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***LEPIDOPTERA* OF HAZEL PLANTS IN POLAND (Part II). THE NATURAL REGULATION OF *LEPIDOPTERA* SPECIES IN DIFFERENT HABITATS**

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ABSTRACT

The species composition of parasitoids and the level of parasitization of *Lepidoptera* species feeding on hazel shrubs in different habitat conditions was studied during the three years period. Twenty-two species of parasitic hymenoptera (*Hymenoptera*, *Parasitica*) and 2 species of diptera (*Diptera*, *Tachinidae*) were collected. Even infrequent treatments of insecticides on hazel plantations have limited the population of parasitoids and reduced their species richness. *Ichneumonidae* (*Hymenoptera*, *Parasitica*) played the greatest role in parasitization of leaf rollers, while *Lyphia dubia* (*Diptera*, *Tachinidae*) and *Macrocentrus marginator* (*Hymenoptera*, *Parasitica*) of *Operophtera brumata*.

Key words: *Hymenoptera parasitica*, *Diptera*, *Tachinidae*, *Lepidoptera*, parasitization, hazelnut.

INTRODUCTION

Lepidoptera caterpillars, which occur commonly in orchards, are frequently accompanied by a considerable number of natural enemies. Clearly, the greatest importance in the nature is attached to the insects belonging to the orders of *Hymenoptera* and *Diptera*. They form one of the most important communities of beneficial organisms occurring in great numbers both in agrocenoses and in the natural environment. Till now the studies were conducted on parasitization of *Lepidoptera* caterpillars occurring in apple orchards, on currant plantations and on ornamental shrubs in Poland [2, 3, 4, 5, 6, 7, 8]. There is no information on the natural regulation of

Lepidoptera larvae in hazel plantations. The present paper is an integral part of the studies concerning the *Lepidoptera* fauna inhabiting cultivated and wild hazel plants. The purpose of these studies was to find out the species composition of parasitoids and to determine the degree of parasitization of *Lepidoptera* of the larval instars.

MATERIALS AND METHODS

The area of the studies was presented in detail in Part I of publication concerning the occurrence of *Lepidoptera* larvae on hazel in different environments of eastern Poland. The initial material was composed of *Lepidoptera* caterpillars collected from hazel shrubs during three vegetation seasons in the years 1994-1996. The rearing of caterpillars was carried out on Petri dishes and in jars. The wintering instars of insects were kept in a fridge or in the insectarium.

RESULTS

Twenty-two species of parasitic hymenoptera (*Hymenoptera-parasitica*), belonging to 3 families and 11 subfamilies, and 2 species of diptera (*Diptera*, *Tachinidae*) were identified. Among the hymenoptera, 10 species has belonged to the family *Braconidae*, 9 to *Ichneumonidae*, and 3 to *Eulophidae*.

Table 1. Parasitoids reared from *Lepidoptera* caterpillars occurring on hazelnut on the protected plantation, unprotected one and in the forest

Parasitoids	Host	Locality		
		Protected plantation	Unprotected plantation	Forest
Hymenoptera <i>Ichneumonidae</i> <i>Tryphoninae</i> <i>Phytodietus segmentator</i> Grav.	<i>Tortricidae</i>	2	4	
<i>Banchinae</i> <i>Lisonota segmentator</i> F. <i>Exetascus</i> spp.	<i>Tortricidae</i> <i>Noctuidae</i>	2	3	3
<i>Campopleginae</i> <i>Campoplex mutabilis</i> Holmg. <i>Campoplex</i> sp. <i>Spudastica robusta</i> Woldst. (syn. <i>S. kriechebaumerii</i> Bridgm.) <i>Diadegma consumptor</i> Grav. <i>Diadegma armillata</i> Grav.	<i>Tortricidae</i> <i>Geometridae</i> <i>Noctuidae</i> <i>Tortricidae</i> <i>Tortricidae</i> <i>Geometridae</i> <i>Noctuidae</i>	 3 2 6 3	 6 2	 5 7 2 4
<i>Ichneumoninae</i> <i>Syspasis eburnifrons</i> Wesmael.	<i>Geometridae</i>			1
<i>Braconidae</i> <i>Doryctinae</i> <i>Oncophanes laevigatus</i> Ratz. (syn. <i>O. minutus</i> Wesm., <i>O. lancedator</i> Nees.)	<i>Tortricidae</i> <i>Geometridae</i>		2 1	4
<i>Euphorinae</i> <i>Meteorus ictericus</i> Nees.	<i>Tortricidae</i> <i>Lymantridae</i>	7	4 1	
<i>Macrocentrinae</i> <i>Macrocentrus linearis</i> Nees. <i>Macrocentrus marginator</i> Nees.	<i>Tortricidae</i> <i>Noctuidae</i> <i>Geometridae</i>	1	9	1 1 7
<i>Homolobinae</i> <i>Holombus</i> (<i>Phylacter</i> Reinh.) <i>annulicornis</i> Nees. (<i>testaceator</i> auct.)	<i>Noctuidae</i>			2
<i>Heloninae</i> <i>Ascogaster rufidens</i> Wesm.	<i>Tortricidae</i>			3
<i>Microgasterinae</i> <i>Microgaster</i> sp. (<i>Microplitis</i> sp.) <i>Apanteles laevigatus</i> Ratz. (syn. <i>A. hoplites</i> Ratz.) <i>Apanteles ater</i> Ratz <i>Apanteles</i> spp.	<i>Noctuidae</i> <i>Tortricidae</i> <i>Tortricidae</i> <i>Tortricidae</i> <i>Geometridae</i> <i>Lymantridae</i>	1	2 2 3 1 1	2 2

