Biotic damage in forests

Edited by:
György Csóka
Anikó Hirka
András Koltay

September 12-16, 2004
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BIOTIC DAMAGE IN FORESTS

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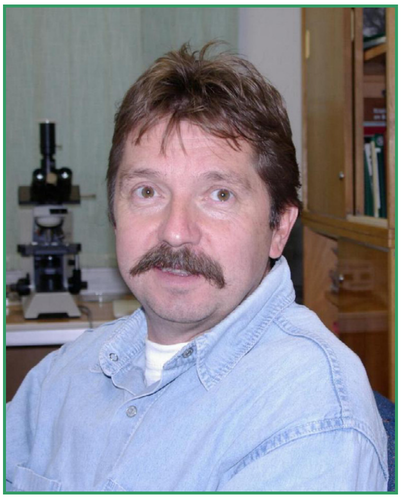

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PREFACE

These proceedings result from a symposium "***Biotic damage in forests***" held in Mátrafüred, Hungary on September 12-16, 2004. The meeting was the 6th meeting of the IUFRO Working Party 7.03.10 (*Methodology of forest pest and disease survey in Central Europe*).

The Mátrafüred symposium was attended by 60 scientists from 22 countries representing 3 continents. 34 oral presentations were given and 21 posters were displayed during the meeting. Some attendants who gave oral presentations did not want to submit paper. Therefore the number of papers is slightly smaller compared to the total number of presentations. Finally the proceedings contain 29 papers based on oral presentations and 21 papers/abstracts based on poster presentations. Sometimes either the titles or number/order of the authors in the papers are different from those of the original program list.

The meeting was organized and hosted and by the Hungarian Forest Research Institute. The organizers received significant help from the Ipolyerdő Rt. (Ipoly Forest Share Holding Company), Hotel Ózon, Agroinform Publishing House, Bükk National Park, Hollókő Municipality and the Radír Advertisement Agency.

The editors (particularly György Csóka) have a good reason to apologize for finishing the proceedings with significant delay. The reason of this delay is simply the overestimation of their capacity.

Attendants of the symposium on morning September 14th, 2004

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Results of *Cameraria ohridella* Deschka & Dimic (Lep., Gracillariidae) appearance and biology in Greece

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Abstract

The horse-chestnut leaf miner is a relative new pest in Europe and especially in Greece, where it was first found in 1996. As part of the EU Program Controcam, in which the Department of Forestry in Drama (Technological Educational Institute of Kavala) takes part together with 7 other European partners, the study of this insect in Greece was started in 2001, in a project that will be completed in 2004. Until now, on-site observations showed that the insect has been attacking horse chestnut trees (wild and planted) at 65 different locations in Greece. With the application of pheromone traps which were installed in three different places (Grevena, Ano Klines and Ioannina) around Greece, together with phenological observations, it has been found that, in Greece, this insect has three generations per year, while under favorable conditions, a fourth may appear (Ioannina 2003). Another very important feature is that differences were found in the population intensity of the moth in the same places, not only from year to year, but also from tree to tree. These differences require further analysis in terms of the climate conditions (first case), as well as of the quality of food (second case).

Key words: *Cameraria ohridella*, Greece, pheromone traps, generations, intensity

Introduction

The Balkans are the area where *Aesculus hippocastanum* grows naturally (Krüssmann 1976, Tutin *et al* 1990, Boratynski *et al* 1992, Polunin, 1997). At the beginning of the ‘80s, in 1984 at this area, and in particular, close to Ohrid lake, a new Gracillariidae species was observed for the first time in Europe, on the leaves of *A. hippocastanum* (Simova-Tosic and Filev 1985).

Two years later, in 1986, this leaf miner was noted by Deschka and Dimic as *C. ohridella*, using the name of the area where it first appeared (Deschka and Dimic 1986).

The further spread of this leaf miner could be said to be very rapid in the area of Central and Eastern Europe, where it was widely spread (Butin and Führer 1994, Puchberger 1995, Liska 1997, Szabóky 1997, Sivicek *et al* 1997, Freise and Heitland 1999).

Today, fifteen years after its first appearance, the moth remains one of the most dangerous defoliators of horse chestnut trees around Europe, with unknown origin till now (Freise *at al* 2002).

Within the framework of the European Community Project named CONTROCAM it was attempted for the first time to study the spread as well as the bio-ecology of this particular leaf miner in Greece. Until the beginning of the CONTROCAM Project, the knowledge about the status of the *C. ohridella* in Greece was very limited. The first record of this moth in Greece was made by Skuhravy. According to his publication that appeared in 1999, he found it in 1996 in a park of the city of Florina (Northern Greece), whilst at the same time he also had oral information about the existence of the leaf miner on two *A. hippocastanum* ornamental trees at the mountain Pelion (Central Greece).

In order to cover the needs of the Project mentioned above, the systematic study of the insect started in Greece in 2001.

Material and methods

The study of the appearance of *C. ohridella* in Greece started in the year 2001 and lasted three years, in order to fulfill the goal of the CONTROCAM Project. The work was mainly based on observation in locations that had been highlighted in information gleaned from:

- Archives and records of the Central Forest Service of the Agricultural Ministry
- Colleges of the local Forest Services
- Shepherds
- Hunters
- People, who are living in the mountainous regions.

For the study of

- the speed of the development,
- the number of the generations per year and
- the population intensity of the moth from year to year,

during the first ten days of April 2001, ten green traps type “Delta” were installed at Grevena (Central Greece), at the lower part of the crown of ten wild trees of *A. hippocastanum*. These trees grow alongside a stream at the altitude of 845 meters (Longitude: E 021^{o} 12. 060, Latitude: 39^{o} 58. 073).

A dispenser was placed in those traps, which was produced for the needs of the Controcam Project at the Institute of Organic Chemistry and Biochemistry of the Academy of Sciences of the Czech Republic.

The observations of the first repetition (2001) started at the beginning of April and finished at the end of September. The dispenser was changed every fourth week and the observation period lasted for 24 hours. This means that at the beginning of every observation period, each trap received a new sticky base, which was removed the next day, after exactly 24 hours.

The same observations took place on the same trees of the same area (Grevena) during 2002 (second repetition) and 2003 (third repetition).

In 2002 two “Delta” pheromone traps were placed in the park at the village Ano Klines (Altitude: 621 meters, Longitude: E 021^{o} 23. 114, Latitude: 40^{o} 50. 683).

This place had been chosen because it is the nearest to Ohrid Lake on the Greek side. The observations at these two traps were made in the same way and on the same day as the ones made in Grevena.

Finally in order to study the phenology of the insect under natural environment conditions, samples (leaves) were gathered from Grevena (2002 and 2003), at Ano Klines (2002) and at Ioannina (Altitude: 507 meters, Longitude: 020^0 51 100, Latitude: 39^0 39 603) in 2003. From April until October, every week, and always on the same day, ten compound leaves were gathered from the lower part of the trees at each of the experimental areas. For the gathering of samples, the ten wild trees at Grevena, two planted trees at Ano Klines, and five trees in a park at Ioannina, were used.

In the laboratory, those leaves were examined in order to note down the different stages of development, meaning eggs, larvae, Sp and pupae.

Results and Discussion

According to the visual observations to study the distribution of the moth in Greece, the problem of the infestation of horse chestnut trees by the insect seems to be more serious than it was first thought to be. Until now, the insect was found in 65 different places, which were distributed in central and northern Greece. The main distribution area is the mountainous region of Pindos, whose direction is from northern to southern Greece. The places where horse chestnut trees were attacked by the moth are presented on the following map.

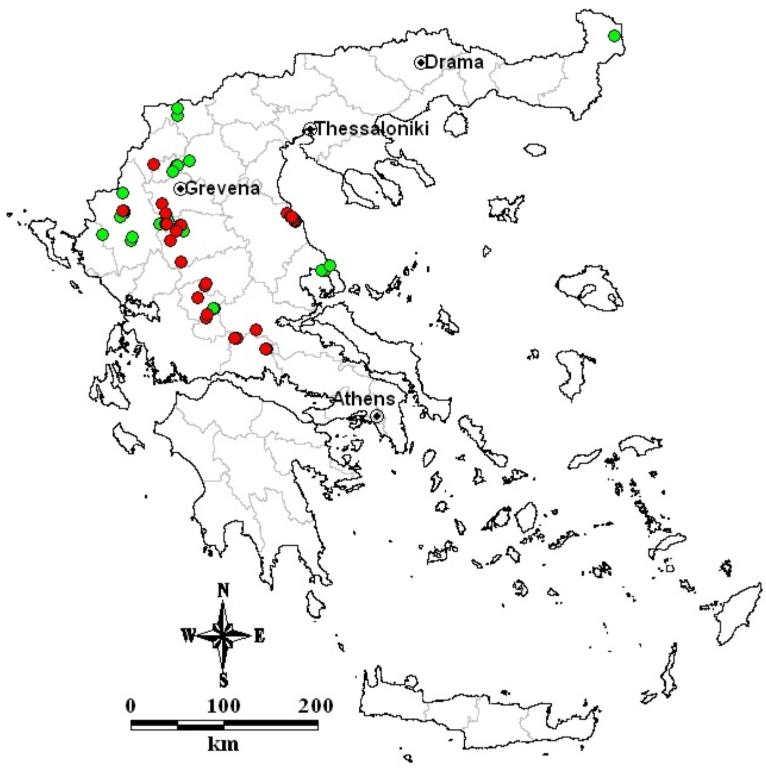

Fig. 1: Distribution of the moth *C. ohridella* in Greece until 2003 (red color points for areas with wild horse chestnut trees, and green for areas with planted trees, which were attacked by the moth).

Until now, on-site observations showed that the insect has been attacking horse chestnut trees (wild and planted) in 65 different locations in Greece, as is shown in Table 1.

	WILD	PLANTED	TOTAL
2001	10	17	27
2002	8	4	12
2003	15	11	26
TOTAL	33	32	65

Table 1: The progress of the new records of *C. ohridella* in the years 2001-2003.

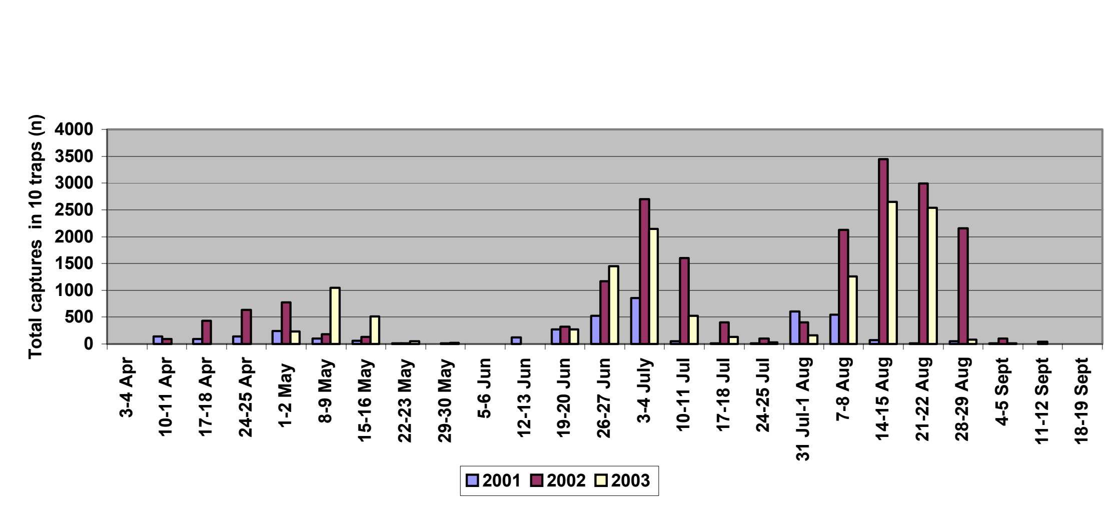

Fig. 2 : Development of *Cameraria ohridella* in Grevena.

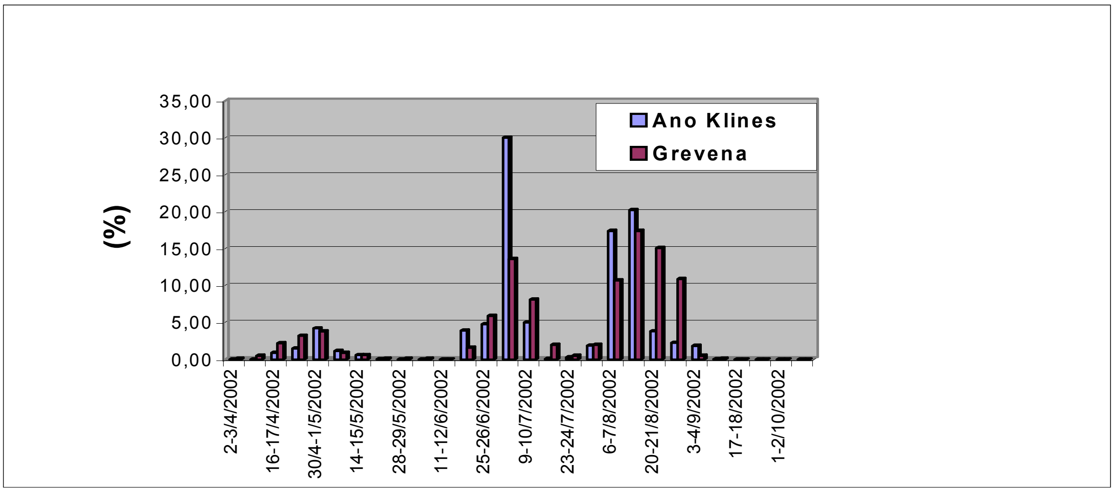

Fig. 3: Development of *C. ohridella* at Grevena and Ano Klines during the second repetition (2002), by using pheromone traps.

The evolution of the insect during the first two repetitions appears to be parallel while in the third repetition the adults show a three-week delay. According to the process of the captures in 2002 in both cases of Grevena and Klines it is very easy to see that the development of the moth, in both cases, has a parallel run (Fig. 3).

The results of the phenological observation show the existence of three generations at Grevena (Fig. 4a, 4b) and Ano Klines as well (Fig. 4c) and four generations per year at Ioannina (Fig. 5).

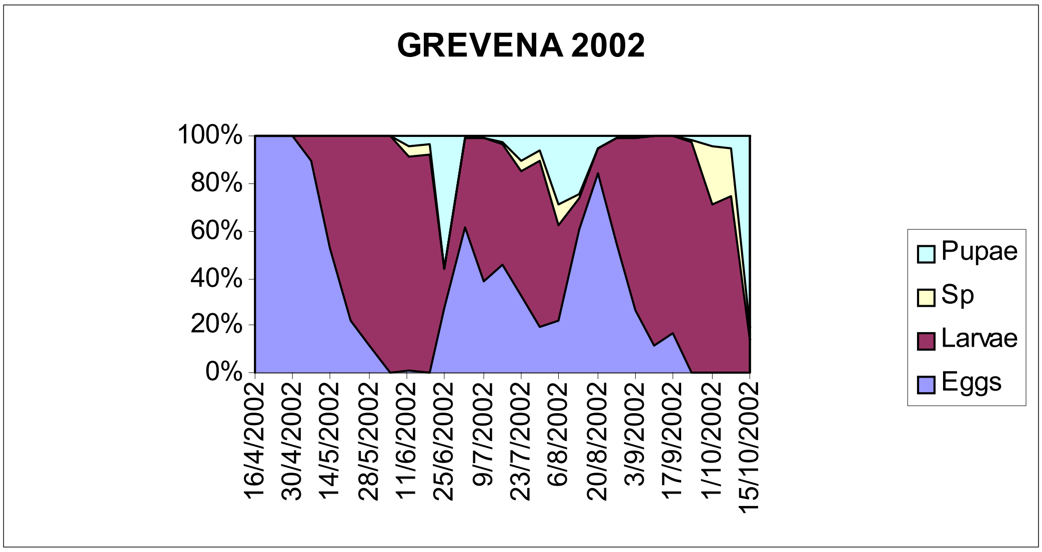

Fig. 4a: Results of phonological observations at Grevena in 2002.

