland, it reaches the north-eastern range limit of its coverage, occupying about 4.9% of the country. Paying attention to its ecological characteristics, it can be stated that this particular species plays a very essential role in creating plant communities in the areas of Pomerania, the Carpathians, in the Sudetes, as well as in the Świętokrzyskie Mountains [Białobok et al., 1990; Sułkowska, 2006].

In recent years, there has been the significant phenomenon of the dieback of beech trees, which has been caused by both biotic and abiotic factors. This process is influenced, to a large extent, by human interference in the natural environment, deterioration of climatic conditions, and the impact of foliophages living on this tree [Skrzypczyńska, Szymczak, 2012]. For this reason, it seems reasonable to draw special attention to the pests occurring on the common beech, which are the cause of considerable economic damages. Such phytophages tend to be both feeding only at some stages of their development as well as occurring throughout the entire period of their activity [Beiger, 2003]. They cause numerous damages to this tree organs. Foliophages should be taken into special consideration, since they cause leaf miner damages (also

known as mines) and galls on the beech leaves, affecting the further development of this kind of tree in a negative way. The damages, such as galls, appear due to the specific reaction of the plant tissue to the irritation caused by the preying organism [Skrzypczyńska, Kowalski 2016]. On the other hand, the process of mining, that is, creating characteristic feeding tunnels in leaf blade by eating the ground tissue of the leaf by the larva living in it, reduces the assimilation surface of the plant [Biej-Bijenko, 1976]. Taking into consideration the limited knowledge dealing with the species found on beech leaves, and their biology, it seems reasonable to carry out a research aiming at:

- identifying the species causing damage to the leaves of the common beech, that is, *Fagus sylvatica* L.,
- performing both the qualitative and quantitative analyses of galls and miner damages (mines) to the beech leaves,
- comparing the species composition of galls and leaf miner damages occurring on the studied surfaces,
- calculating the population density index of the listed species.

These preliminary research studies were conducted in 2018 and they were carried out up to the year 2020.