Table 1. cont.

<i>Eulophiidae</i> <i>Eulophus larvarum</i> L.	<i>Tortricidae</i> <i>Geometridae</i> <i>Lymantridae</i> <i>Noctuidae</i>	2	3	3 2 4
<i>Eulophus</i> spp.	<i>Tortricidae</i> <i>Geometridae</i> <i>Lymantridae</i> <i>Tortricidae</i>	1 1 6	1	1
<i>Sympiesis viridula</i> Thomson.				
Diptera <i>Tachinidae</i> <i>Lyphia dubia</i> Fall. <i>Phryxe vulgaris</i> Fall.	<i>Geometridae</i> <i>Noctuidae</i>		38 1	8 1
Total	<i>Tortricidae</i> <i>Geometridae</i> <i>Lymantridae</i> <i>Noctuidae</i>	28 (9 species) 1 (1 species) 2 (1 species) 6 (2 species)	24 (7 species) 52 (5 species) 3 (3 species) 5 (3 species)	14 (5 species) 31 (7 species) 1 (1 species) 17 (7 species)

General parasitization of *Lepidoptera* larvae in the course of three years' studies was over 19%, and depending on the locality it remained at the level of 23% on the protected plantation, 18% on the unprotected one, and 17% in the forest environment (tab. 1). The species composition of parasitoids was also related to the locality.

The greatest number of species and individuals was reared from the larvae of leaf rollers (tab. 2). The majority of parasites belong to this very species, which is connected with a clear domination of *Archips rosanus* species. *Campoplex mutabilis* reared from the larvae feeding on the unprotected plantation and in the forest, and *Meteorus ictericus* from the protected plantation were the most effective. Ichneumons played the greatest part in parasitization of leaf rollers, independent of the localization of the studied site. They limited the population of this family of *Lepidoptera* by more than 10% on the protected plantation, by 6% on the unprotected plantation, and by 5% in the forest (fig. 1). Parasitoids from the family *Braconidae* have parasitized 6% of tortricid larvae on average in all the examined objects. *Hymenoptera* from the family *Eulophidae* were not observed on the unprotected plantation.

Table 2. Parasitization of *Lepidoptera* caterpillars on the protected plantation, unprotected one and in the forest in years 1994-1997

Locality	Family of <i>Lepidoptera</i>	Total number of individuals	Number of individuals parasitized by				Total parasitization (%)
			<i>Ichneumonidae</i>	<i>Braconidae</i>	<i>Eulophidae</i>	<i>Tachinidae</i>	
Protected plantation	<i>Tortricidae</i>	114	12	9	7	0	23.71
	<i>Geometridae</i>	4	0	0	1	0	
	<i>Lymantriidae</i>	11	0	0	2	0	
	<i>Noctuidae</i>	27	6	0	0	0	
	Total	156	18	9	10	0	37
Unprotected plantation	<i>Tortricidae</i>	215	13	11	0	0	18.12
	<i>Geometridae</i>	193	0	11	3	38	
	<i>Lymantriidae</i>	36	0	2	1	0	
	<i>Noctuidae</i>	25	3	2	0	1	
	Total	469	16	26	4	39	85
Forest	<i>Tortricidae</i>	106	5	6	3	0	17.15
	<i>Geometridae</i>	148	10	11	2	8	
	<i>Lymantriidae</i>	16	1	0	2	0	
	<i>Noctuidae</i>	109	7	5	4	1	
	Total	379	23	22	11	9	65