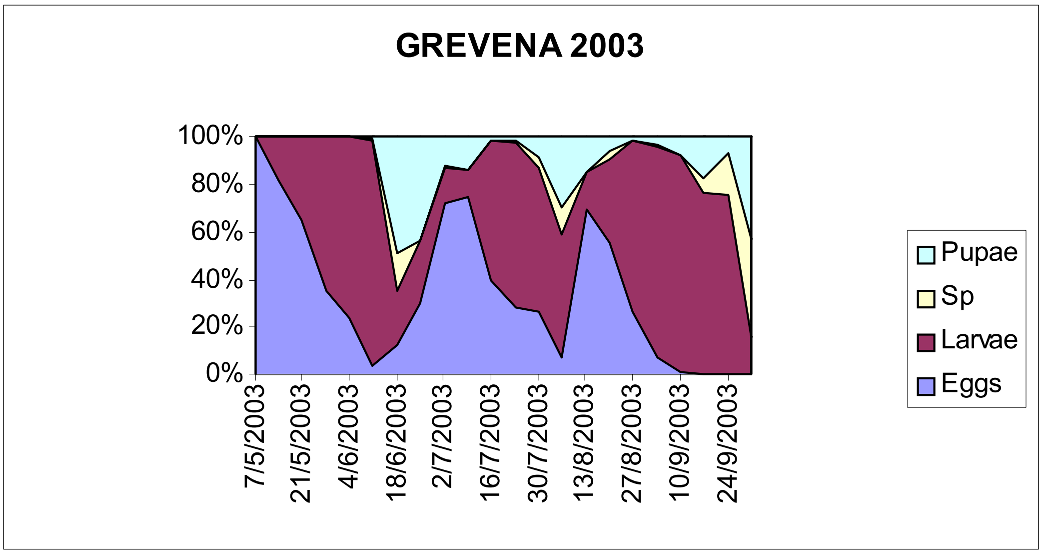

Fig. 4b: Results of phonological observations at Grevena in 2003.

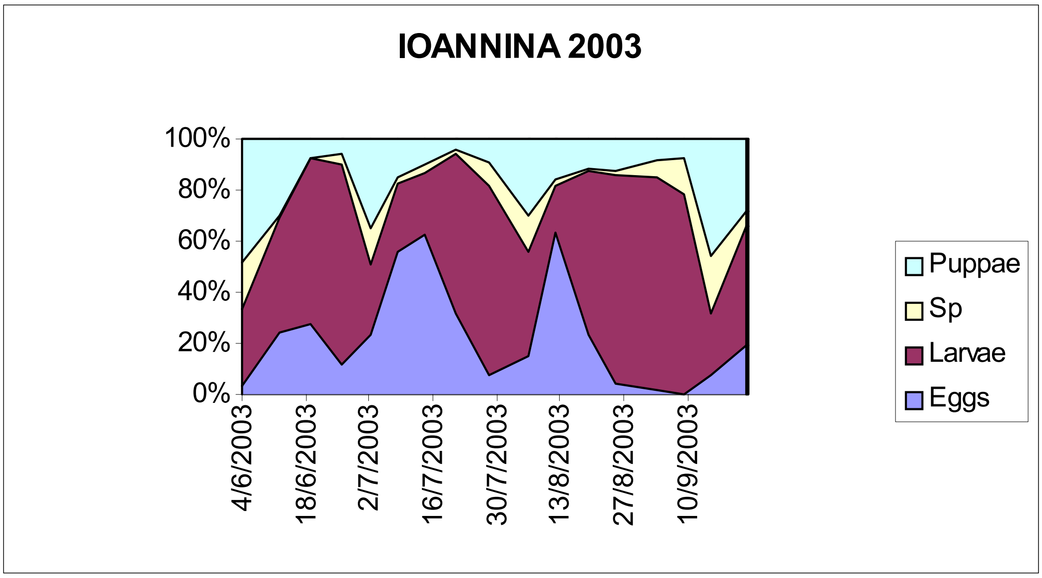

Fig. 4c: Results of phonological observations at Ioannina in 2003.

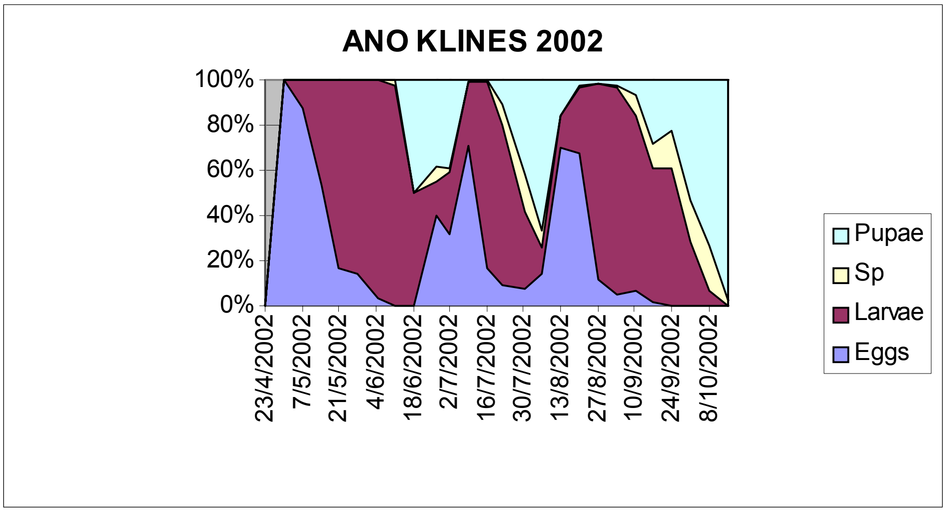

Fig. 5: Results of phonological observations at Ano Klines in 2002.

The result relating to the number of generations per year is in accordance with the existing literature, according to which the number of generations per year fluctuated between three and five (Deschka and Dimic 1986, Pschorn-Walcher 1994, Skuhravy 1999).

Another result that has to be mentioned is that the total number of captured adults per repetition varied from year to year. In particular, in the pheromone traps, 3.938 adults were captured in 2001, 19,828 in 2002 and 13,097 in 2003.

Under the circumstance that the 'quality' of the dispensers used was the same in every one of the three repetitions, this phenomenon can be related to changes of weather conditions, and/or the complex (quality /quantity) of the natural enemies of the insect at the area of observation from year to year. Both parameters, the weather and natural enemy complex, could be studied.

Regarding the number of captures per tree, the observations over the three years show strong differences between the ten trees involved in the observations at Grevena. In each repetition (2001, 2002 and 2003) on the same four trees, numbered 2, 3, 5 and 10, were captured the majority of the insects, that were captured in all the ten traps (Fig. 6).

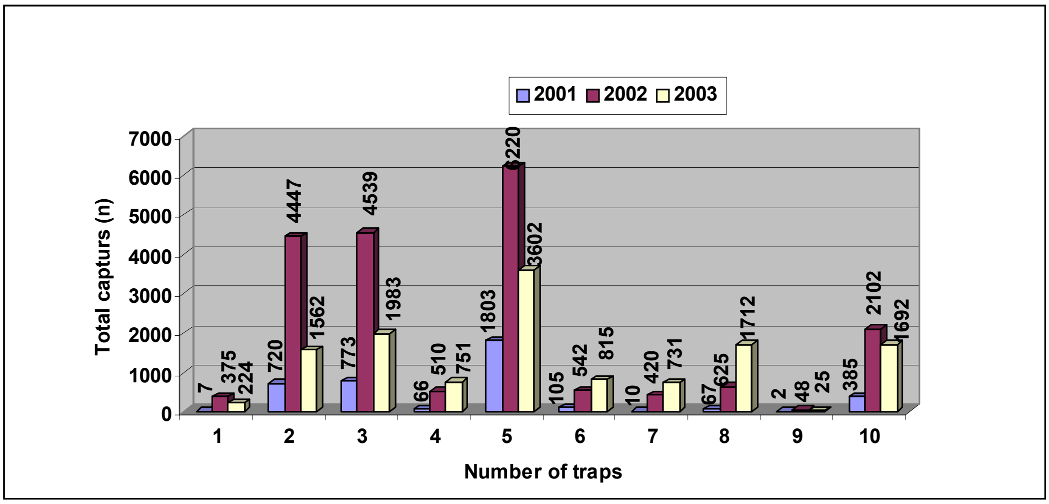

Fig. 6: Number of total catches per trap at Grevena during the three repetitions.

Fig. 7 shows the differences from tree to tree regarding the total number of the moths that were captured per trap during the three-year period of the observations at Grevena.

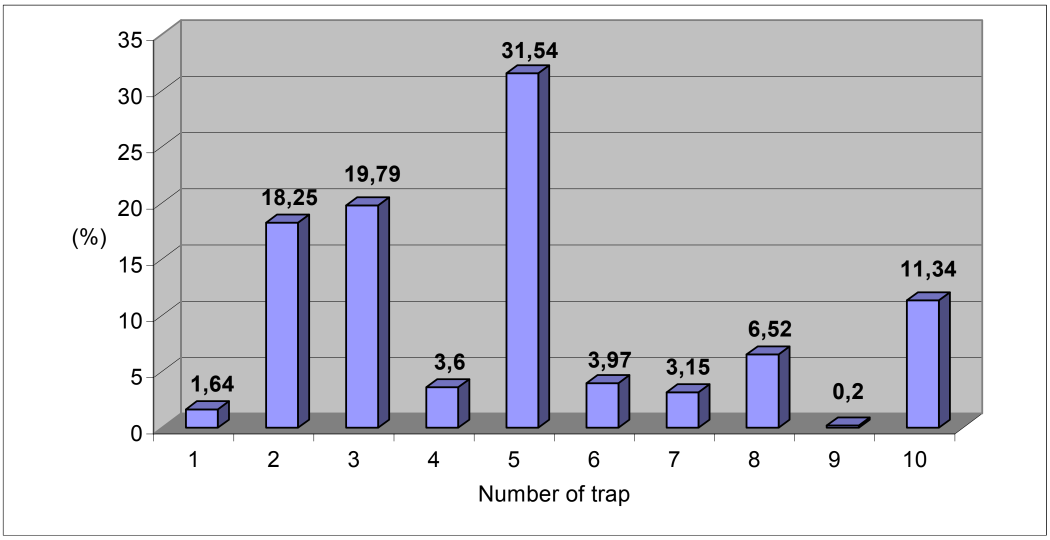

Fig. 7: Total captures per trap at Grevena during the three-year period (2001-2003).

We have reached a similar conclusion about the two trees of Ano Klines. During the observations, one of these trees had a higher catch total than the other. Being more specific the first one of them gathered 31% while the second one 69% of the caught moths.

This result may have occurred because of the different genetic material of the trees (structure or chemical features of the available nutrition).

Conclusion

1. The infestation of the moth in Greece appears to be greater than first suspected (infected trees are already found in 65 localities round Greece).
2. Moreover, in many places in Greece, the planted horse chestnut trees are not attacked by the moth, probably due to their geographical isolation.There are localities where for the past three years (2001-2003) no infestation has been found, while in 2004 the first mines on the leaves have been noticed.
4. In conclusion, the intensive use of *A. hippocastanum* to create parks, gardens and avenues of trees that has been noticed in Greece in recent years, indicates the size of the problem that will affect our country in the close future. According to literature, there are *Aesculus* species that are found to be resistant to the moth. Their use may provide a way to restrict the problem.

Acknowledgements

The present study is a part of the EU project entitled "Sustainable control of the horse chestnut leafminer *Cameraria ohridella* (Lepidoptera, Gracillariidae), a new invasive pest of *Aesculus hippocastanum* in Europe" (CONTROCAM, Contract number QLK5-200001684). We are very grateful to General Coordinator of the project Dr. Werner Heitland for his valuable assistance.

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Oral presentation

European host plants and potential distribution of *Corythucha arcuata* (Say) (Heteroptera: Tingidae)

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Abstract

The oak lace bug (*Corythucha arcuata* (Say)) was recently found in Europe. This insect is widely spread in North America and it is spreading in Europe. In this work, field observation and laboratory bioassay were carried out to investigate potential host plants of the insect in Europe. Climatic conditions and plant distribution were assessed to outline the potential distribution of *Corythucha arcuata* in Europe.

Keywords: *Corythuca arcuata*, oak, climatic conditions

Introduction

The oak lace bug (*Corythucha arcuata* (Say)) was firdt recorded in Northern Italy in 2000 (Bernardinelli and Zandigiacomo 2000) on different European oaks, first of all *Quercus robur* L.. This lace bug comes from North America where it can use different oaks as host plants, mainly the ones belonging to the "white oaks" group (Ewart and Torres 2000).

In the Nearctic region the host plants of the oak lace bug are: *Quercus alba* L., *Quercus macrocarpa* Michaux, *Quercus montana* Willdenow, *Quercus muehlenbergii* Engelmann, *Quercus prinoides* Willdenow, *Quercus rubra* L., *Quercus* sp.; it can also be found on *Castanea* sp. and occasionally on *Pyrus malus* L. (*Malus domestica* Borkh.), maples and wild roses (Drake & Ruhoff, 1965)[1].

In North America *Corythucha arcuata* is present wherever host plants are present (Connel and Beacher 1947).

The aim of this work was to find out on which plant species of the Palaearctic region *Corythucha arcuata* can develop so as to work out the potential distribution areas of this insect.

[1] Darake and Ruhoff (1965) indicates as host plants *Quercus acuminata* and *Quercus prinus* that are actually synonyms of *Quercus muehlenbergii,* and *Castanea americana,* which binomia has not been found in literature, so that, regarding this species, the generic name has been used (*Castanea* sp.).

Materials and Methods

Field observations

A preliminary visual investigation on the leaves of different oak species and other plants was carried out in the area where *Corythucha arcuata* was first found on *Quercus robur* L. to see if the lace bug was present or not.

Laboratory bioassay

Different species of lace bugs were reared in the laboratory under different conditions to study the development and the survival of the young stages (Vogt and McPherson 1986; Schultz and Coffelt 1987; Neal and Douglass 1988; Connor 1988). On the ground of these experiences a laboratory bioassay was developed to evaluate the different developmental rate of *Corythucha arcuata* from the first instar to adult on different plant leaves (the design of the bioassay is described in Bernardinelli 2003).

The following oaks that can be found in Italy and other potential host plants were tested: *Quercus robur, Quercus pubescens* Willdenow*, Quercus petraea* (Matt.) Liebl.*, Quercus cerris* L.*, Quercus rubra* L.*, Quercus suber* L.*, Quercus ilex* L.*, Castanea sativa* Mill.*, Malus domestica* Borkh.*, Rosa canina* L.*, Acer platanoides* L.*, Acer pseudoplatanus* L.*, Acer campestre* L.*, Acer negundo* L.. As a result of field observations the development of *Corythucha arcuata* was also tested in laboratory on *Rubus idaeus* L., *Rubus caesius* L., *Rubus ulmifolius* Schott.

Each plant was tested at least twice with five replications each time (except *Rubus idaeus,* which was tested only once). In each bioassay there were two controls, one with *Quercus robur* leaves and one with no food, each of them in five replications.

The results of the laboratory tests on development rate were analysed with ANOVA (after angular transformation of data).

Presence of Corythucha arcuata on Rubus ulmifolius in natural conditions in the infested area

In three different places inside the infested area, 50 leaves of *Quercus robur* and 50 leaves of *Rubus ulmifolius* from nearby the infested oaks were collected in September and observed to check the presence of egg clusters. Data were analysed by the G-test.

