THESES OF DOCTORAL (PHD) DISSERTATION

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BIOLOGY AND PARASITOID COMMUNITY OF THE HORSE-CHESTNUT LEAFMINER (*CAMERARIA OHRIDELLA*) IN SZIGETKÖZ

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1. INTRODUCTION

The horse-chestnut tree (*Aesculus hippocastanum* L. 1753) was introduced in 1576 from its original range of distribution, South-East Europe to central and western parts of the continent. Today it is one of the most frequently planted ornamental trees in Europe, widespread all over the continent. It plays an important role in making urban life more convenient both by its aesthetic appearance and by filtering polluted air through its foliage. Until roughly two decades ago, at least from the point of view of insect pests, horse-chestnut trees had been ranked among the healthiest garden trees ever planted. The situation changed basically in 1984, with the arrival of the horse-chestnut leafminer (*Cameraria ohridella* Deschka et Dimič, 1986). Spreading very rapidly, the moth has established major parts of the European range of *Aesculus hippocastanum* and is still expanding its area. Compared to other leafminer pests, *C. ohridella* is special for two reasons: first, density of the larvae in the mines by far exceeds that of closely related species; second, infestation level of the trees has not declined until recently due to natural enemies and the moth is able to maintain epidemic population densities in the long run (Grabenweger, 2004/a).

Due to the conspicuous nature of the infestation, the new species soon aroused public interest, becoming target of intensive research. *C. ohridella* is now undoubtedly one of the best known insect pests in many European countries (Grabenweger, 2004/a).

However, the knowledge gained in the last 20 years is insufficient in many regards. There are no studies available on the long-term changes in infestation level of the trees, in parasitism rates or in the parasitoid community of the moth. We know not enough about the biology of the parasitoids; we do not know their demands on the host organism or the environment, their migration habits or their level of adaptation to the new host. Specialist literature is very laconic in terms of the ecological demands of the moth, and is not known how parasitoids are distributed vertically between canopy levels. Above all, it is missing an efficient and inexpensive method to control the horse-chestnut leafminer without posing environmental hazard or threatening the health of the trees.

2. OBJECTS

In compliance with the considerations above, the aimes of our investigations can be summarized as follows:

1. Parasitism of the horse-chestnut leafminer
2. The parasitoid community of the horse-chestnut leafminer
3. Parasitism of different development stages of the moth
4. Flight periods of the horse-chestnut leafminer and its parasitoids, calculated densities of different development stages and aspects of the synchronized development
5. Relation between the parasitism of *C. ohridella* and the attack intensity of the parasitoids
6. Infestation level of the horse-chestnut leaves

3. MATERIAL AND METHODS

3.1. Location and date of investigations:

Our Investigations were carried out between 1998 and 2004 in four different locations in Szigetköz, North-West Hungary. One location is situated near a village (Hédervár), while three in a cathment area (Gombócos, Patkányos, Medve) close to the Danube.

The locations studied were as follows:

1. Gombócos (outskirts of Lipót)

A group of 20 horse-chestnut trees growing in a cultivated poplar plantation. The trees are situated on an island often flooded in the flood plain and can be approached by crossing a barrage. The distance to the nearest settlement (Lipót and Ásványráró) is ca. 3 air kilometers.

2. Patkányos (outskirts of Vámosszabadi)

A young, solitary horse-chestnut tree on an island in the flood plain, growing on the side of a gravel path. The most abundant woody plants in its surroundings are *Populus alba, P. canescens* and other *Populus* species*, Cornus sanguinea, Robinia pseudo-acacia, Quercus robur, Ulmus laevis.* The distance to the nearest settlements (Medve, Slovakia and Vámosszabadi) is 3 air kilometers.

3. Medve (outskirts of Vámosszabadi)

A young, solitary horse-chestnut tree on an island in the flood plain, growing on the side of a gravel path. The most abundant woody plants in its surroundings are cultivated poplar and willow trees (*Populus sp., Salix sp.*), *Quercus robur, Acer negundo, Viburnum opulus, Cornus sanguinea.* The distance to the nearest settlements is 2 air kilometers (Vámosszabadi, Medve).

4. Hédervár

Mostly older trees, arranged in rows in the outskirts of the village. The trees are surrounded by plough-lands and the vegetation under the trees consists of grass species.