The most frequent representative of *Lepidoptera* was *Operophtera brumata* from the family *Geometridae* on the examined hazel shrubs. It appeared gradually on the unprotected plantation in the years 1994-1995. The most frequent parasite of *Operophtera brumata* was *Lyphia dubia*, which in the 1994 parasitized more than a half and in the 1995 almost 20% of the population of this pest (fig. 2). Another parasite of *Operophtera brumata* was hymenopteron *Macrocentrus marginator* from the family *Braconidae*. Besides, ichneumons from the genera *Campoplex* sp., *Diadegma armillata* and *Syspasis eburnifrons*, as well as *Oncophanes laevigatus*; hymenoptera

from the genus *Apanteles* sp., from *Braconidae* and *Eulophus larvarum* and hymenoptera from the genus *Eulophus* spp. from *Eulophidae* were obtained from the larvae *Geometridae* collected on the unprotected hazel plantation and in the forest environment. Nine species of parasitoids have emerged from the larvae of *Lepidoptera* belonging to the family *Geometridae*. The smallest number of parasites was obtained from the larvae of *Noctuidae* and *Lymantriidae* but the number of larvae from those families was low on hazel plants.

Fig. 1. Parasitization of tortricid larvae (*Tortricidae*) by *Hymenoptera parasitica* on the protected plantation, unprotected one and in the forest in years 1994-1997

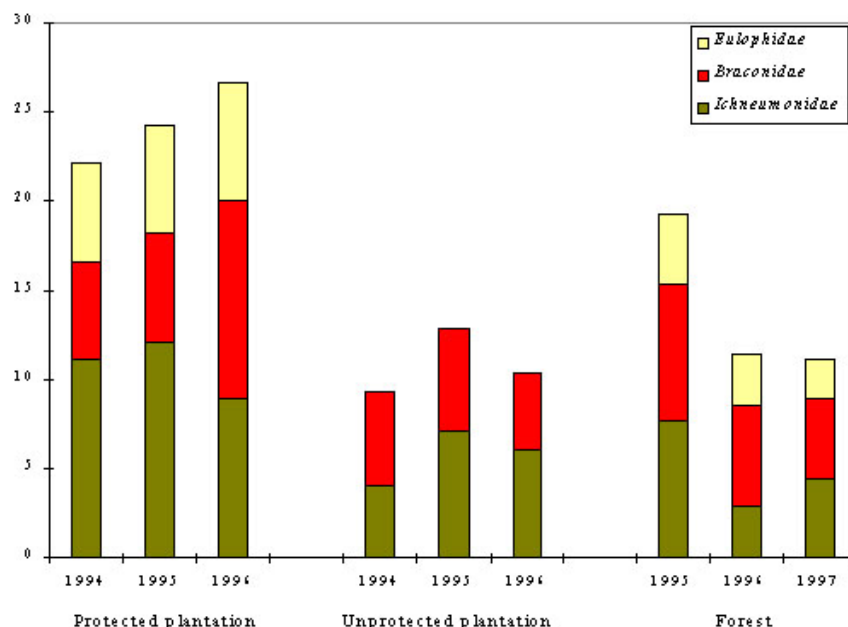
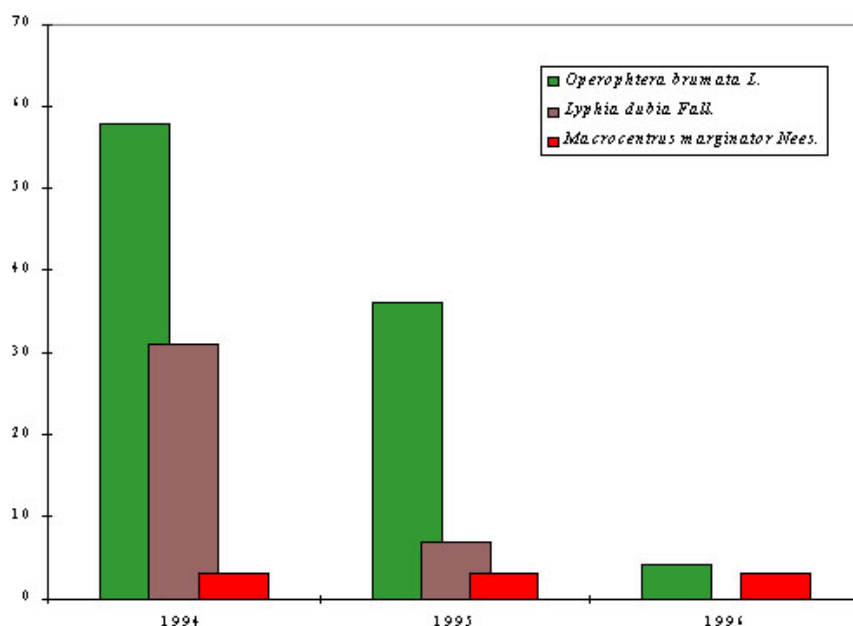