Climate evaluation

In North America, *Corythucha arcuata* is present in USA (Maine, New Hampshire, Massachusetts, Vermont, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Maryland, District of Columbia, Virginia, Delaware, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Ohio, Illinois, Indiana, Montana, Michigan, Wisconsin, Nebraska, Minnesota, Iowa, North Dakota, South Dakota, Colorado, Utah, Arizona, New Mexico, Texas) and Canada (Quebec, Ontario) (Drake and Ruhoff, 1965). A climatogramme was built considering the monthly average of temperature (y axis) and precipitation (x axis) of each state where the insect is present in America. This climatogramme was compared to the data of temperature and precipitation of some European countries to evaluate if the climatic conditions can allow the development of *Corythucha arcuata* in Europe.

Distribution of host plants in Europe

According to this work the main hosts are the deciduous oaks: *Quercus robur, Quercus pubescens, Quercus petraea, Quercus cerris* and *Quercus frainetto* Ten.. Each of this species is largely spread in Europe. All the areas of the known host oaks were summed to compute the area where *Corythucha arcuata* could find its host plants.

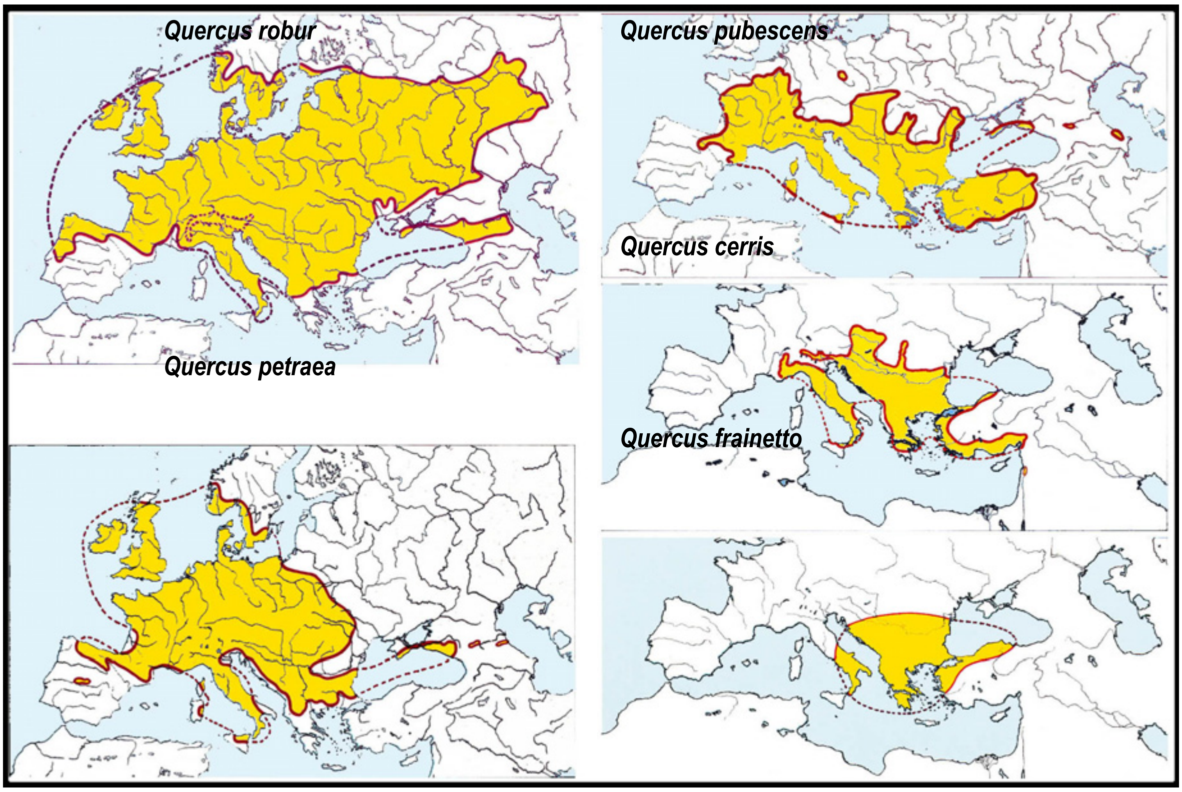

Fig. 1: Distribution of different oak species in Europe, from Fenaroli (1984).

Results and discussion

Field observations

Data on field observation are presented in Table 1. Interestingly, no specimens of *Corythucha arcuata* were found on *Quercus rubra or* on *Malus domestica*, whereas a few specimens and egg clusters were observed on *Rubus ulmifolius*. In particular, on the latter, many specimens of the insect were found during winter on the leaves that had not wilted.

Investigated plant species	**Present**	**Not found**
Quercus robur	X	
Quercus pubescens	X	
Quercus petraea	X	
Quercus cerris	X	
Quercus frainetto	X	
Quercus rubra		X
Castanea sativa		X
Rosa canina		X
Rubus ulmifolius	X	
Acer pseudoplatanus		X
Acer monspessulanus		X
Acer campestre		X
Populus nigra		X
Betula pendula		X
Alnus glutinosa		X
Ulmus minor		X
Malus domestica		X
Frangula alnus		X
Fraxinus excelsior		X
Sambucus nigra		X

Table 1: Results of field observations on different plant species.

Laboratory bioassay

Around 60% of the first instar insects can reach the adult stage on most European oak deciduous species; some *Rubus* species can also allow the development of the oak lace bug (figure 2). Tested plants can be divided in three groups:

1) Plant species where the oak lace bug can develop, as on *Quercus robur.*
2) Plant species where a reduced number reach the adult age.
3) Plant species where the lace bug cannot complete its life cycle.

The first group includes all the tested deciduous oaks with the notable exception of *Quercus rubra* that is reported as a host plant (Drake and Ruhoff 1965). The presence in this group of *Rubus ulmifolius* and of *Rubus idaeus* was unexpected.

The second group includes *Castanea sativa* and *Rosa canina,* known as occasional host plants (Drake and Ruhoff 1965), and *Rubus caesius,* which is considered as a potential occasional host plant. The third group includes evergreen oaks, as well as all tested maples, *Malus domestica* and *Quercus rubra*, which are reported as occasional host plants (Drake and Ruhoff 1965).

Presence of Corythucha arcuata on Rubus ulmifolius in natural conditions in the infested area

Clusters of eggs were observed in all the samples both on *Quercus robur* and *Rubus ulmifolius* (Fig. 3) but the number of egg clusters on *Quercus robur* was significantly different from that on *Rubus ulmifolius*. Also the number of eggs per cluster on *Rubus ulmifolius* leaves was much smaller than that on *Quercus robur*.

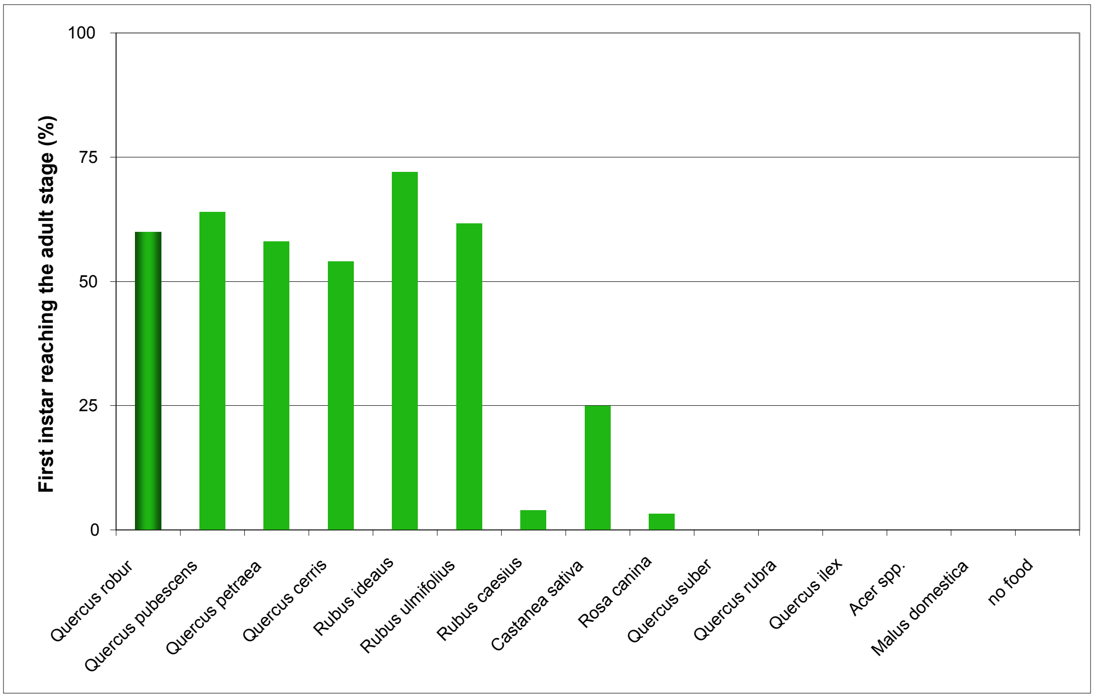

Fig. 2: Rate of development in laboratory bioassay on different plant species.

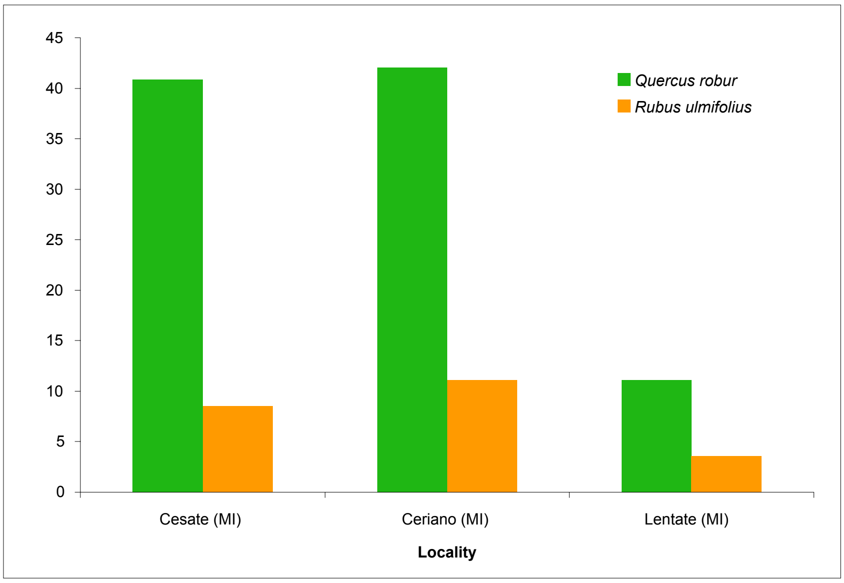

Fig. 3: Percentage of leaves with *Corythucha arcuata* egg clusters in three localities of the infested area.

Climate evaluation

The climatogramme of the States where *Corythucha arcuata* is present in America (Fig. 4) includes a large variety of climatic conditions.

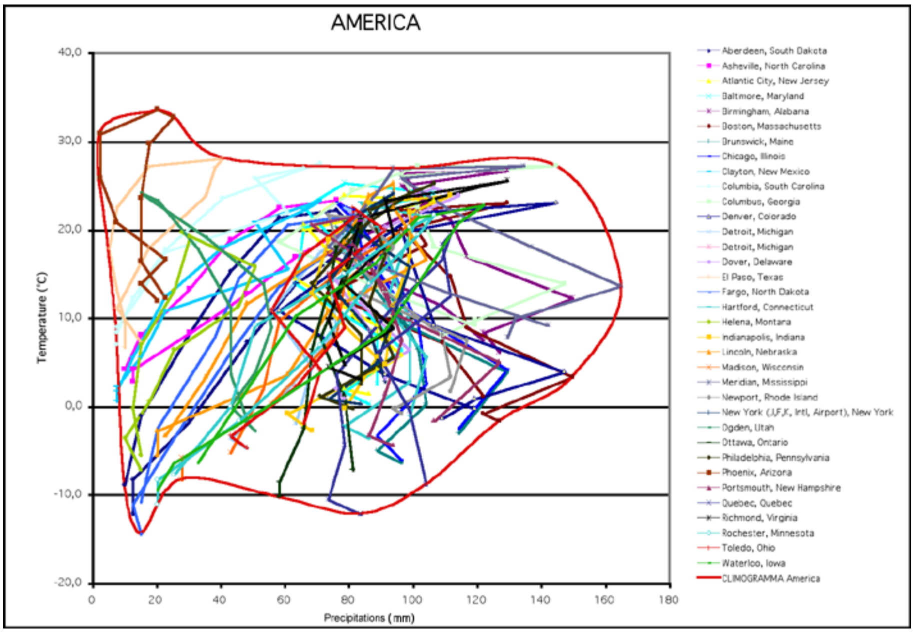

Fig. 4: Climatogramme of the American states where *Corythucha arcuata* is present.

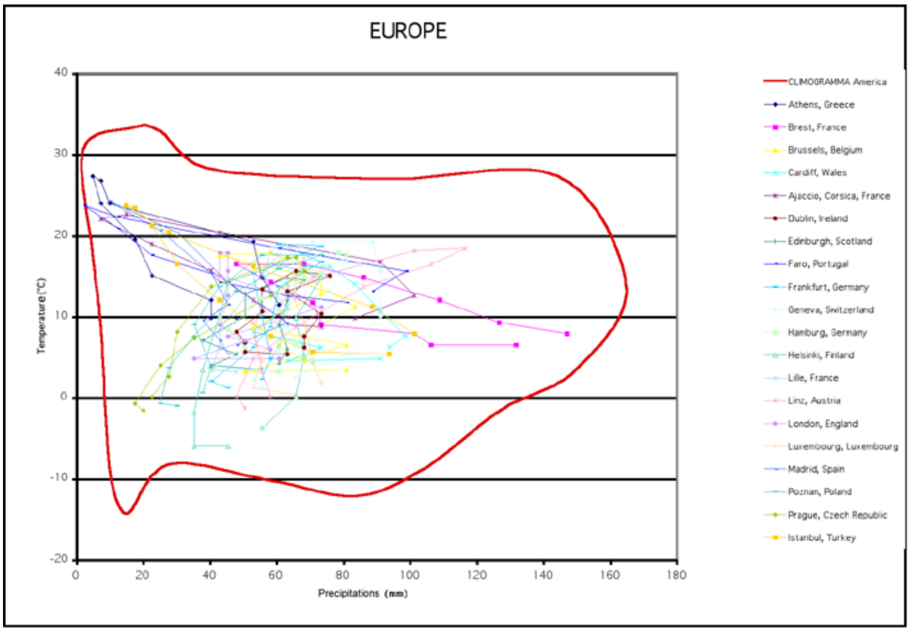

Fig. 5: Climatogramme of the American States where *Corythucha arcuata* is present compared to some European States climatic conditions (temperature and precipitation).

The climatic conditions (temperature and precipitation) of the European States that were considered are all included inside the climatogramme of North American States (Fig. 5) so that the settlement of *Corythucha arcuata* could be possible all over Europe.

Distribution of host plants in Europe

By summing the areas of all the European oaks where *Corythucha arcuata* can complete its life cycle, it appears that the oak lace bug can find its host plants in the most of Europe (Fig. 6).