3.2. Methods of investigations

In the course of the 7-year investigations, we used different methods of research as our yearly intentions changed. The methods are detailed below:

1998, Hédervár
On the 3rd and 21st of October 1998 and on the 27th of February 1999 – before the flight of the wintering generation - we collected fallen horse-chestnut leaves and put them in paper sacks. Each sample consisted of 1100 pieces of leaflets. The sacks were stored under shelter at a temperature which was more balanced but very close to the outdoors. Before the moths and the parasitoids started to hatch in the spring, transparent jars were fastened in the mouths of the sacks to make insects gather in the jars when flying towards light. The jars were emptied every day, the moths counted and the parasitoids collected for determination. All the parasitoids were identified by dr. Csaba Thuróczy, Systematic Parasitoid Laboratory, Kőszeg. Since non-chalcidoid individuals (Ichneumonoidea: Ichneumonidae, Braconidae) were very rare and hatched only occasionally, and the specialists needed were not available, solely chalcidoid parasitoids were taken into consideration during the whole investigation period (7 years).

1999, Hédervár
On the 8th of October 1999 we collected leaves both from the lower branches (1,5-2,5 m) and from the top of a tree (12-13 m). The leaves were put in two distinct paper sacks according to the level they were collected from. The first sack - with leaves from lower canopy – contained 1100 leaflets. The second sack held 1200 leaflets collected from the top. Despite of the slightly greater number of leaflets, this sample was much less in volume or in mass. Clamping the leaves, rearing and sorting out the insects were done just like in the previous year.

2000, Hédervár and Patkányos
In Hédervár, on the 14th or 20th of October 2000 leaf samples were taken from three levels of the canopy of horse-chestnut trees: one from the lower (1,5-2,5 m), one from the middle (ca. 5 m) and one from the higher level of the canopy (12-13 m). Half of the samples from the lower part of the foliage were taken from branches exposed to the sunshine and the rest from branches which were in the shade; the sample from the middle levels contained shaded leaves only since sunlit parts of the canopy were practically out of reach. The leaves from the top were exposed to direct sunlight during the whole day. The samples were put in three distinct paper sacks according to the level they came from. In Patkányos, on the 13th of October 2000 additional leaf sample was taken from

the lower canopy and the leaves were put in a fourth paper sack. The sacks were stored and the insects were reared just like in the previous year. After hatching had come to an end, the mass of each dry leaf sample was measured with 0.01 g accuracy on a digital scale.

2001, Hédervár, Gombócos, Patkányos

In Hédervár, from June 26 to October 23, 2001, leaf samples were taken fortnightly from several different parts of the horse-chestnut tree canopy. Samples from the lower braches were collected on 9 occasions altogether, 60-60 leaves each time. Half of each sample (30 leaves) consisted of sun-exposed, the other half (30 leaves) of shaded leaves. From the top of the canopy, samples – consisting of 60 sunlit leaves - were taken 9 times during the year. From the middle levels we collected 8 samples, 30 shaded compound leaves each time. On three occasions (26. 6., 100 pieces; 9. 7., 50 pieces; 1. 8., 100 pieces) we also collected minute leaves from the inner canopy; they were attached to thick boughs and all shaded.

According to collecting data and leaf type, the samples were put in sacks made of newsprint paper. The sacks were carefully closed and stored in unheated rooms until insect hatching ended.

In this year, some of the paper sacks (containing leaf samples taken in July, September and October) were opened in January 2002 and the samples were searched for hatched insects. After sorting out and counting insects, the sacks were closed again and put back for a second review in the summer.

In the summer we opened all the sacks and the hatched adult insects – all dead by that time – were sorted out and counted and the mass of each dry leaf sample was measured with 0.01 g accuracy on a digital scale.

In the locations in the flood plain (Gombócos, Patkányos), the leaf samples were taken fortnightly from the lower parts of the canopy; leaf types were not distinguished. Putting the leaves in newspaper sacks, wintering, rearing, determination of the insects and measuring the samples on a scale were done as described previously.

2002, Hédervár, Gombócos, Patkányos

In Hédervár, between June 9 and August 14 leaf samples were taken with 2 weeks intervals from the horse-chestnut trees. Three kinds of samples were taken: one from sunlit parts of the lower canopy (30 leaves a time), one from shaded parts of the lower canopy (30 leaves a time) and one from the sunlit top of the canopy (30 leaves a time). From late of August additional samplings came to grief due to early leaf falling. In the locations in the flood plain (Gombócos, Patkányos), the leaf samples were taken fortnightly from the lower parts of the canopy; leaf types were not distinguished. Putting the samples in newspaper sacks and wintering in an unheated room, sorting out adult insects, parasitoid determination and measuring the samples on a scale were done just like in the previous year.