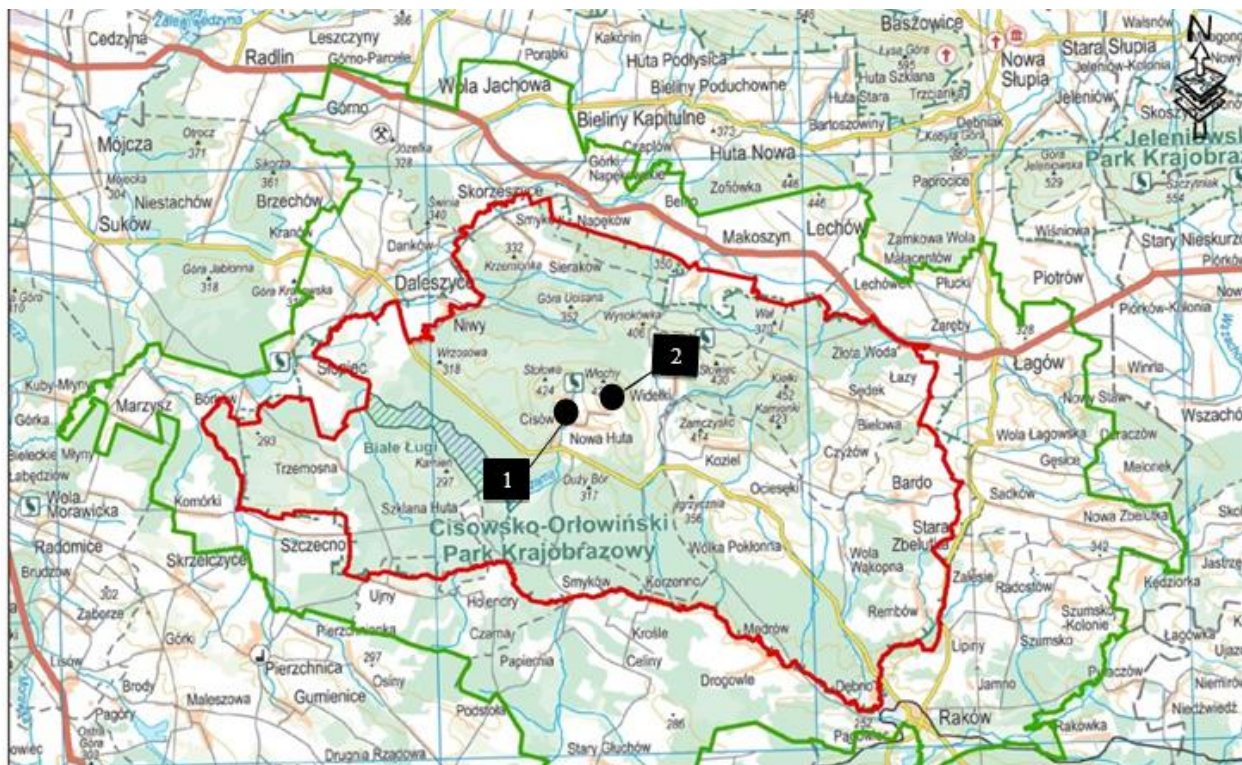


Figure 1. The map of the Cisów-Orłowiny Landscape Park including the study sites. (1) the Cisów Reserve, (2) in the forest used for economic reasons in Widelki (<https://www.pk.kielce.pl/cisowsko-orlowinski/mapa/>, accessed on 26 June 2019)

2. MATERIAL AND METHODOLOGY

The study material was collected in August 2018 in Cisów-Orłowiny Landscape Park (C-OLP) at two study sites. They were located in the Forest Nature Reserve, specifically the Cisów Reserve (named after Professor Zygmunt Czubiński) in 81b forest division and in the forest used for economic reasons in Widelki, that is, 26a forest division (Fig. 1).

Five trees were randomly selected from each study site; moreover, these five trees provided 400 leaves, 100 of which were collected from four corners of the world. In total, 4,000 leaves from 10 trees were selected to be examined. Then, they were thoroughly analysed taking into account the occurrence of leaf miner damages (mines) and galls caused by foliophages. The Schnaider's atlas [1991] was used to determine the leaf miner damages and galls.

To identify the density index of the occurrence (WD) in case of leaf miner damages (mines) and galls at the particular study site, the following formula was used [Segebadé, Schaefer, 1979]:

$$WD = (z/n)a*d$$

where:

z – number of trees with galls and leaf miner damages,
n – number of examined trees,

a – ratio of affected leaves in relation to all analysed leaves,
d – average number of galls and leaf miner damages per one attacked leaf.

3. RESULTS

Among the 4,000 leaves of common beech, that is, *Fagus sylvatica* L., which were analysed, 398 galls represented by five insect and mite species and 498 leaf miner damages caused by six leaf mining insect species were found. Such damages were caused by the representatives of the following orders, namely Diptera, mites Acari and aphids Aphidoidea.

There were 5 species discovered that tended to cause the appearance of galls, namely *Hartigiola annulipes* (132 representatives at the study site No. 1 and 161 representatives at the study site No. 2), *Mikiola fagi* (32 representatives at the study site No. 1 and 11 representatives at the study site No. 2), *Phyllaphis fagi* (8 representatives at the study site No. 1 and 15 representatives at the study site No. 2), *Aceria stenaspis* (24 representatives at the study site No. 1 and 1 representative at the study site No. 2) and *Aceria nervisequa faginea* (14 representatives at the study site No. 2) (Table 1). However, 6 species responsible for the leaf miner damages were determined there, specifically *Stigmella tityrella* (26 representatives at the study site No. 1 and 22 representatives at the study site No. 2), *Stigmella hemargyrella* (14 representatives at the study site No.

Table 1. Occurrence of the density index (WD) in the range of galls found on the examined leaves of *Fagus sylvatica* L., that is, common beech at study site No. 1 (the Cisów Reserve) and No. 2 (in the forest used for economic reasons in Widełki)

SPECIES	NUMBER OF TREES WITH GALLS		NUMBER OF ATTACKED LEAVES		NUMBER OF LEAVES WITH GALLS		Density Index WD	
	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
<i>Hartigiola annulipes</i>	3	5	58	109	132	161	0.4041	0.797
<i>Mikiola fagi</i>	5	4	24	10	32	11	0.1633	0.0436
<i>Phyllaphis fagi</i>	2	5	8	15	8	15	0.0163	0.0742
<i>Aceria stenaspis</i>	1	1	24	1	24	1	0.0245	0.001
<i>Aceria nervisequa faginea</i>	-	2	-	5	-	14	-	0.0277

1 and 1 representative at the study site No 2), *Parornix fagivora* (4 representatives at the study site No. 1 and 28 representatives at the study site No. 2), *Lithocolletis maestingella* (180 representatives at the study site No. 1 and 198 representatives at the study site No. 2), *Chimabacche flagella* (3 representatives at the study site No. 1 and 1 representative at the study site No. 2), *Rhynchaenus fagi* (1 representative at the study site No. 1 and 3 representatives at the study site No. 2) (Table 2).