Fig. 2. The occurrence of winter moth larvae (*Operophtera brumata* L.) and participation of parasitoids in reduction of their number on the unprotected plantation in years 1994-1996



Representatives of the family *Noctuidae* mainly belonged to three species, as: *Orthosia cerasi*, *O. cruda* and *Cosmia trapezina*. Their parasites were mainly ichneumons (*Ichneumonidae*) – *Spudastica robusta*, *Diadegma armilata*, *Exetascus* spp., *Braconidae* – *Macrocentrus linearis*, *Holombus annulicornis* and *Microplitis* as well as *Eulophidae* – *Eulophus larvarum*. The most important representatives of *Lepidoptera* species from the family *Lymantriidae* were *Lymantria dispar*, *Calliteara pudibunda* and *Euproctis chrysorrhoea*. Their larvae were hosts of hymenoptera from the family of *Braconidae*: *Apanteles* spp., *Meteorus ictericus* as well as from the family *Eulophidae* – *Eulophus* spp.

DISCUSSION

Totally, 22 species of parasitic hymenoptera (*Hymenoptera Parasitica*) and 2 species of the dipterous (*Diptera*, *Tachnidae*) were found in the groups of collected caterpillars feeding on cultivated and common hazel in different environmental conditions. Eleven species of parasites were observed on the protected plantation, 13 on the unprotected plantation, and 16 in the forest environment. The majority of the obtained parasites are polyphagous species that can feed on representatives of various families of the order *Lepidoptera*. Only *Spudastica robusta* was included in the group of specific hymenoptera connected with the family *Noctuidae*, and *Lyphia dubia* is an olyphagous species feeding on the species from the family *Geometridae* [9].

The natural tendency of entomocenosis to relative species stability can be observed on the example of the processes of self-regulation. *Operophtera brumata* was found among the hazel pests, which its population was regulated by parasites in a significant degree. *Lyphia dubia* turned out to be its main enemy. It parasitized more than 53% of the population in the first years of studies. Besides, two species of parasitic hymenoptera, namely *Oncophanes laevigatus* and *Macrocentrus marginator* as well as one species of *Eulophidae*, namely *Eulophus larvarum* have emerged from *O. brumata* caterpillars. The complex of these parasitoids reduced the number of *Operophtera brumata* almost to a zero. Olszak [5] found out a similar percent of this pest's parasitization, with some differences related to the year and the environment.

The species from the family *Tortricidae* were the most parasitized group of *Lepidoptera* species on the plantation of protected hazel. The complex of leaf roller parasitoids has been the subject of a number of studies, e.g. in orchards [1, 2, 3, 6, 7, 8]. Tortricids were parasitized in 24.5% on the protected, and in 11% on the unprotected plantation of hazelnut. The main role in limiting their numbers was played by *Ichneumonidae*. Similar results were achieved by Miczulski and Koślińska [3], who established the level of parasitization of leaf roller complex in apple orchards of the Lublin area within the range from 3% to 30%. The most effective parasitoids of tortricid caterpillars were *Campoplex mutabilis* from the family *Ichneumonidae*, *Meteorus ictericus* from *Braconidae*, and *Sympiesis viridula* from *Eulophidae*. In the study by Zajanczkaukas [9], all the mentioned above species were mostly noticed as a parasitoids of *Archips rosanus*.

Comparing the species composition of leaf roller parasitoids on both plantations it can be stated that in spite of chemical treatments the parasitic entomofauna was only slightly greater on the protected plantation than on unprotected one. According to Olszak [5], one of the factors increasing the efficiency of parasitoids is maintenance of small populations of pests ensuring the survival of parasitoids.

In conclusion, it should be stated that species and quantity diversity of the observed parasitoids was modified by habitat conditions, including man's activity. The great majority of parasitoid complex was made up of polyphagous species, whose effect is connected with low numbers of the phytophagous, which in this case were *Lepidoptera* caterpillars. Even an infrequent use of insecticides, like on hazel plantations, results in reduction of the population of parasitoids and reduction of the species. Only diversity in the case of leaf rollers, the insecticide treatments had no effect on the level of parasitization of lepidopterous larvae or a diversity of parasitoid species complex.

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CONCLUSIONS

1. Habitat conditions and man's activity modified the occurrence of parasitoids belonging to the orders *Hymenoptera* and *Diptera* in hazel plantations.
2. Most of the parasitoids are polyphagous or olygophagous species the effect of which was associated with small numbers of the phytophagous hosts.
3. Even infrequent treatment of insecticides on hazel plantations reduced the population of parasitoids and their species diversity.
4. *Ichneumonidae* played the greatest role in parasitization of tortricid larvae, while *Lyphia dubia* and *Macrocentrus marginator* were the most effective parasites of *Operophtera brumata*.

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