2003, Hédervár, Gombócos, Patkányos, Medve

In Hédervár, between June 7 and September 28 leaf samples were taken with 2 weeks intervals from the horse-chestnut trees. Two kinds of samples were taken: one from the lower branches (sunlit as well as shaded leaves, altogether 30 pieces a time) and one from the top of the canopy (30 sunlit leaves a time). In the locations in the flood plain (Gombócos, Patkányos), the leaf samples were taken fortnightly from the lower parts of the canopy; leaf types were not distinguished. Putting the leaves in newspaper sacks, wintering, rearing and determination of the insects were done just like in the previous year.

2004, Hédervár

Between July 3 and October 3 altogether 2x13 leaf samples were taken from the horse-chestnut trees. We distinguished between two kinds of samples, one from the sunlit parts of the lower canopy (15 leaves a time) and one from the shaded parts of the lower canopy (15 leaves a time). The samples were put in sacks made of newsprint paper. The sacks were carefully closed and stored in an unheated room up to the end of February 2005. After that date we carried the sacks into a heated room to accelerate insect development. Sorting out adult insects after the flight period and determining parasitoids were done just like in the previous examinations.

In order to determine the most parasitized development stages of the moth, in the spring 2004, before the appearance of the first flying moths, twig ends of the trees were carefully covered with gauze bags to isolate the leaves and prevent them from later moth infestation or parasitoid attack. The bags were ca. 50 cm x 80 cm spread out in a plane and were made of a translucent material used in agriculture to protect young plants from insect pests or slight frost because they do not hinder significantly photosynthesis or breathing of the leaves.

Altogether 66 twig ends were enclosed in gauze bags each of which contained 15 compound leaves on average. Each bag was removed twice during the investigation: the first time to expose the leaves to oviposition of the female moths (Exposure 1), the second time to allow parasitoids to lay their eggs into the mines (Exposure 2). When closing the bags we carefully removed moths and other insects or spiders from the leaves. In all cases, the exposure times were uniformly 1 week.

The 66 gauze bags were divided into 11 groups consisting of 6 bags each. The 6 bags of a group were removed not on the same week for the first time. For instance, the first bag of the first group (bag I/1) was removed between May 10-17 for the first time (Exposure 1), the second bag of the first group (bag I/2) between May 17-23, the third (bag I/3) between May 23-30 and so on, always with one week time lag. When it came to the second exposure, we opened all bags of a group at the same time; in the case of the first group, the bags were removed from July 3 to July 11. Following this procedure ensured that, after the end of Exposure 1, the larvae of the leafminer could develope for at least 7 weeks in bag I/1, for at least 6 weeks in bag I/2 and so on, and for at least 2 weeks in bag I/6 till the encounter with the parasitoids (Exposure 2), allowing parasitoids to choose freely from a range of different development stages of the moth.

Opening and closing bags of the second group (bags II/1-6) were done the same way but always a week later, bags of the third group (bags III/1-6) two weeks later and so on. Group XI was an exception as the procedure with it was started with a delay of 6 (and not 1) weeks after group X.

Leaves from under the bags were picked continuously. We removed leaves before the appearance of the first adult moths, but allowed enough time for the development of the parasitoids after exposure 2. Removed leaves of a bag were put into the same gauze bag and kept in an unheated room up to the end of February 2005. Then all the bags were carried to a heated outbuilding to accelerate development of the insects. After the flight period, dead adult moths and parasitoids were sorted out and counted in the case of each bag.

4. SUMMARY

The main aimes of our investigations were to disclose lesser-known details of the biology of the moth and its parasitoids and to collect data on the structure and the changes of the parasitoid community. We also wanted to determine the most parasitized development stages of the moth.

4.1. Rate of parasitism of *Cameraria ohridella* populations

The rate of parasitism of *C. ohridella* was found to be increasing in all locations investigated. Recessions in some years in Hédervár could be explained by very cold winter temperatures (2002) or lack of water in the mines due to dry and hot weather (2004).

The rates of parasitism in Hédervár were strongly fluctuating in the investigation period but a breaking between the years – apart from one year - could not be realized in spite of the hibernation periods of 7 months between the seasons. In all locations, the parasitism of the horse chestnut leafminer strongly depended on the parasitism in the previous year.