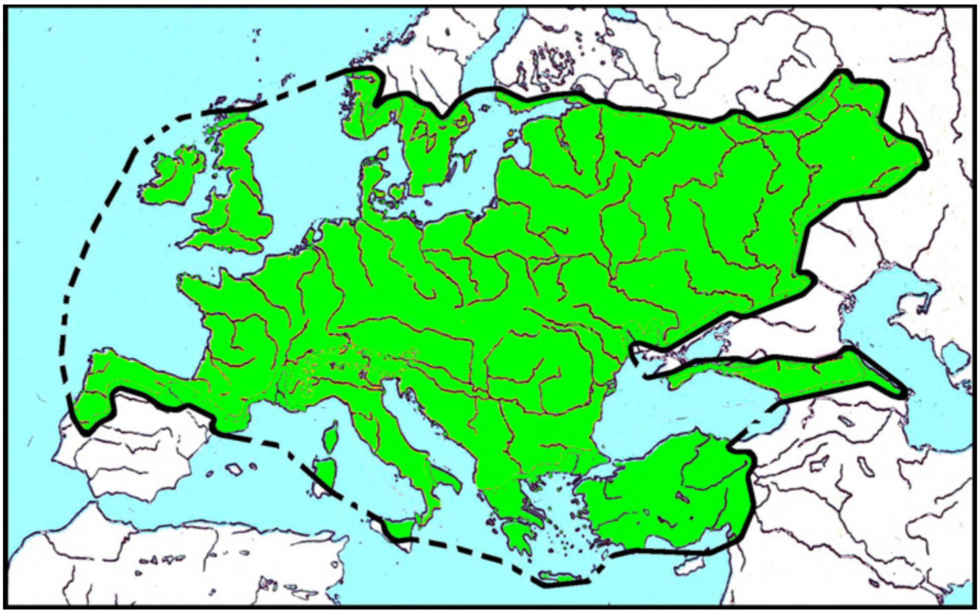

Fig. 6: Oak distribution in Europe

If we consider both the host plant distribution and the climatic conditions under which the insect can develop, we can conclude that *Corythucha arcuata* could well spread all over Europe.

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Oral presentation

Herbivore insect guild of oaks in Hungary

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Abstract

Oaks play outstanding role both from economical and ecological point of view in Hungary. 32.5% (ca. 568 thousand hectares) of the Hungarian forested is covered by oak forests. 658 species of herbivore insects have been recorded so far to feed on oaks. This number is far higher than the species richness recorded from any other tree genus in Europe. 46.7% of the quercivore insects are oak specialist. Insect orders are significantly different from point of their specificity/fidelity related to oaks. While other orders are dominated by oligo- and polyphagous species, dipterans and hymenopterans show outstandingly high host specificity that often goes beyond the genus level. Introduced oak species are easily colonized by generalist herbivores, but sessile and specialist species (i.e. gall midges, gall wasps, leaf miners) utilize only oak species closely related to their native hosts (i.e. Eurasian oaks belonging to either *Quercus* or *Cerris* sections). North American oaks are colonized by vagile generalist species and avoided by the strictly specialist sessile groups as gall midges and gall wasps. Parallel to their extremely rich insect herbivore fauna oaks also are hot spots of great insect outbreaks. An increasing number of less known species have outbreaks on rather local, but already not negligible scale. Some of the classic outbreak species as gypsy moth produced outbreak damaging unperceived area. Severe damage events caused by gypsy moth were observed far beyond its "classic" damage area reaching forest types in mountainous regions (i.e. beech forests.)

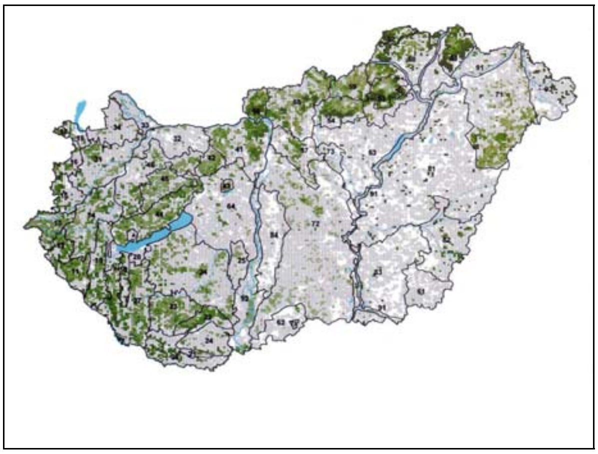
Keywords: *Quercus*, herbivore insects, species richness, host specificity, specialist herbivores

Introduction

Forests cover approximately 1.75 million ha of the land of Hungary (Table 1). Hungarian forests are dominated by broadleaved tree species. Among them oaks play an outstanding role both from economical and ecological point of view. Oaks together are dominant species on 568 thousand hectares (32.5%) of the total forested area. Contribution of the different oaks species can be found in Table 2. Besides the oaks occurring naturally, some exotic oak species, particularly the North American red oak (*Quercus rubra*) are planted at an increasing scale.

Tres species	1,000 ha	%
Oaks	568.3	32.5
Beech	108.9	6.2
Hornbeam	99.0	5.6
Black locust	379.8	21.8
Other hardwood	79.9	4.6
Hybrid poplars	118.4	6.8
Native poplars	53.5	3.1
Other softwood	97.3	5.6
Conifers	241.7	13.8
Total	**1746.8**	**100.0**

Table 1. Contribution of the different tree species in the forested area of Hungary.
(State Forest Service 2001)



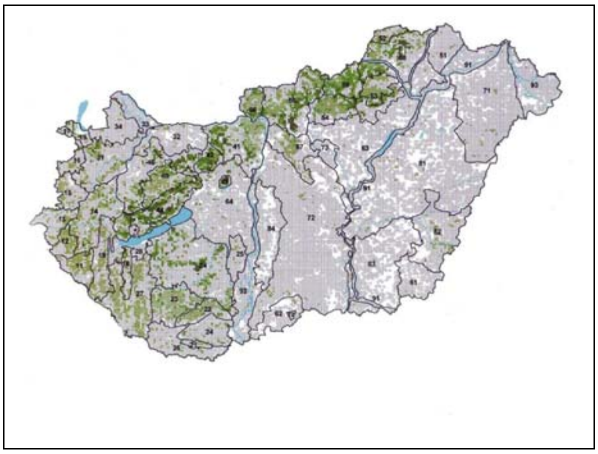


Fig. 1 (left): Distribution of oaks (excluding *Quercus cerris*).
Fig. 2 (right): Distribution of *Quercus cerris* in Hungary.
(Maps: State Forest Service 2001)

Oak species	1,000 ha	%
Quercus cerris	192	10.9
Quercus petraea	177	10.1
Quercus pubescens	17	1.0
Quercus robur	145	8.3
Quercus rubra	14	0.8
Other oaks	24	1.4
Total	**568**	**32.5**

Table 2: Contribution of the oaks in the forested area of Hungary

Methods

Original data have been collected by the author since the early 1980's. Gaps in data set were amended with literature data. Original Hungarian food plant data (including exact host name, location, date, etc.) have received priority over data included in general foreign literature (i.e. handbooks, etc.).

Data concerning the damage of oak-feeding insects were obtained from the database of the Forest Damage Reporting Network (established in 1961) maintained by the Department of Forest Protection of the Hungarian Forest Research Institute.

This paper gives only a brief summary of the results gained from evaluation of the data sets mentioned above.

Results

Species richness of herbivore insects on native oaks

Number of herbivore insect species recorded from different tree genera can be found in Table 3.

Tree genus	UK	Germany	Hungary
Acer	46/38	-	178
Betula	330	164	305
Fagus	94	96	147
Fraxinus	65	-	81
Picea	70	150	131
Pinus	171	162	169
Populus	186	85/67	197
Quercus	423	298	658
Salix	445	218	458
Tilia	53	-	137
Ulmus	117	79	127

Table 3: Number of herbivore insects registered in the UK, Germany and Hungary.

Seeing the numbers in Table 3, it can be concluded, that oaks are among the tree genera maintaining the highest species richness of herbivore insects in all three countries. Data for the UK are taken from Southwood (1961) and for Germany from Altenkirch (1986). The data for Hungary are modified and actualized from Csóka (1998).

The differences between the numbers of oak herbivore insects in the three countries can be explained by two different reasons. The intensity of faunistic study, and availability of faunistic literature can cause considerable differences in number of species recorded on different host species. On other hand, the oak flora is significantly richer and oaks are more widespread in the Carpathian basin than in Western Europe. On top of this, more oak species occur here naturally than in Germany or in the UK. These facts certainly influence their herbivore insect richness.

Host specificity/fidelity of oak herbivore insects

Explanations for the host specificity /fidelity categories given in Table 4 can be found below:

1: Feeding exclusively on one oak species
2: Feeding on oaks belonging to same section (i.e. Section *Quercus* or section *Cerris*)
3: Feeding on oaks (including both sections)
4: Feeding on hosts belonging to *Fagaceae* family
5: Feeding on host belonging to *Fagales* order
6: Polyphagous – feeding on host belonging to different order

Order/Host specificity	1	2	3	4	5	6	Total
Orthoptera	0	0	0	0	0	4	**4**
Thysanoptera	0	0	0	0	0	5	**5**
Heteroptera	0	0	0	0	0	4	**4**
Homoptera	9	4	12	3	2	26	**56**
Coleoptera	1	0	19	9	10	84	**123**
Lepidoptera	18	11	65	20	14	164	**292**
Diptera	9	1	3	0	0	0	**13**
Hymenoptera	38	77	40	0	0	6	**161**
Total	**75**	**93**	**139**	**32**	**26**	**293**	**658**

Table 4: Numbers of species by orders, belonging to different host specificity/fidelity categories

Order	Percentage of the oak specialist species (%)	Average host specificity index for the order
Orthoptera	0.0	6.0
Thysanoptera	0.0	6.0
Heteroptera	0.0	6.0
Homoptera	44.6	4.1
Coleoptera	16.3	5.3
Lepidoptera	32.2	4.7
Diptera	100.0	1.5
Hymenoptera	96.3	2.2
Average	**46.7**	**4.1**

Table 5: Percentage of the oak-specialist species and the average host specificity index by orders

658 species of herbivore insects have been registered so far as feeding on oaks. Their host specificity/fidelity evidently varies a lot. Table 4 gives data about the distribution of these 658 species by order and specificity/fidelity categories (explanations for the categories are given above the Table 4), and Table 5 summarizes the ratio of oaks specialists and the average specificity index by order. Higher number of the host specificity/fidelity index evidently means lower level of specificity and lower fidelity to oaks as food-plants.

All of the very few orthopteran, thysanopteran and heteropteran species are broadly polyphagous, and these species can rather be considered as random feeders on oaks. Contrary to these, all dipteran species feeding on oaks are strictly oak specialist, and the average host specificity index (1.5) indicates an even stronger host fidelity. Quercivore (=feeding on oaks) dipterans (mainly sessile gall midges) distinguish accurately among the species within genus *Quercus*. While some species are exclusively found on oaks belonging to section *Cerris*, others develop only on host species in the section *Quercus*. Quercivore hymenopterans show a similarly high level of host specificity and fidelity. Only a few species of them are known to be able to feed on food plants not belonging to genus *Quercus*.

Only approximately one third of quercivore lepidoptera is strictly oak specialist and the 4.7 value of average host specificity index indicates rather oligophagous/polyphagous characters of the order. However the 32.2% ratio of oak specialist species still means 94 oak specialist lepidopteran species.

In total, 46.7% of the quercivore insects (307 species) are oak specialist. This number clearly indicates the irreplaceable role of oaks in maintaining the species richness of herbivore insects.


Fig. 3-4: An example of oak specialist Lepidoptera: *Neozephyrus quercus* - caterpillar (left) and adult (right).

Extremely sophisticated interactions are very common among the specialist sessile oak herbivores such as leaf miners or gall wasps. Some of cynipid gall wasps (Hymenoptera: Cynipidae) are often restricted to one single species of oak. On top of this, some species have two alternating generations, either on the same oak species, or even more interestingly, on two oak species belonging to different oak sections. While galls of sexual generation of *Andricus quercuscalicis* develop in spring on catkins of *Quercus cerris* (Fig. 5), galls of its asexual generation live on acorns of *Quercus robur* (Fig. 6). So this species needs individuals of these two different oak species to live in close vicinity to one another in order to complete its life cycle.


Fig. 5-6: An example of host alternating gall wasps: Sexual (left) and asexual gall (right) of *Andricus quercuscalicis*.

Pea size sexual galls (Fig. 7) of *Dryocosmus ceriphillus* are found in May on leaf margins of *Quercus cerris*. Clustered galls of the asexual generation develop on shoots of the same oak. The galls secrete honeydew in order to attract ants (Fig. 8). Ants, as reciprocation for the honeydew, protect the galls against parasitoids seeking oviposition places.

Fig. 7-8: Gall of sexual generation (left) and asexual generation (right) of *Dryocosmus cerriphillus*. The asexual gall is patrolled by ants.

Colonization of native herbivore insects on introduced oaks

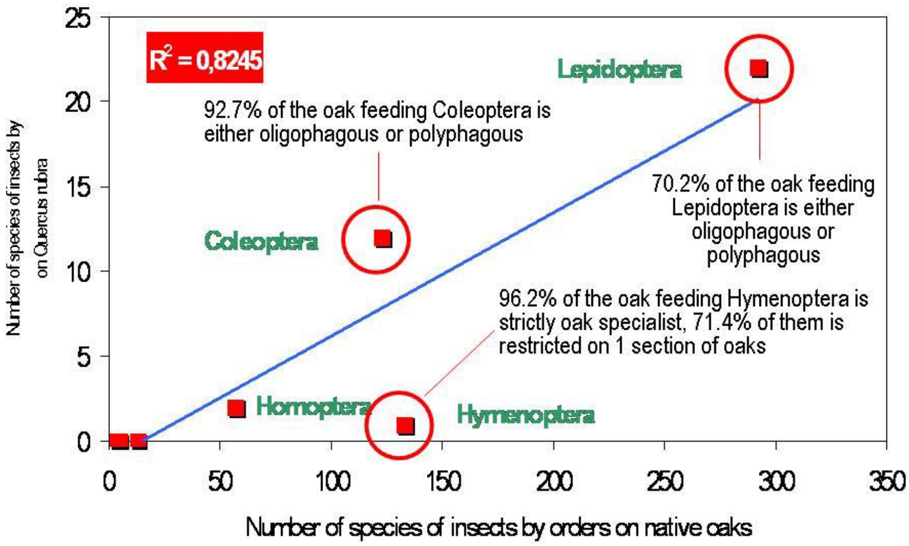


Fig. 9: Correlation between the number of herbivore insets by orders on native and exotic oaks

As it is shown in Fig. 9 there is strong positive correlation between the number of herbivore insect species by order on native oaks (as independent variable) and that of found on exotic oaks (as dependent variable). However there are two orders located significantly above and two orders located significantly below the trend-line. These deviations can be explained by the different host specificity of these orders (see Table 5). A major part of the species in Lepidoptera and Coleoptera is either oligophagous or polyphagous. The ratio of oak specific species is relatively low both in Coleoptera (16.3 %) an Lepidoptera (32.2%).This characteristic results in a significantly higher chance of colonization on introduced oak species. Contrary to this, orders Homoptera and particularly Diptera a

Hymenoptera (ratio of oak specialists are 44.6 %, 100 % and 96.3 %) includes much less oligophagous or polyphagous species, and much more specialist restricted to genus *Quercus*. Even higher degrees of host specificity are common among Hymenopteran herbivores feeding on oaks. A significant number of species feed exclusively on oaks belonging to one section (either section *Cerris* or section *Quercus*), and slightly less, but still a considerable number of species can feed (develop) only one single species of oak.

Contrary to some earlier publications, specialist sessile herbivore hardly ever colonize the North American red oak, *Quercus rubra* (Csóka and Hirka 2002).