Comparing the number of foliophages found there, it was shown that the number was similar at both study sites. The species of *Mikiola fagi* was more frequently discovered at study site No. 1, while a greater number of *Hartigiola annulipes* was observed at study site No. 2. The number of aphids of *Phyllaphis fagi* species was outnumbered almost twice at study site No. 2, while the mites of *Aceria stenaspis* dominated at study site No. 1 (Table 1).

Analysing the number of leaf miner damages at both study sites, it was observed that they were also similar at both sites – namely at study site No. 1, it was 228 damages, whereas at study site No. 2, it reached 253. At study site No. 1, *Stigmella tityrella* dominated more frequently, while at study site No. 2, *Parornix fagivora* prevailed (Table 2). *Lithocolletis maestingella* was the most common leaf mining insect at both study sites, that is, No. 1 and No. 2. The number of species discovered at both study sites was similar, that is, 180 and 198, respectively.

Among the insects creating galls on the common beech leaves, the density index at study sites No. 1 and No. 2 reached the largest value for *Hartigiola annulipes* and was equal to 0.4041 and 0.797, respectively. The smallest value at the study site No. 1 was recorded for *Phyllaphis fagi* (i.e., 0.0163). At study site No. 2, the index was the lowest for *Aceria stenaspis*, that is, 0.001. Among the other species causing the galls, at study site No 1., the index for *Aceria*

stenaspis reached 0.0245 and for *Mikiola fagi* – 0.1633, whereas at study site No. 2, the index reached the following values: for *Mikiola fagi* – 0.0436, for *Phyllaphis fagi* – 0.0742 and for *Aceria nervisequa faginea* – 0.0277 (Table 1).

Conversely, for the insects causing the leaf miner damages to the common beech leaves, the index reached the largest value in case of *Lithocolletis maestingella*, namely 0.77627 (study site No. 1) and 0.7557 (study site No. 2). The smallest value of this index, at study site No. 1, was recorded for *Rhynchaenus fagi*, that is, 0.0008. At study site No. 2, the smallest value was reached for *Stigmella hemargyrella* and *Chimabacche flagella*, specifically 0.0008. For the remaining leaf mining insects occurring at study site No. 1, the index was equal to 0.0661 for *Stigmella tityrella*, and 0.0593 for *Stigmella hemargyrella*, as well as 0.0101 for *Parornix fagivora*, and finally, 0.0051 for *Chimabacche flagella*. At study site No. 2, the index values reached 0.0839 for *Stigmella tityrella*, 0.1069 for *Parornix fagivora*, and 0.0046 for *Rhynchaenus fagi* (Table 2).

4. DISCUSSION

The frequency of gall occurrence on the common beech leaves clearly tends to fluctuate, which can be caused by many factors, such as meteorological conditions or biotic factors.

At present, the research conducted in the Cisów-Orłowy Landscape Park has shown that the damage caused by some species found there is incomparably greater than in other examined parks. As for Cisów-Orłowy Landscape Park, in case of *Hartigiola annulipes*, the density index of the occurrence at study site No. 1 and No. 2 reaches 0.4041 and 0.797, respectively. However, the research conducted in 1999 in Chęciny-Kielce Landscape Park revealed that the index value was equal to 0.002. Moreover, in Świętokrzyski

Table 2. Occurrence of the density index (WD) in the range of leaf miner damages (mines) found on the examined leaves of *Fagus sylvatica* L., that is, common beech at study site No. 1 (the Cisów Reserve) and No. 2 (in the forest used for economic reasons in Widelki)

SPECIES	NUMBER OF TREES WITH LEAF MINER DAMAGES		NUMBER OF ATTACKED LEAVES		NUMBER OF LEAF MINER DAMAGES		Density Index WD	
	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
<i>Stigmella tityrella</i>	3	5	26	22	26	22	0.0661	0.0839
<i>Stigmella hemargyrella</i>	5	1	14	1	14	1	0.0593	0.0008
<i>Parornix fagivora</i>	3	5	4	28	4	28	0.0101	0.1069
<i>Lithocolletis maestingella</i>	5	5	188	207	180	198	0.7627	0.7557
<i>Chimabacche fagella</i>	2	1	3	1	3	1	0.0051	0.0008
<i>Rhynchaenus fagi</i>	1	2	1	3	1	3	0.0008	0.0046

National Park, such an index value was insignificant, that is, 0.000027 [Bąk, 2000].