Our results contradict the widespread opinion that the adaptation of the native parasitoids to the horse-chestnut leafminer was very slow. In our investigations this process seems to be fairly rapid but the pace can be decreased by adverse weather conditions. We suppose that larvae of parasitoids are even more sensitive to high temperatures or lack of water in the mines than leafminer larvae. Similarly, we suggest that the majority of the parasitoids overwintering in the fallen leaves do not wander away to seek suitable leafminer hosts on other plants. In contradiction with earlier studies, we assume that a partially stable permanent parasitoid community is under development around the horse-chestnut leafminer.

We found considerable differences between parasitism rates in different locations. The values at Hédervár were usually higher and the fluctuations within a season smaller than in other locations which can probably be attributed to a possible later infestation of the trees in the flood plain.

In 1999-2001 the rate of parasitism at the top of the crown was lower, in 2002-2003 it was higher than below. This tendency implies that the parasitoids exploit the rich food source at the top more and more, which is probably a sign of the adaptation process of the parasitoid community.

Rate of parasitism proved to be considerably higher in shaded leaves than in sun-exposed ones which is probably related to the microclimatic demands of the parasitoids.

It was established that parasitism rates in minute leaves are the least among all leaf types investigated. It is highly probable that most parasitoids of *C. ohridella* search visually for hosts and prefer visiting leaves or parts of the foliage where the density of their potential hosts is higher. These places are the large leaves which possess a lot of mines and grow in the outer parts of the lower canopy. Small leaves that carry a few mines only and are dispersed on thick branches in the inner parts of the canopy are not very attractive hunting fields. We suppose that the low values of parasitism in minute leaves can be attributed to the foreging behaviour of the parasitic chalcidoids.

4.2. The parasitoid community of the moth

Altogether 20 species of parasitoids could be reared during the 7-year investigation at Hédervár and additional two species were found in the flood plain. The number of the parasitoid species was higher in Hédervár than in other locations which can be attributed to a more diverse environment and a possible earlier infestation of the trees. The structure of the parasitoid community was changing from year to year and in none of the years occurred all the species in a location. There was a recession even in the number of species at Hédervár in 2002 and 2004 that possibly can be ascribed to adverse weather conditions. 5 species were stable members of the parasitoid community in this location and occurred in all 7 years: *Pnigalio agraules, Minotetrastichus frontalis, Baryscapus nigroviolaceus, Closterocerus trifasciatus* and *Cirrospilus pictus. Pediobius saulius* could not be reared in 1998 but from the next year on it was a dominant or subdominant parasitoid of *C. ohridella*. On the other hand, the importance of *M. frontalis* was decreasing in time.

The number of the members of the parasitoid community was growing from 2001 to 2003 in all locations investigated what is a phenomenon often observed by other authors in the first years after the moth's establishment. Similar to what we found at Hédervár years earlier, *M. frontalis* ranked among the most abundant species in the flood plain, supporting our hypothesis about a later infestation of the horse-chestnut trees in the latter type of locations.

The structure of the parasitoid community showed striking differences between foliage levels. In the years 1999-2001 more species could be reared from the samples collected at the top, while in 2002 and 2003 the low-level samples proved to be more rich in species. On the other hand, the rate of parasitism at the top was growing *compared* to the parasitism rates below in the canopy. These observations imply that, regarding species constitution, the parasitoid community is heading to a different balance in the two foliage levels. In the top of the canopy, the balance state is probably characterized by relatively few species that reach a higher rate of parasitism than below.

Some of the parasitoids were more abundant low in the canopy than at the top; others behaved just the opposite way, but the preference of the species often changed during the years. A typical instance is *P. saulius* which was gradually switching over to the upper canopy level, considerably raising the parasitism at the top.

The difference between the parasitoid communities in the two foliage levels can possibly be attributed to at least 3 reasons: different microclimatic demands of the species, different body sizes and different attack times. Probably all three factors contribute to the distribution of the parasitoid species but - because of permanent changes in the proportions of the species, their gradual adaptation and the changeable weather - it can not be determined which one is the most important in the case of a given species.

The relative difference in the number of parasitoid species between shaded and sunlit leaves was growing in the investigation period (2001-2004). It means that the parasitoid community of the leaves that are exposed to direct sunlight is more efficient in keeping its diversity than that of the shaded leaves. This is possibly another sign of the adaptation process of the parasitoids.

We found much less parasitoid species in minute leaves than in large ones. Only the 3 most abundant chalcidoids could be detected: *Pediobius saulius, Pnigalio agraules* and *Minotetrastichus frontalis*.

None of the moth pupae from autumn (September-October) or summer (July) samples hatched prior to January, while the parasitoids emerged partly before January and partly later, depending on the sampling date.