Sesonality of leaf feeding herbivore insects

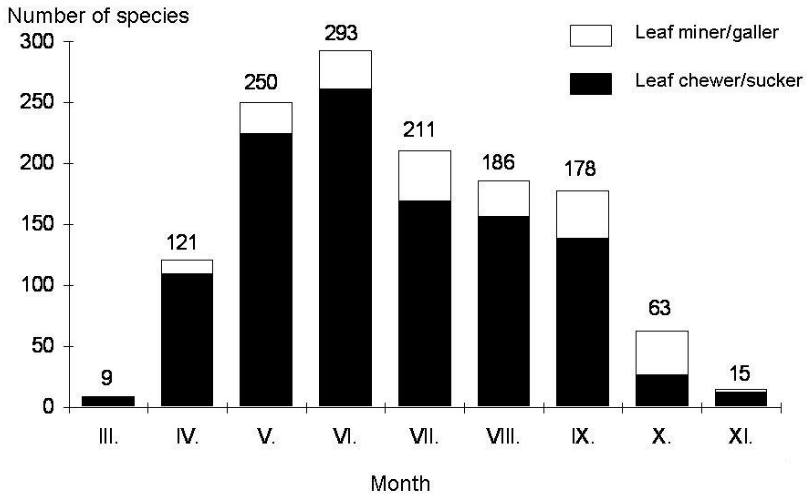


Fig. 10: Numbers of leaf feeding insects on oaks in Hungary during the growing season

The number of insects feeding on the foliage of oaks reaches its peak in June, then gradually decreases until September, followed by a sudden drop in October and November (Fig,). However the temporal patterns of the different feeding guilds are considerably different. While leaf chewers and suckers (considerably less specialised in average) show a definite peak in June, more specialized guilds (such as leaf miners and leaf gallers) have two peaks, one in June/July and another in September/October. This pattern can be explained by two different reasons. While a majority of generalist leaf chewers is univoltine, quite a few specialist leaf miners have two (or even three) generations per year, and their 2nd or 3rd generations certainly increase the species number later in the growing season. On other hand, the asexual generations of the host alternating gall wasps appear later in the season increasing the species richness in autumn.

The feeding time of the most important oak-defoliating insects (gypsy moth, geometrids, browntail moth, cockchafers, etc.) coincides with the highest richness of leaf feeding insects. This means, that an extremely high number of "innocent" rare and protected species are strongly affected by spraying with various types of pesticide. This fact should be taken into account during the decision-making process, and great caution exercised during the application of pesticides, particularly in protected areas.

"New" oak pests, record-breaking damage and increasing damage trends of some "classic" oak pests

Parallel to their extremely rich insect herbivore fauna oaks also are hot spots of great insect outbreaks. In the last 1-2 decades several species earlier not known as outbreak species had local, but already significant outbreaks (i.e. *Tischeria ekebladella*, *Caliroa* sp., *Phylloxera quercus*, etc.). These species are native to Hungary and are mentioned in general in the older literature, but their notable outbreaks were not recorded during the last half-century.

An even more frightening fact, that the most recent (and not yet concluded) outbreak of the Gypsy Moth exceeded all expectations (Fig. 11). The Gypsy Moth caused damage on 108 thousand hectares in 2004, and has doubled even this record-breaking number in 2005, causing damage on nearly 215 thousand hectares (Hirka 2005, 2006). Strangely, severe damage events were observed far beyond its "classic" damage area (turkey and pedunculate oak stands at lowlands and lower hilly regions) penetrating into forest types in mountainous regions (i.e. beech and sessile oak forests). While defoliated turkey (Fig. 13-16) and pedunculate oak stands regenerate their foliage successfully within a couple of weeks, beeches and sessile oaks struggle to compensate the defoliation within the same growing season. The long-term effects of gypsy moth defoliation on these "unprepared" tree species are still unknown.

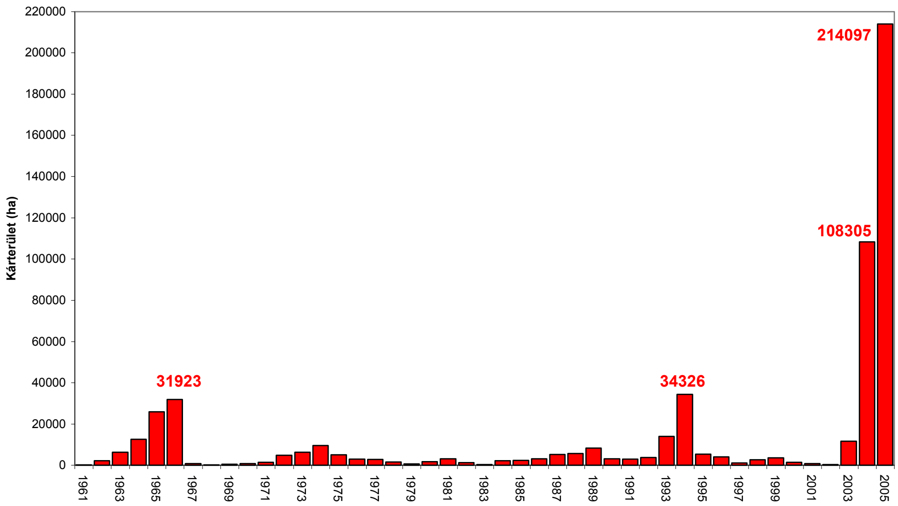


Fig. 11: Area damaged by gypsy moth in Hungary between 1961 and 2005.

Although the scale of *Euproctis* damage is one magnitude smaller than that of the Gypsy Moth, its damage shows a consistently increasing damage trend in the period 1961-2005 (Fig. 12). The most important outbreak foci of this species can be found in the young, mid-age, artificially planted pedunculate oak stands in the SE part of the country. The increasing damage trend of this species, which favours hot and dry weather, is probably not independent from the increasing frequency and severity of droughty periods during the last half-century. The increasing damage trend of *Euproctis* is not the only one in Hungary, even if it is one of the most spectacular examples.

The size of area damaged by forest insects in Hungary is in positive correlation with the 2-3 years moving average of the drought indices. Therefore it is quite evident, that if some forecasts about the climate changes in the Carpathian basin come true (more frequent and more severe drought), we will have to face even more frequent and more severe insect outbreaks in our oak forests (Csóka 1997).

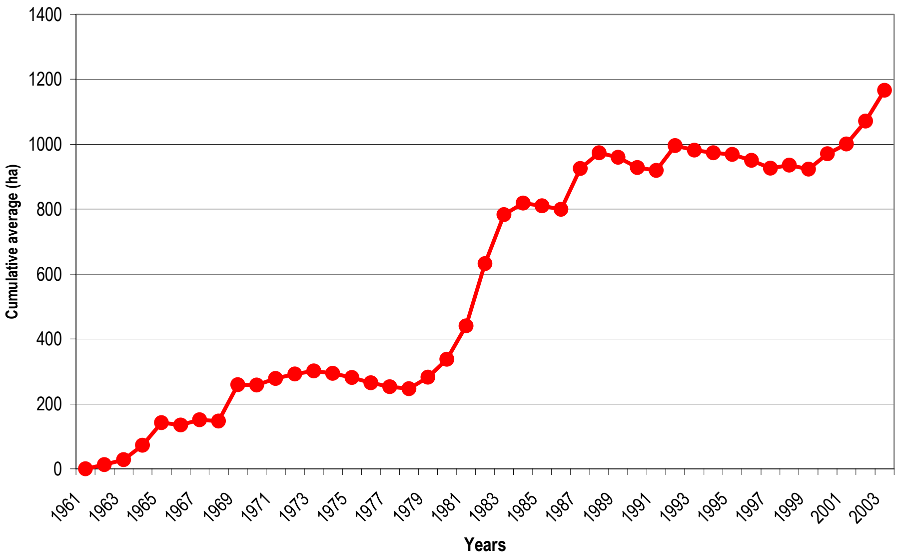


Fig.12: Cumulative averages of yearly damage caused by *Euproctis chrysorrhoea*

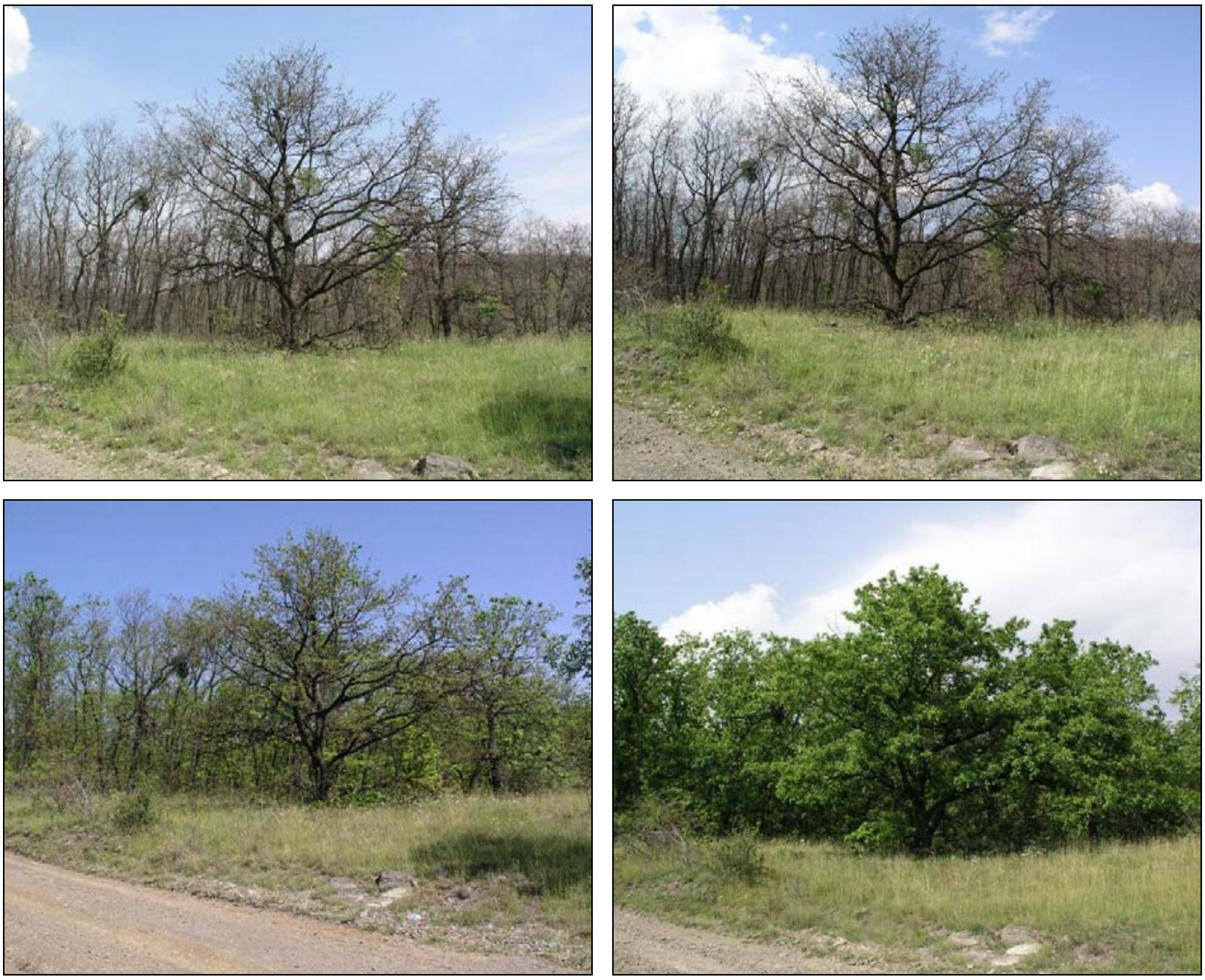


Fig. 13-16: Regeneration process of turkey oak crown after total defoliation by gypsy moth in two-weeks interval (left-top: 6th June; right-top: 20th June; left-bottom: 4th July; right-bottom: 20th July)

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Oral presentation

Bark-breeding beetles on beech in context to the drought of 2003 in Germany

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Abstract

In 2004, following the extreme drought and heat of the summer 2003, serious attacks of bark-breeding beetles have been detected in many areas in the Southwest of Germany. The small beech bark beetle (*Taphrorychus bicolor* Hrbst.) and the buprestidean beech agrilus (*Agrilus viridis* L.) are the major species involved. A first overview of the distribution, the symptoms and the potential risks are presented.

Keywords: *Agrilis viridis, Taphrorychus bicolor,* beech

Following the extreme drought and heat of the summer of 2003 an unusual infestation of bark-breeding beetles on standing European beech (*Fagus sylvatica* L.) has been detected in many areas in the Southwest of Germany (Delb 2004) (Fig. 1-2). The main agents are the small beech bark beetle (*Taphrorychus bicolor* Hrbst.) and the buprestidean beech agrilus (*Agrilus viridis* L.). The infestation is often apparent at the edges of stands which originated from wind damages, as in the 1999 "Lothar" storm (Fig. 3). In contrast to the infestation of beech bark beetle, which had already been observed in autumn 2003, the infestation of the beech agrilus, with very few exceptions, did not emerge before 2004.

Damages caused by outbreaks of the small beech bark beetle (Fig. 4-5) following a drought year are known, i.e. from Hessen in 1976 (Schönherr *et al* 1983, Postner 1974). Without an increased susceptibility of the beech trees, as it was the case in the current extreme drought year 2003, the beech bark beetle is apparently not of relevance to forestry.

As it is known the beech agrilus (Fig. 6-7) occurs in outbreaks after years of drought and heat (Schönherr 1974). Around 1950 a massive outbreak which mainly affected older beech trees occurred in Middle Europe. According to experiences gained at this time, beech on shallow sites, on edges with a high ground exposure to the sun and on southern exposed steep slopes are especially endangered.

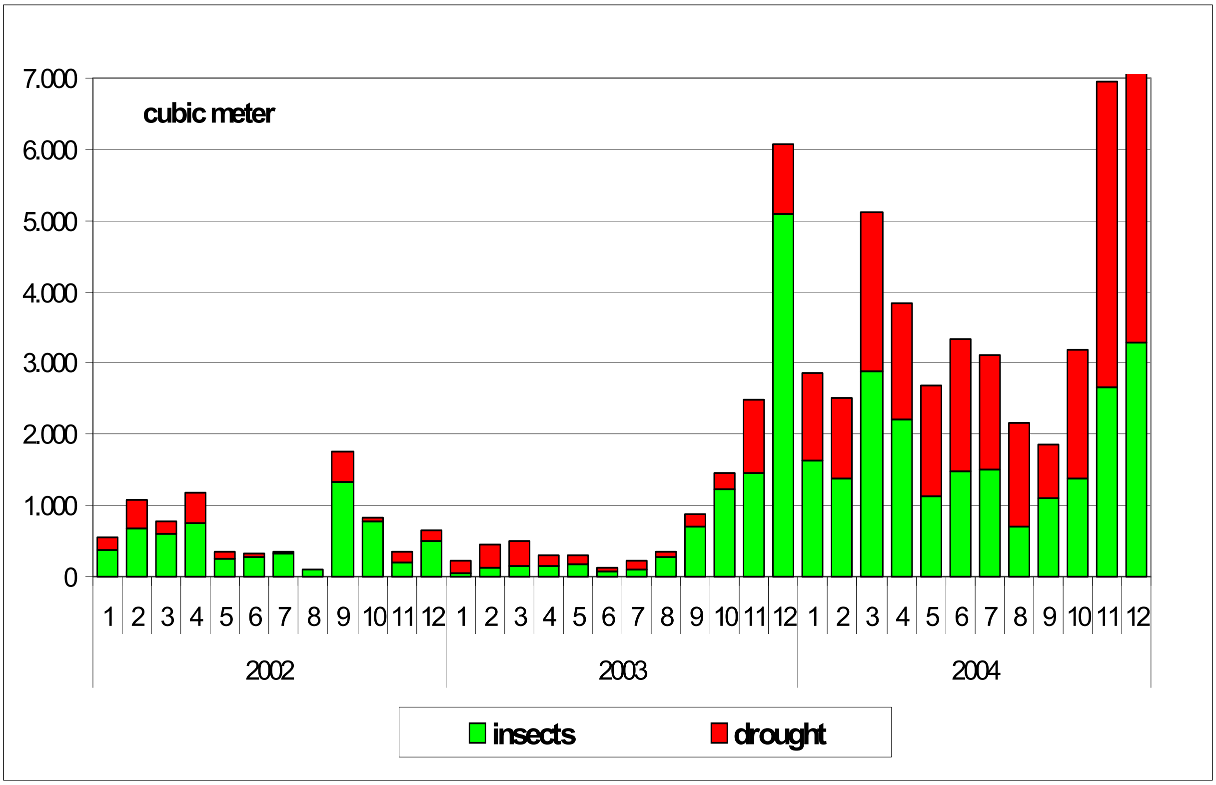

Fig. 1: Irregular harvesting due to insects and to direct drought damages; monthly cubic meters 2002, 2003 and 2004.