As for *Mikiola fagi* in the Cisów-Orłowiny Landscape Park, there were found more galls on beech leaves than in the Chęciny-Kielce Landscape Park as well as in the Świętokrzyski National Park. The density index of the appearance of this particular species in the Cisów-Orłowiny Landscape Park at study site No. 1, to be precise in the Cisów Reserve, was equal to 0.1633, and at study site No. 2, in the forest used for economic reasons in Widelki, it reached 0.0436. However, in Chęciny-Kielce Landscape Park, this index was equal to 0.107, whereas in Świętokrzyski National Park, it reached 0.127 [Bąk, 2000]. The number of leaf miner damages caused by *Lithocolletis maestingella* was greater during the research conducted in August 2018 in the Cisów-Orłowiny Landscape Park. The density index of the occurrence of this species was equal to 0.7627 (study site No. 1) and to 0.7557 at study site No. 2. In contrast, this index value in the area of Chęciny-Kielce Landscape Park reached 0.03 during the research carried out in 1999 and 2002. Similarly, in Świętokrzyski National Park, no greater occurrence of this species was found, and this index was equal to 0.002 in this area [Bąk, 2000].

The research studies performed by Bąk [2000] in the area of the Chęciny-Kielce Landscape Park showed that no mite species of *Aceria nervisequa faginea* kind was found there, while its occurrence has been exposed in the current studies.

The Diptera flies, to be precise, gall midges from the *Cecidomyiidae* family, namely *Hartigiola annulipes* and *Mikiola fagi*, tend to cause serious problem to the common beech. Many galls caused by *M. fagi* were indicated in the Tatra National Park [Skrzypczyńska, 1983], the Ojców

National Park [Skrzypczyńska, 1990; 1993; 2001], and the Bieszczady National Park [Piotrowska, 2004].

According to the research studies conducted in July 2010, the occurrence of both species of flies was discovered, that is, they were found at three different study sites, namely Staszów, Wolski Forest and Ojców National Park [Skrzypczyńska, Szymczak, 2012]. A massive appearance of *Mikiola fagi* was observed in the Staszów Forest District, where the density index rate of this insect was equal to 0.2115. A large number of *Hartigiola annulipes* was also identified at the study sites in Wolski Forest and Ojców National Park. Comparing the research studies conducted by Skrzypczyńska [2006] in the Ojców National Park and the Wolski Forest, with the earlier research studies [2001], huge differences in the number of galls found on beech leaves have been discovered. Such results clearly indicate the fluctuations and differences in the intensity of the occurrence of insects damaging the beech leaves. They may depend on many factors, both biotic as well as abiotic. Making references to the research studies carried out by Skrzypczyńska and Szymczak [2012], it can be stated that the number of individuals of the identified fly species in the current research studies conducted in the Cisów-Orłowiny Landscape Park was much greater than at the study sites analysed by the above-mentioned authors. The occurrence of these insects in the studied area in the Cisów-Orłowiny Landscape Park was significant enough that further research should be carried out in order to monitor this phenomenon.

Taking into consideration the problem of pest control in case of common beech, it would seem effective to use biological methods of reducing the number of pests by using their natural enemies. Such methods do not pose

any threat to the environment. This problem still seems to exist, therefore, conducting further research in this range and carrying out more detailed analyses tend to be necessary to learn more about this phenomenon and to establish a plan of beech pest control, that is, *Fagus sylvatica* L., in order to prevent its further degradation.