4.3. Parasitism of different developmental stages of the moth

According to our investigations, 4-week-old moth instars (mainly larval instars 3-4) are the most favourable targets of parasitoid attack. Older larvae and pupae are less frequent victims of parasitoids.

The preference of the parasitoids for certain development stages of *C. ohridella* proved to be quite different. *P. saulius* preferred older stages while *P. agraules* preferred younger stages of the moth. We could not draw much conclusion based on the single individual of *M. frontalis* that could be reared from the isolators.

4.4. Flight periods of *C. ohridella* and the parasitoids, calculated relative densities of developmental stages of the moth and the level of synchronization

The main flight periods of the moth (21. 4. and 3. 5. in 1999 and 2001, resp.) and of its parasitoids in the spring was quite different. Some parasitoids emerged earlier (e.g. *M. frontalis* and *Pnigalio sp.*), others later (e.g. *C. trifasciatus, B. nigroviolaceus*) than the moth. We suggest that sparing parasitoids by destroying leaf litter just a few days prior to the main flight period of *C. ohridella* is efficient only in certain cases.

Using the flight curve of the horse-chestnut leafminer, we made an attempt to determine how densities of different larval instars changed in the leaves during the investigation. The calculated time for the full development of a moth generation (67 days) and the calculated main flight period of the next generation (July 13) squared with the facts, showing raison d'étre for the calculation method.

From the parasitoids that emerged in relatively high abundance, flight periods of *Pediobius saulius* and *Baryscapus nigroviolaceus* were closest to the appearance of mature larval instars of the moth. The abundance of *B. nigroviolaceus* was decreasing during the years which implies that, despite of its favourable flight period, it failed to increase its level of adaptation to the new host.

Pnigalio agraules flies somewhat earlier than *Pediobius saulius* what can be part of the reason why it prefers younger moth larvae.

4.5. Relation between parasitism of *C. ohridella* and the intensity of parasitoid attack

We determined how the attack intensity of the most abundant parasitoids changed in Hédervár during the year 2004. *P. saulius* was most active at the end of August what resulted in high parasitism rates of the moth after September 18. Similarly, the high willingness of *P. agraules* to lay its eggs in September 4-11 yielded high parasitism rates in early October.

4.6. The infestation level of the horse-chestnut leaves

During the investigation period, there were considerable differences in the number of moths that hatched from a given amount of horse-chestnut leaves. When the number of the moths per leaf increased from one year to the other, the rate of parasitism decreased and the opposite almost at all instances. For some reason, parasitism was higher in years that were unfavourable for the horse-chestnut leafminer. However, the changes in the infestation levels were not the result of parasitoid action, as rates of parasitism were too low to be the main factor in determining abundance of *C. ohridella*.

There were no significant differences in infestation levels in the four locations studied. Fluctuation in the population density of the moth was similar in all locations in spite of their good distance. Low mean daily amounts of precipitation combined with high average temperatures and longer daily sunshine duration probably reduces the population density of the moth.

The number of the moth individuals, which were reared from a given number of top-of-the-tree leaves, was always lower than the number of the moth individuals reared from low-level samples of equivalent quantity. Our investigations confirm previous observations that the moths lay their eggs preferably on leaves that grow close to the ground and visit high foliage levels only in the second part of the season, in search for free leaf surfaces.

On yearly average, in 100 grams of leaves (dry weight) close to the ground developed more moths than in leaves high in the canopy but the relation could be changed due to parasitoid action.

From shaded leaves emerged less moths than from leaves that grew in direct sunlight. The difference was quite high and kept growing during the examination period. The reason for the phenomenon is probably the fact that mines on shaded leaves occupy twice as much area than on sun-exposed leaves (Birner - Bohlander, 2004). On the other hand, the absolut number of the moths that could be reared from a given number of leaves was growing in both leaf types. The growth occured in spite of that conditions in the mines - due to adverse weather conditions - became more and more unfavourable for the moth larvae. It seems that the growth in infestation level could have been the result of the leafminer population getting more stabile in the course of years.

We found that in the number of emerged moths per unit mass of dry leaves there were no considerable differences between shaded and sun-exposed leaves. Taken into account the moths that fell prey to parasitoids, the number of mines per unit leaf weight proved to be higher in the case of shaded leaves. The difference can be explained based on the different dry weight per unit leaf area of the two leaf types (Birner - Bohlander, 2004).