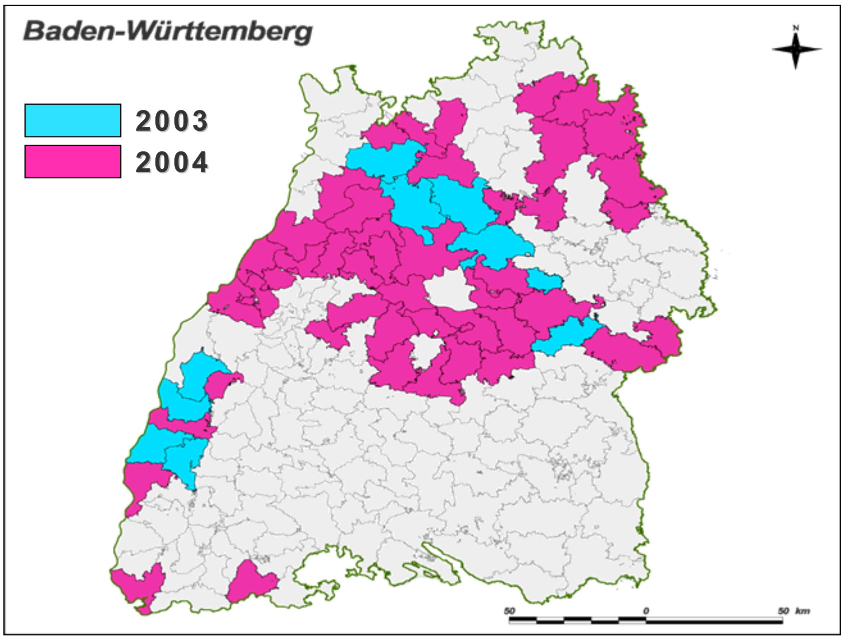

Fig. 2: Occurrence of bark-breeding beetles on beech, Baden-Württemberg 2003.

Fig. 3: Steep edge of a old growth beech stand due to wind damages, Kenzingen Forest District.

Fig. 4: Small slime flux spots due to penet-ration efforts of the small beech bark beetle.

Fig. 5: Large slime flux spot due to ongoing larval feeding of beech agrilus in the bark.

Fig. 6: Brood galleries of the small beech bark beetle under the bark.

Fig. 7: Larval feeding galleries of the beech agrilus under the bark.

Due to the current alarming infestation by bark breeding beetles, a study area was set up at the end of 2003 to asses the objective danger and effects of these beetles on beech. The investigations take into account the future weather conditions and vitality of beech stands.

Aside from the monitoring of swarming time and dispersion process, the question is asked whether old infested beech trees located at the edge of the wind throw die as a consequence of the infestation. In addition, the risk of these trees as a source of infection to the nearby closed beech stand should be assessed.

Based on the results of these studies, the present strategy and the recommended measures to limit wood destruction and to reduce population density in order to secure beech forests will be enhanced. In the same way silvicultural and economic consequences should be determined.

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Oral presentation

Can pheromone trapping predict *Ips typographus* outbreaks?An example from the Southern Alps

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Abstract

Ips typographus is the main forest pest of Italian spruce forests. Beginning in 1996, the populations of *I. typographus* occurring in NE Italy have been annually monitored by using pheromone traps. Monitoring lasts about 18 weeks (May – August), with replacement of pheromone dispensers after 8-10 weeks. Traps are checked and emptied weekly. Insects trapped before dispenser changing are called "spring captures" (May-June), whereas beetles caught after dispenser changing are "summer captures" (July-August). Preliminary analysis of the data (1996-2004) reveals a strong correlation between the ratio of spring and summer captures of the year x ($spring_x/summer_x$), and the ratio of total captures of the following year ($Y_{(x+1)}$) and those of the current year (Y_x) (Y_{x+1}/Y_x). This relationship shows that:

- $Spring_x/summer_x$ ratios lower than 1.5 indicate increasing populations in the following year;
- $Spring_x/summer_x$ ratios around 1.5-2 indicate stable populations in the following year;
- $Spring_x/summer_x$ ratios higher than 2 indicate decreasing populations in the following year.

The correlation allows us to estimate the captures of the following year. In this respect, high summer captures mean high risk of outbreak in the next year. The risk of outbreak is affected by the breeding performance of the spring generation (summer captures).

Keywords: monitoring, traps, spruce pest, bark beetle, pheromone, outbreak, forecasting, Italy, *Ips typographus*.

Introduction

The spruce bark beetle *Ips typographus* (Linnaeus) (Coleoptera Scolytidae) is one of the most destructive pests attacking European spruce forests (Christiansen and Bakke 1988). The beetle also causes great damage to Italian stands growing in the southern Alps (Lozzia 1993; Faccoli 1999; Frigimelica *et al* 2000; Stergulc *et al* 2000). In Italy *I. typographus* attacks host trees early in spring (end of April), when the mean air temperature reaches 18°C. Adults of the parental generation emerge from over-wintering sites and look for a suitable host to begin the first generation. Then, at the beginning of July, the offspring emerge and start a second generation, which will conclude in September (Faccoli 1999; Netherer 2003).

Modern strategies for *I. typographus* control include the use of traps baited with aggregation pheromones (Bakke *et al* 1977). Traps are useful both in control by mass-trapping (Raty *et al.*, 1995), and in population monitoring (Lindelöw and Schroeder 2001). Preliminary results concerning *I. typographus* monitoring were recently presented for some Italian populations (Faccoli and Stergulc 1999; Marchetti *et al* 1999; Frigimelica *et al* 2000; Stergulc *et al* 2000). In general, data from multi-year monitoring give indications about the population trend over time (Bakke 1985). However, no prediction about the population density is given for the following year, which could show either low or high captures. In this paper we summarize data obtained from an *I. typographus* monitoring carried out over a period of nine years, and discuss how pheromone trapping could forecast the mean captures of the following year.

Materials and Methods

Monitoring network

Since 1994, a monitoring network called "BAUSINVE – Forest Phytopathologic Inventory" is checking the main forest pests and diseases occurring in Friuli – Venezia Giulia, north-eastern Italy (Stergulc and Frigimelica 1997). The forest health is monitored daily by about 60 foresters working for the Regional Forest Service and supervised by a team of entomologists and pathologists in collaboration with many scientific institutes. Data concerning pest and disease outbreaks (species, instar development, density of population), and their damage (number of attacked/killed trees, volume of wood lost, extension of defoliated areas) are recorded in a database, which includes both climatic (temperature and rainfall) and sylvicultural (forest composition, tree age, stand origin...) information.

Monitoring of Ips typographus populations

Beginning in 1996, populations of *I. typographus* are monitored permanently in some spruce forests of the region by using ca 30 pheromone traps per year (Theysohn® slot-trap) baited with pheromone dispensers containing 80 mg of cis-verbenol, 1,8 mg of 2-metil-3-butin-2-ol and 8 mg of ipsdienol. The monitored stands are about 70-80 years old, growing at altitudes between 800 and 1200 m a.s.l. The traps are set up and baited at the end of April, checked weekly, and all captured beetles are collected and counted. In accordance with manufacturer recommendations, the pheromone dispensers are replaced after 8-10 weeks (end of June) in order to cover the whole activity period of *I. typographus.* Monitoring lasts until September (about 18 weeks) and data are reported in the BAUSINVE database as mean captures per trap. Previous investigations carried out in the study area report the development of the first generation as taking 7-9 weeks depending on weather conditions (Faccoli, 1999). Therefore, beetles captured before the end of June, when the dispensers are changing, are only parental adults coming from overwintering ("spring captures"), whereas later catches ("summer captures") are their offspring. The total captures per year (Y_x) are reported as mean number of insects per trap.

Statistical analysis

Correlations between the ratio of spring and summer captures of the current year (x) ($spring_x/summer_x$), with the ratio of total captures of the following year (Y_{x+1}) and the captures of the current year (Y_x) were analysed by using a multiple regression procedure giving an R^2-value, adjusted for the number of parameters (Zar 1999). A confidence level of 0.05 was considered significant.

Results

Flight phenology of I. typographus in SE Alps

The flight activity of *I. typographus* is very extended and occurs over a period of about four months (May - August) (Fig. 1). During the monitoring it is possible to detect two main peaks of *Ips typographus* captures, the first occurring in the middle of May and the second at the beginning of July (Fig. 1). Spring captures include both overwintering and re-emerging adults, which fly around searching for suitable spruces on which to start the first generation, whereas summer captures are the emerging adults of both first and sister-generations. Spring captures may be higher than summer ones (Fig. 2), but in other cases, sometimes the opposite can be observed (Fig. 3). Mean annual captures are very variable (Fig. 4), indicating either epidemic or endemic *Ips typographus* populations.

Data correlations

There are two different significant correlations between $spring_x/summer_x$ ratios and Y_{x+1}/Y_x ratios, when the $spring_x/summer_x$ ratios are respectively higher (d.f.= 1; 20, F=17.15, $P<0.001$, R^2=0.89) (Fig. 5), and lower than 2 (d.f.= 1; 17, F=73.62, $P<0.001$, R^2=0.90) (Fig. 6). In both the cases, greater is the $spring_x/summer_x$ ratio and smaller the corresponding Y_{x+1}/Y_x ratio (Fig. 5 and 6). Ratios between annual captures (Y_{x+1}/Y_x) higher than one indicate increasing populations for the following year, whereas Y_{x+1}/Y_x ratios lower than one indicate decreasing populations. In this respect, when the $spring_x/summer_x$ ratios are lower than 1.5, the Y_{x+1}/Y_x ratios are mainly higher than one, indicating increasing populations (Fig. 6), whereas when the $spring_x/summer_x$ ratios are higher than two, the Y_{x+1}/Y_x ratios are lower than one, indicating decreasing populations (Fig. 5). Finally, when $spring_x/summer_x$ ratios are ranging between 1.5 and 2.5, the Y_{x+1}/Y_x ratio is about one, indicating stable populations. The model is validated by the high correlation between observed and expected data (Fig. 7). Moreover, the accuracy of the model indicates an 11% of overestimation of the total captures expected for the following year, whereas a 5% of underestimation can occur (Fig. 8).

Discussion

One of the aims of a monitoring program should be to use capture data as an index of population density, to estimate the risk for outbreaks. However, data obtained from monitoring systems based on pheromone trapping only give general information about population density of the current year. Data from monitoring carried out annually can only delineate the temporal trend of the population (Bakke 1985). Nevertheless, no certain information is given for the coming year (Fig. 4). Exceptional breeding performance and large food availability could quickly increase the population density. On the other hand, unfavourable climatic conditions could reduce outbreak populations to endemic levels. From this point of view, a more reliable estimation protocol has to be found.

The high correlation between the number of trapped insects in spring and summer and the variation of the population densities between different years (Fig. 5 and 6) allows us to estimate the amount of insects, which will be caught in the following year. The investigated correlations show that a spring/summer ratio higher than two corresponds to decreasing populations (Fig. 5), whereas spring/summer lower than 1.5 means increasing populations (Fig. 6). In this respect, high summer captures, reducing the spring/summer ratio, indicate high risk of outbreak in the next year. However, summer captures are directly dependent on the breeding performance of the first generation, affecting the risk of outbreak.

Spring catches are supplied by over-wintering adults that produce offspring during the summer. Therefore, a first generation having a high rate of reproduction will produce high summer captures, indicating the beginning of a big second generation. Although pheromone traps cannot provide data concerning the second generation, high summer captures may produce many offspring, some of which survive the winter causing outbreaks in the next season. Otherwise, high spring/summer ratio means low reproductive rate of the first generation, indicating decreasing populations (Fig. 5). In spite of a large number of parent adults trapped in spring, the offspring are very few and spread without making outbreak populations. Finally, spring/summer ratios ranging between 1.5 and 2 indicate populations showing only small density variation, with a reproductive rate too low to cause outbreaks.

For the same area of investigation, Faccoli and Stergulc (2004) found a strong correlation between the number of insects per trap and the number of trees attacked by *Ips typographus*. Cost/benefit analyses, therefore, allow a “catch threshold” to be fixed to decide if additional control measures are required. The threshold found by Faccoli and Stergulc (2004) was about 8,000 insects/trap/year. Once the catch prediction surpasses the risk-threshold, many control strategies could be applied, e.g. increasing the number of traps, setting-up trap-trees, making a more careful survey of spruce stands, and applying sanitation felling. Monitoring data are available at the end of summer when flight period is over. However, if an outbreak forecast is available, specific control programs can be quickly applied in the following spring when over-wintering adults fly, looking for host trees.

The accuracy of the model indicates a mistake percentage in catch prediction for the following year (Fig. 8). In the 11% of tested cases the model overestimates the expected captures above the risk-threshold, whereas in the 5% an underestimation below that threshold is observed (Fig. 8). An overestimation of captures can induce the operators to apply control strategies without a real outbreak danger, so leading to unjustified costs. Nevertheless, underestimation is much more dangerous as the operators do not control expanding populations, which can begin outbreaks causing severe damage. Thus, overestimation is safe but expensive, whereas underestimation is cheap but dangerous.

These correlations can provide us with opportunities to assess in advance the risk of outbreaks giving the time to apply control strategies.

Acknowledgements

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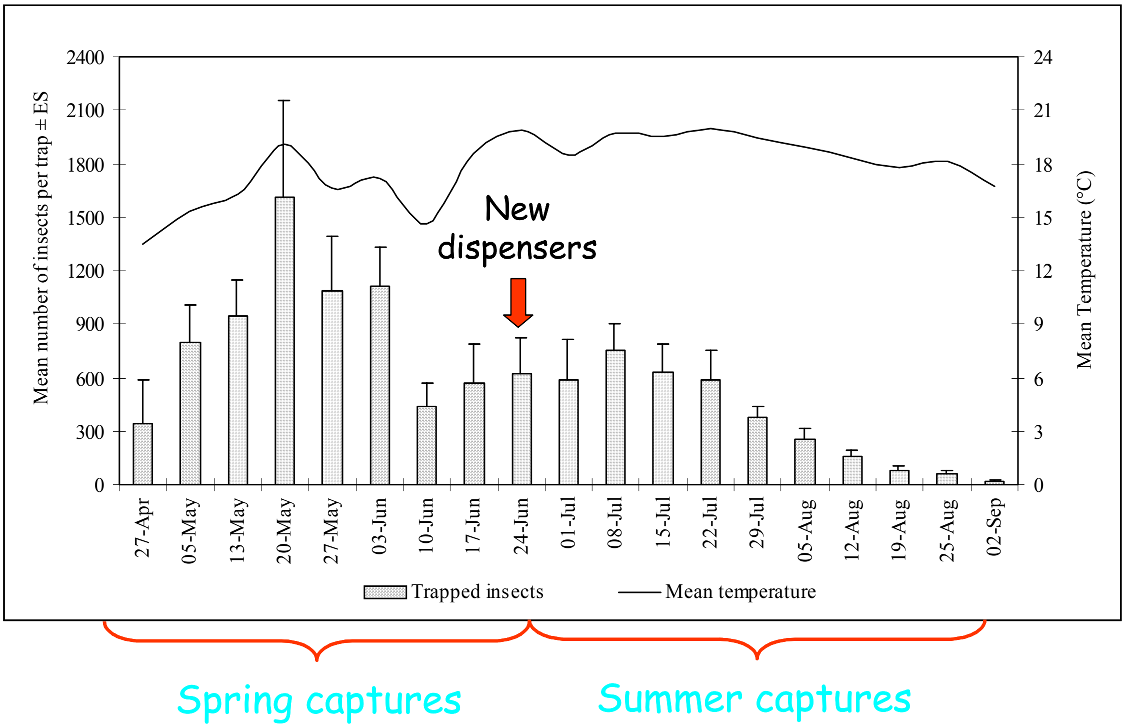

Fig. 1: Phenology of *Ips typographus* in south-eastern Alps (from Faccoli and Stergulc (2004), modified).