5. CONCLUSIONS

1. Among the identified species, recognised as harmful to the common beech *Fagus sylvatica* L., creating galls and leaf miner damages (mines), a total of 11 species damaging the common beech leaves were found. They were discovered at study site No. 1 (the Cisów Reserve) and No. 2 (in the forest used for economic reasons in Widelki). Such species included: *Hartigiola annulipes*, *Mikiola fagi*, *Stigmella tityrella*, *Stigmella hemargyrella*, *Lithocolletis maestingella*, *Parornix fagivora*, *Chimabacche fagella*, *Phyllaphis fagi*, *Rhynchaenus fagi*, *Aceria stenaspis* and *Aceria nervisequa faginea*.
2. The analysis of collected material gathered in two research areas shows that the species of *Hartigiola annulipes*, *Mikiola fagi*, *Lithocolletis maestingella*, *Stigmella tityrella* and *Parornix fagivora* caused the greatest damage to the common beech leaves.
3. *Hartigiola annulipes* (a total of 290 individuals) turned out to be the most abundant species causing galls at both study sites. In turn, the most numerous leaf mining species, also at each of the sites, appeared to be *Lithocolletis maestingella* (a total of 395 individuals).
4. Carrying out further research dealing with the role of foliophages in relation to their host plants seems to be necessary so as to learn more about the phenomenon of dieback of the common beech.

REFERENCES AND LEGAL ACTS

- BAK J. 2000. Przyczynę do znajomości owadów wywołujących miny i wyrośla na liściach buka *Fagus sylvatica* L. w Górach Świętokrzyskich. Sylwan 9: 113–117.
- BEIGER M. 2003. Stan poznania fauny owadów minujących Polski. Wiadomości entomologiczne 22: 11–105.
- BIĄŁOBOK S., BORATYŃSKA K., BORATYŃSKI A., CHAŁUPKA W., DZWONKO Z., FOBER H., GIERTYCH M. 1990. Buk zwyczajny *Fagus sylvatica* L. Instytut Dendrologii PAN, Warszawa - Poznań.
- BIEJ-BIENKO G. 1976. Zarys entomologii. PWRiL, Warszawa.
- PIOTROWSKA M. 2004. Badania liczebności populacji owadów wywołujących wyrośla na liściach buka zwyczajnego *Fagus sylvatica* L. w wybranych drzewostanach Bieszczadzkiego Parku Narodowego. Praca magisterska. Kat. Entomologii Leśnej AR w Krakowie, pp. 34.
- SCHNAIDER Z. 1991. Atlas uszkodzeń drzew i krzewów powodowanych przez owady i pajęczaki. PWN, Warszawa.
- SEGEBADE R., SCHAEFER M. 1979. Zur Ökologie der Arthropodenfauna einer Stadtlandschaft und ihrer Umgebung II. Pflanzengallen und Pflanzenminen, Anzeiger für Schädlingskunde, -Pflanzenschutz, Umweltschutz: 117–121.
- SKRZYPCZYŃSKA M. 1983. Wstępne badania gęstości populacji gatunków wywołujących wyrośla i miny na liściach buka pospolitego *Fagus sylvatica* L. w Polsce. Polskie Pismo Entomologiczne 53: 415–429.
- SKRZYPCZYŃSKA M. 1990. Wstępne badania muchówek przyszcarkowatych (Diptera, Cecidomyiidae) w Ojcowskim Parku Narodowym. Prądnik 1: 87–94.
- SKRZYPCZYŃSKA M. 1993. Badania owadów i pajęczaków powodujących wyrośla na liściach buka pospolitego *Fagus sylvatica* L. w Ojcowskim Parku Narodowym. Polskie Pismo Entomologiczne 62: 133–138.
- SKRZYPCZYŃSKA M. 2001. Badania częstości populacji owadów i pajęczaków powodujących wyrośla na liściach buka pospolitego *Fagus sylvatica* L. w południowej Polsce. Acta Agraria et Silvestria series Sylvestris 39: 195–204.
- SKRZYPCZYŃSKA M. 2006. Częstość występowania wyroślośprawców na liściach buka zwyczajnego *Fagus sylvatica* L. na wybranych stanowiskach w południowej Polsce. Acta Agraria et Silvestria series Sylvestris 44: 79–89.
- SKRZYPCZYŃSKA M., KOWALSKI T. 2016. Wyrośla drzew i krzewów leśnych. PWRiL, Warszawa.
- SKRZYPCZYŃSKA M., SZYMCHAK E. 2012. Częstość występowania wyrośli powodowanych przez przyszcarki (Diptera: Cecidomyiidae) na liściach buka zwyczajnego *Fagus sylvatica* L. Dipteron 28: 17–22.
- SUŁKOWSKA M. 2006. Zróżnicowanie ekotypowe populacji buka zwyczajnego (*Fagus sylvatica* L.) w Polsce. Sylwan 150, 7: 38–50.