From a given number of small leaves we could rear far less moths than from larger ones, regardless of their position. On the other hand, comparing the number of the hatched moths per unit leaf weight, the value for minute leaves proved to be the highest. Its seems that *C. ohridella* females lay more eggs on a unit leaf area if it is made up of several distinct leaves than if it forms an integral whole. Since minute leaves carry only a few mines, the leafminer instars are distributed in a bigger space which decreases population density and the inherent intraspecific competition.

Leaves from middle heights of the canopy show no middle-values in the level of infestation. The number of hatched moths per unit leaf weight was higher in the middle part of the foliage than either close to the ground or high in the canopy. If moth instars that were killed by parasitoids are also considered, this type if leaves were the most infested of all. The great number of moth larvae in middle-height leaves probably can be attributed not to their height above the ground but to their shaded position and small size.

5. NEW SCIENTIFIC FINDINGS

1. Our results contradict the widespread opinion that the adaptation of the native parasitoids to the horse-chestnut leafminer was very slow. In our investigations this process seems to be fairly rapid but the pace can be decreased by adverse weather conditions. In contrast with previous studies we found that a stabile parasitoid community is under development around the horse-chestnut leafminer.

2. I found that in the last years of the investigations the rate of parasitism reached a significant level even at the top of the crown. This tendency implies that the parasitoids exploit the rich food source at the top more and more, which is probably a sign of the adaptation process of the parasitoid community.

3. I showed that parasitism rates in minute leaves are the least among all leaf types investigated, probably because parasitoids of *C. ohridella* prefer visiting leaves where the density of their potential hosts is higher. It means that small leaves that carry a few mines only and are dispersed on thick branches in the inner parts of the canopy are not very attractive hunting fields.

4. Out of the way places in the flood plain probably were infested later, as rapid growth of parasitism, the fluctuation within the seasons and the different constitution of the parasitoid community suggest.

5. I showed that the constitution of the parasitoid community differs considerably between foliage levels. My observations imply that the parasitoid community is heading to a different balance in the two foliage levels. In the top of the canopy, the balance state is probably characterized by relatively few species that reach a higher rate of parasitism than below.

6. According to my investigations, 4-week-old moth instars (mainly larval instars 3-4) are the most favourable targets of parasitoid attack. *P. saulius* prefers older stages while *P. agraules* prefers somewhat younger stages of the moth.

7. I pointed out that in the shaded leaves develope less moth larve than in the sun-exposed ones but their level of parasitism is higher.

8. I ascertained that females of *C. ohridella* lay more eggs on a certain leaf surface if it is made up of several distinct leaves than if it forms an integral whole.

6. LIST OF PUBLICATIONS

Articles published:

Horváth B. – Benedek P. (2001): Parasitoiden der Roßkastanien-Miniermotte (*Cameraria ohridella* Deschka & Dimič, 1986) in Nordwest-Ungarn. Acta Agronomica Óváriensis **43,** (1) 35-48.

Lectures held:

1. Horváth B. – Benedek P. (2000): Előzetes vizsgálatok a vadgesztenyelevél-aknázómoly (*Cameraria ohridella* Deschka & Dimic, 1986, Lepidoptera: Gracillariidae) parazitoidjairól Északnyugat-Magyarországon. Növényvédelmi Tudományos Napok, 2000. február 22-23.
2. Horváth B. – Benedek P. (2001): A vadgesztenyelevél-aknázómoly (*Cameraria ohridella* Deschka & Dimic, 1986, Lepidoptera: Gracillariidae) parazitoid közöségének szerkezete két egymást követő esztendőben és a lombkorona két szintjében. Növényvédelmi Tudományos Napok, 2001. február 27-28.

Further articles submitted or in preparation:

1. Horváth B. – Benedek P.: Parasitization of the horse chesnut leafminer's (*Cameraria ohridella*) life stages and the relationships between the seasonal life cycles of the host and its parasitoids

2. Horváth B. – Benedek P.: Changes in the population density of the horse-chestnut leafminer, *Cameraria ohridella,* and of its parasitoid community at Hédervár during 7 consecutive years (1998 – 2004)

3. Horváth B. – Benedek P.: Development and parasitism of the horse chestnut leafminer, *Cameraria ohridella* in different leaf types and canopy levels

4. Horváth B. – Benedek P.: A vadgesztenyelevél-aknázómoly (*Cameraria ohridella*) populációinak és parazitoid közösségeinek változásai különböző élőhelyeken 2001 és 2003 között

5. Horváth B. – Benedek P.: A vadgesztenyelevél-aknázómoly (*Cameraria ohridella*) Európában