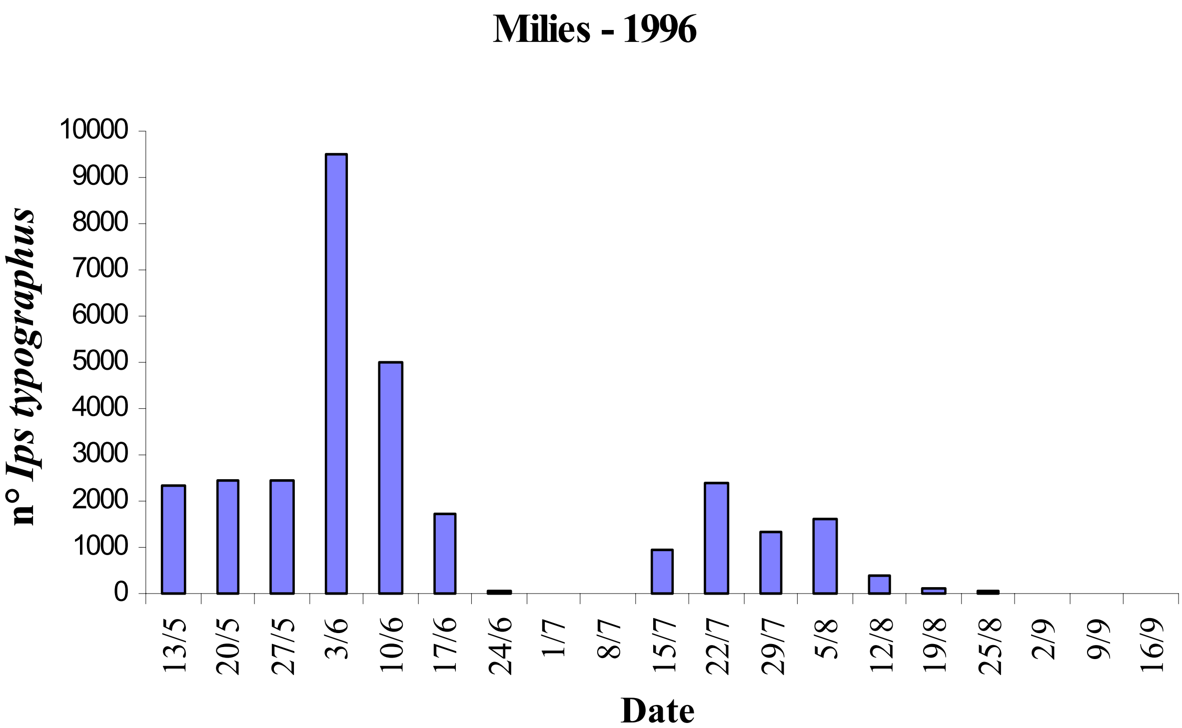

Fig. 2: example of monitoring of *Ips typographus* populations where spring captures are higher than the summer ones.

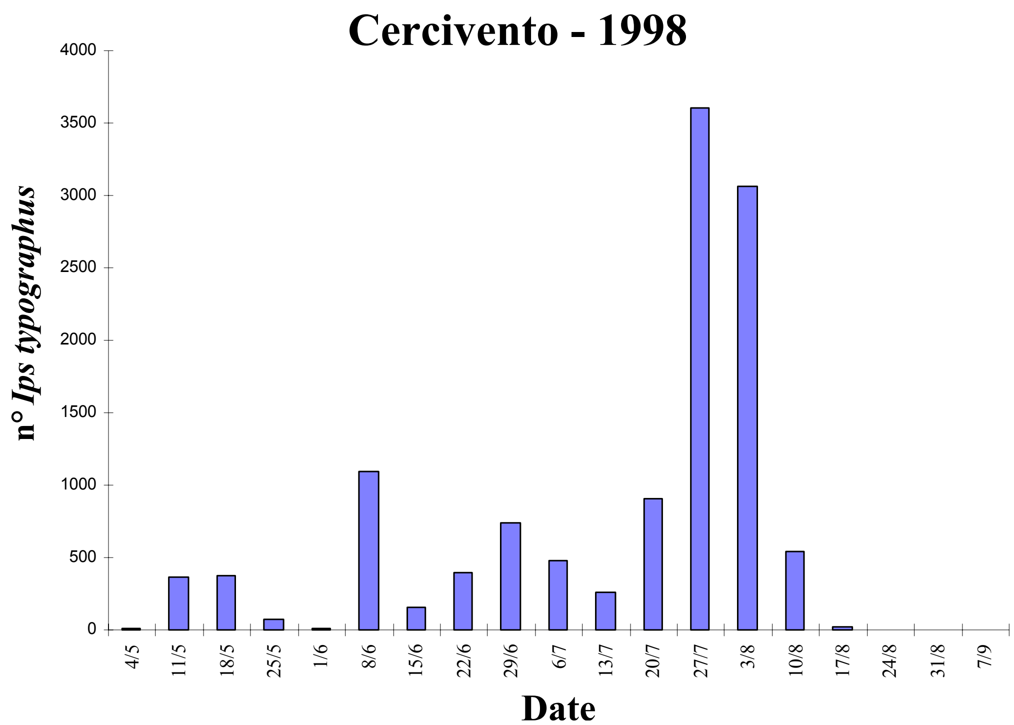

Fig. 3: example of monitoring of *Ips typographus* populations where spring captures are lower than the summer ones.

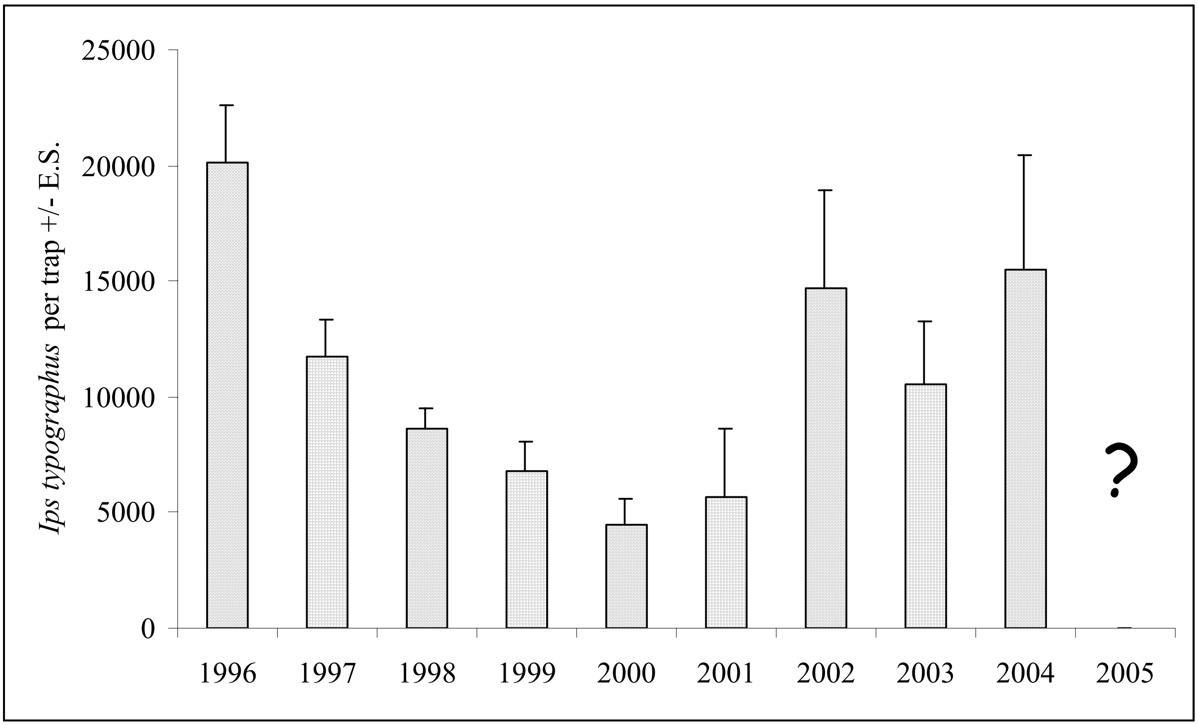

Fig. 4: Monitoring of *Ips typographus* populations from 1996 to 2004. Monitoring gives data concerning the population density in the investigated year, but no prevision for the following year.

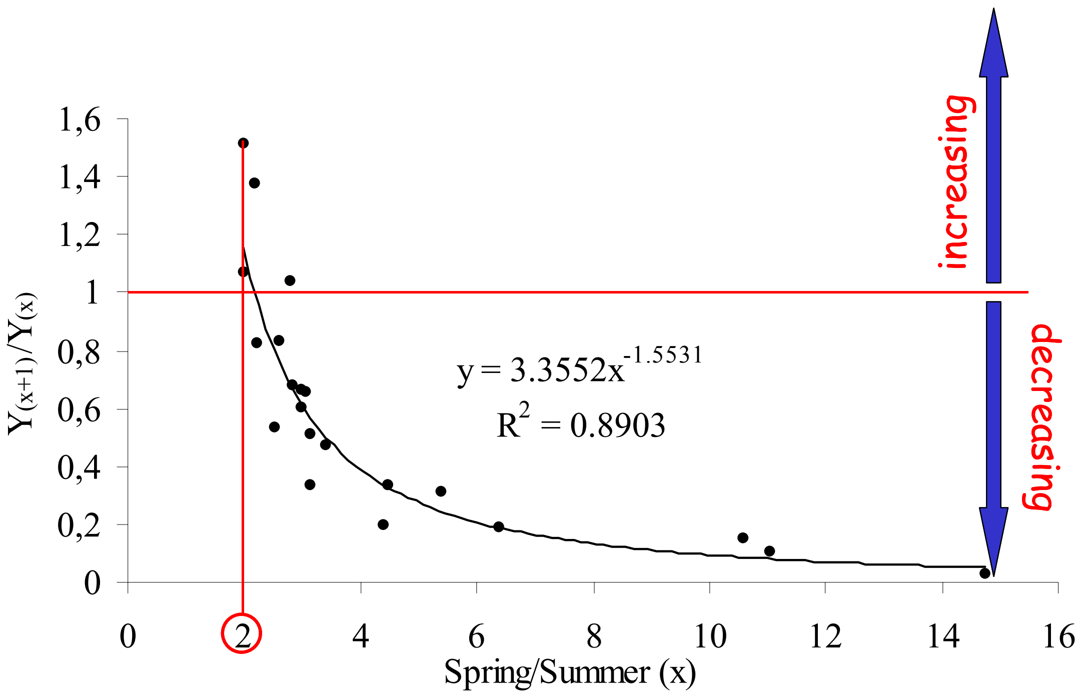

Fig. 5: correlation between spring and summer captures of the year x, and the ratio of total captures of the following year ($Y_{(x+1)}$) and those of the current year ($Y_{(x)}$). The graphic reports values of spring/summer ratio higher than 2.

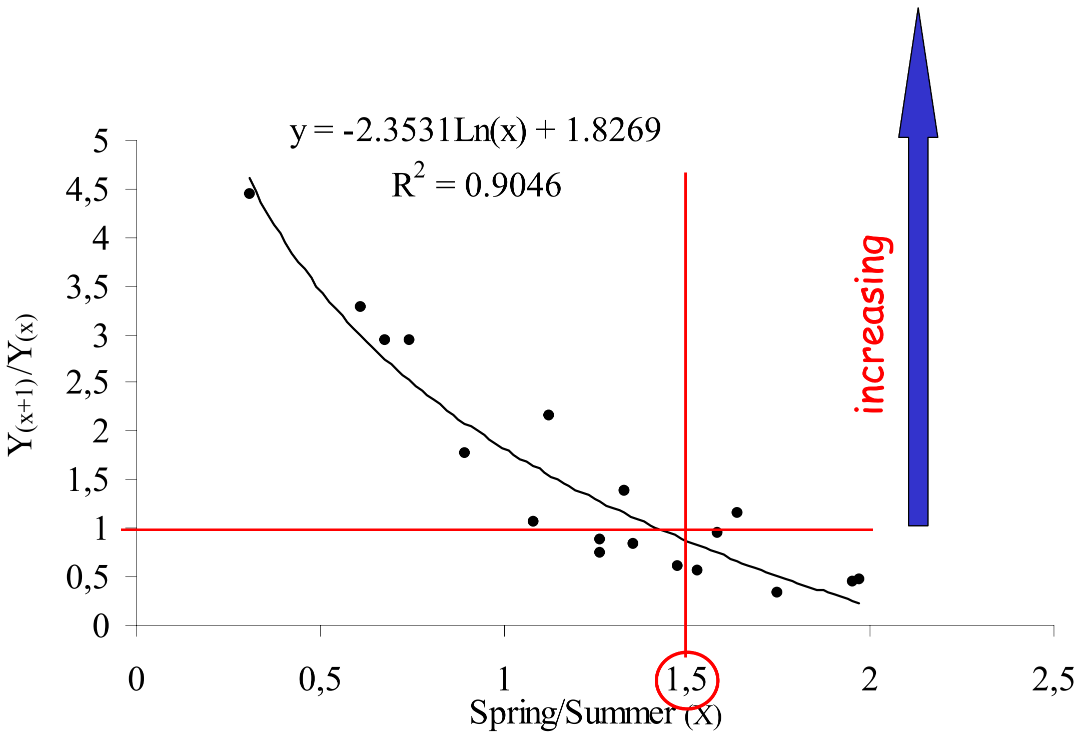

Fig. 6: correlation between spring and summer captures of the year x, and the ratio of total captures of the following year ($Y_{(x+1)}$) and those of the current year ($Y_{(x)}$). The graphic reports values of spring/summer ratio lower than 2.

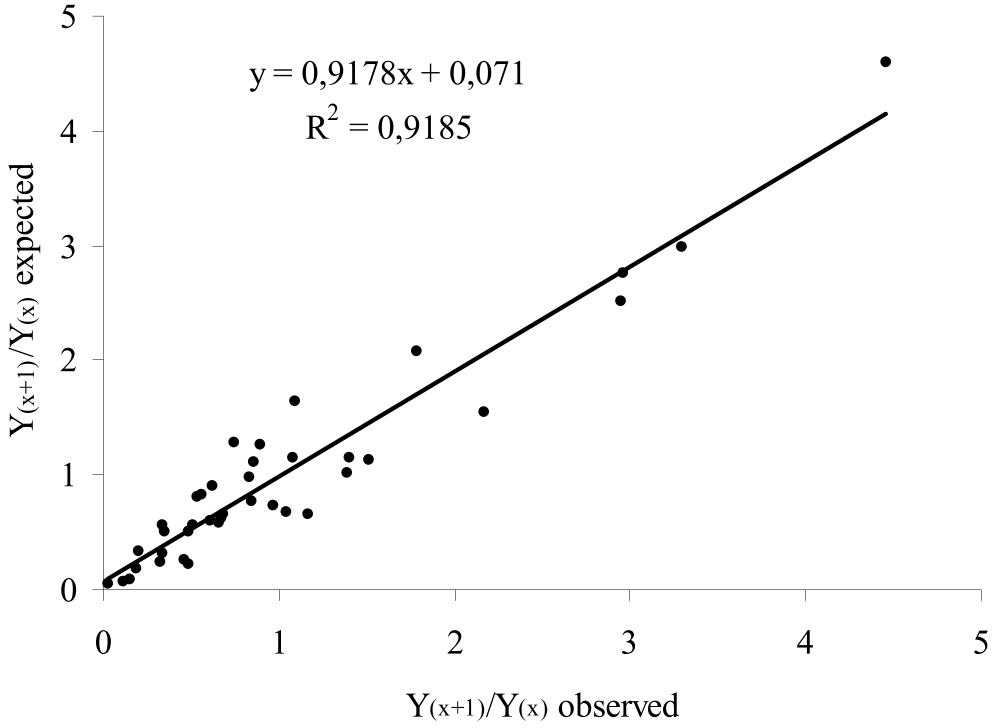

Fig. 7: Observed versus expected data from the model.

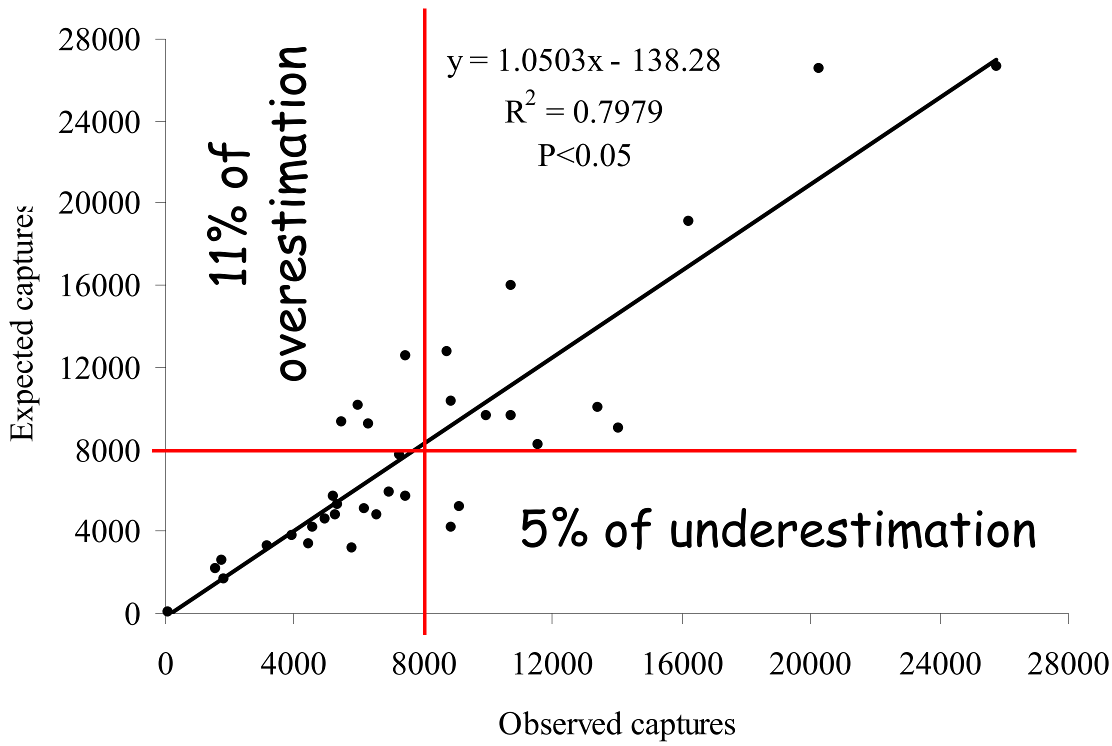

Fig. 8: Accuracy of the model: The proposed model has 11% of possibilities to overestimate the total capture expected for the following year and 5% for an underestimation.

Oral presentation

Climate change and management change: the response of forest insects in Switzerland

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Abstract

In Central Europe, the climate of the last decade was warmer than that of any time during the past 500 years. The vegetation period of 2003 was extremely hot and dry. In the last 40 years, 3 heavy storms struck considerable parts of the Swiss forests. Such favorable conditions leaded to mass attacks of the eight-toothed spruce bark beetle (*Ips typographus*). Strategies in forest protection and bark beetle management are changing. Due to logistical, economical and ecological reasons more and more suitable breeding material and infested trees will remain in the stands. Since 1999 a total of about 4.5 million cubic meters of standing spruce were killed in Switzerland by *Ips typographus*, a record that has never been registered before. In some regions the bark beetle outbreaks are still going on.

Keywords: climate change, storm damage, management change, bark beetles, *Scolytidae*, *Ips typographus*, forest protection

Introduction

The Central European climate of the last decade was warmer than that of any period during the past 500 years. The growing season of 2003 was extremely hot and dry. Also the frequency of climate extremes like heat and drought has been significantly increasing in the last two decades. In the last 40 years, 3 heavy storms struck considerable parts of the Swiss forests.

Strategies in forest protection and bark beetle management are also changing. Due to logistic, economic and ecological reasons, more and more suitable breeding material and infested trees will remain in the stands. Very little growing stock is harvested, and the volume increases year by year. Forest insects, mainly bark beetles, respond to these changing environment and habitat conditions by increasing their populations. Unsalvaged infestation spots favour further infestations and gradations. The aspect of the landscape is changing.

Climate change

The climate in Central Europe of the last few years was warmer than that of any period during the past 500 years (Rebetez 2004). By an increase of average temperatures a general warming trend can be observed during the last century (Fig. 1). The frequency and length of climate extremes like heat and drought have increased during the last decades as well.

In many places, the growing season of 2003 was the hottest and one of the driest since Swiss measurements started in the middle of the 19th century. In 2003 the annual precipitation in Switzerland amounted to only 50 to 80% of the norm.

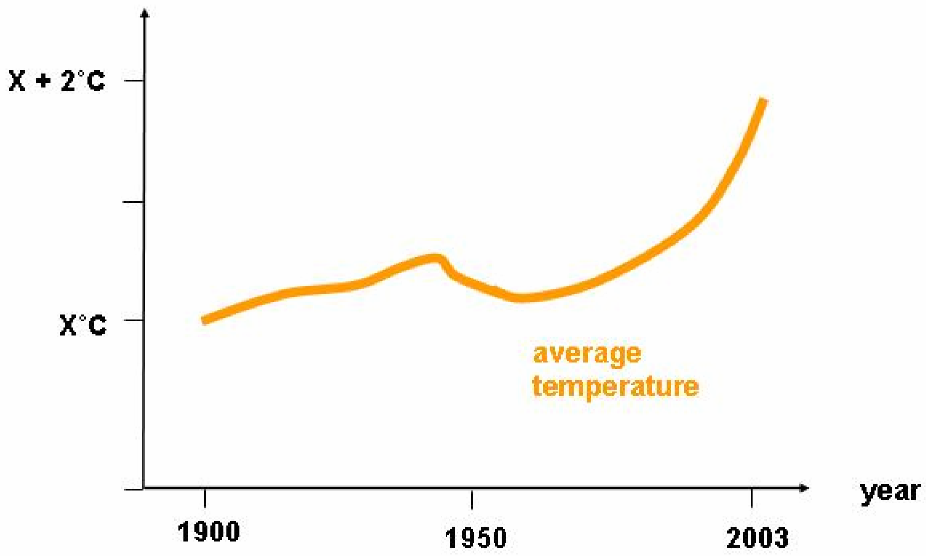

Fig. 1: Trend of average temperature in Switzerland in the last decades. Simplified after ProClim – Forum for Climate and Global Change, Platform of the Swiss Academy of Scineces: www.proclim.ch

During the last 40 years, three heavy storms struck considerable parts of the Swiss forests (Fig. 2). In 1645 and 1739 probably even stronger storms occurred, but the three latest storms in a relatively short period seem to accumulate the frequency of heavy wind-blows. But a general increase of storm events cannot yet be proved.

The storms created a lot of breeding material for forest insects, especially when conifer stands were affected (Fig. 3). The 1999 storm "Lothar" was the worst gale recorded in Central and Western Europe for two centuries at least. Approximately 200 million cubic meters of timber were downed. The most severe damage was noted in France, but also Southern Germany and Switzerland were considerably affected (Table 1).

Country	**timber damage (mio. m^3)**	**% of stock**	**% of annual cut**
France	140.0	6.5	300
Germany: Baden-Württemberg	25.0	5.0	250
Germany: Bavaria	4.3	0.5	40
Switzerland	14.0	3.8	300

Table 1: Wind-thrown timber after "Lothar" 1999.

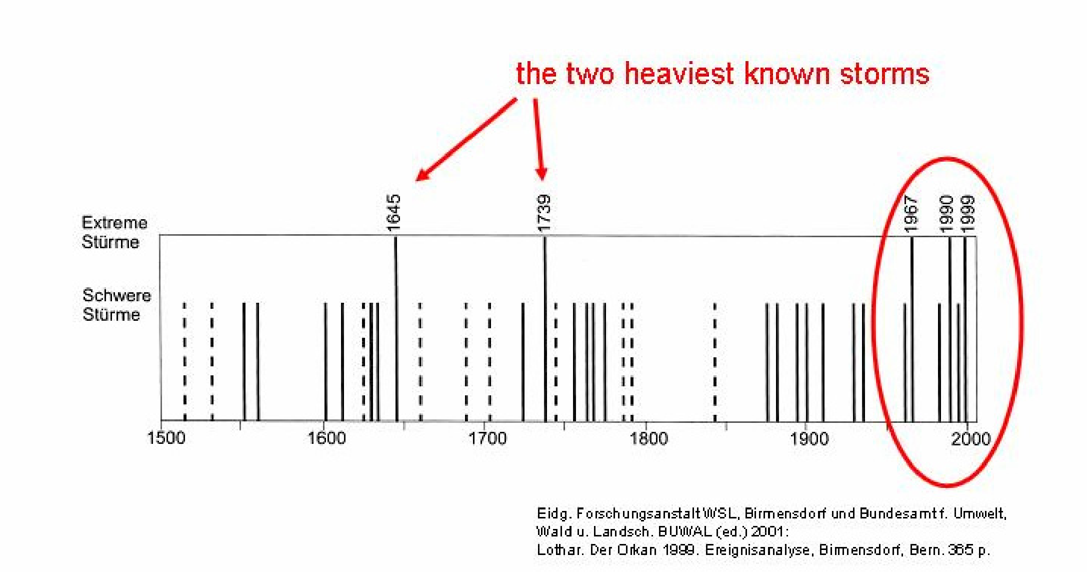

Fig. 2: Heavy storms in Switzerland during the last 500 years.

Fig. 3: Sudden increase of breeding material in storm areas.

The 14 million cubic meters of "Lothar" damaged timber in Switzerland equaled three annual cuts, including 8.5 million cubic meters of spruce, the main host tree of the eight-toothed spruce bark beetle (*Ips typographus*). Approximately one million cubic meters of wind-thrown spruces remained in the storm areas and in the damaged stands. This temporarily increased the amount of suitable breeding material and significantly augmented the dead wood quantities in the affected stands. In 2003 several regions with 1999 wind blows also suffered from the summer drought, which re-increased the breeding material for the bark beetles (Fig. 4). Many beetle outbreaks in these regions are still going on.

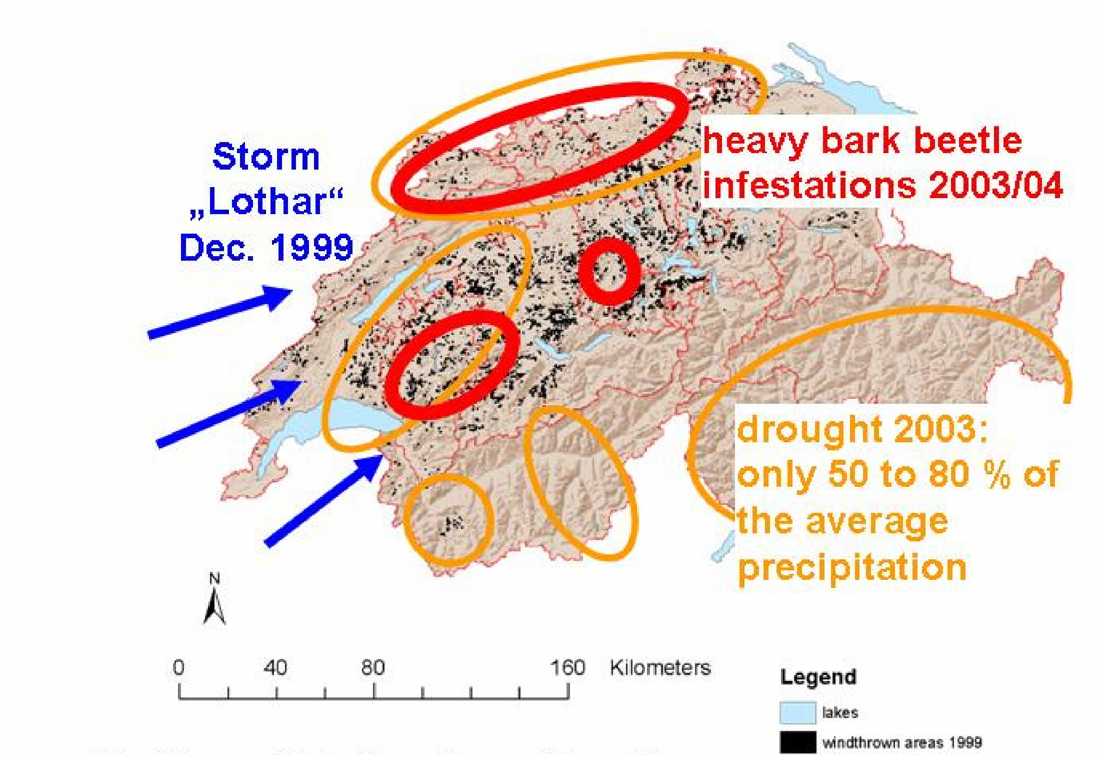

Fig. 4: Areas suffering from storm and drought.

Management change

Swiss forests total 1’200’000 hectares and cover 30% of the country. Only half of the annual timber growth has been harvested for decades. In many mountain forests, the harvesting costs cannot be recouped by timber revenue (Fig. 5). One cubic meter of timber pays less than 1.5 working hours of a cutter. This economic situation leads to the highest growing stock in Europe, with an actual volume of more than 350 cubic meters per hectare. The most abundant tree species is Norway spruce (*Picea abies*), the host of *I. typographus*.

Since the 1990 and 1999 storms, wind-thrown trees and bark beetle infestation spots are no longer salvaged in all Swiss forests. Since 2000 a total of more than half a million cubic meters of standing attacked spruce trees have remained in the stands (Fig. 6). Forest owners and the public mainly focus on protection forests, where sanitary felling can still be supported by subsidies from public funds. As a consequence, more attack and longer gradations of *I. typographus* occur in places without control measures (Fig. 7). Widely spreading attack has to be accepted (Fig. 8, Fig. 9). In some cases, this leads to a considerably changing aspect of the landscape (Fig. 10).

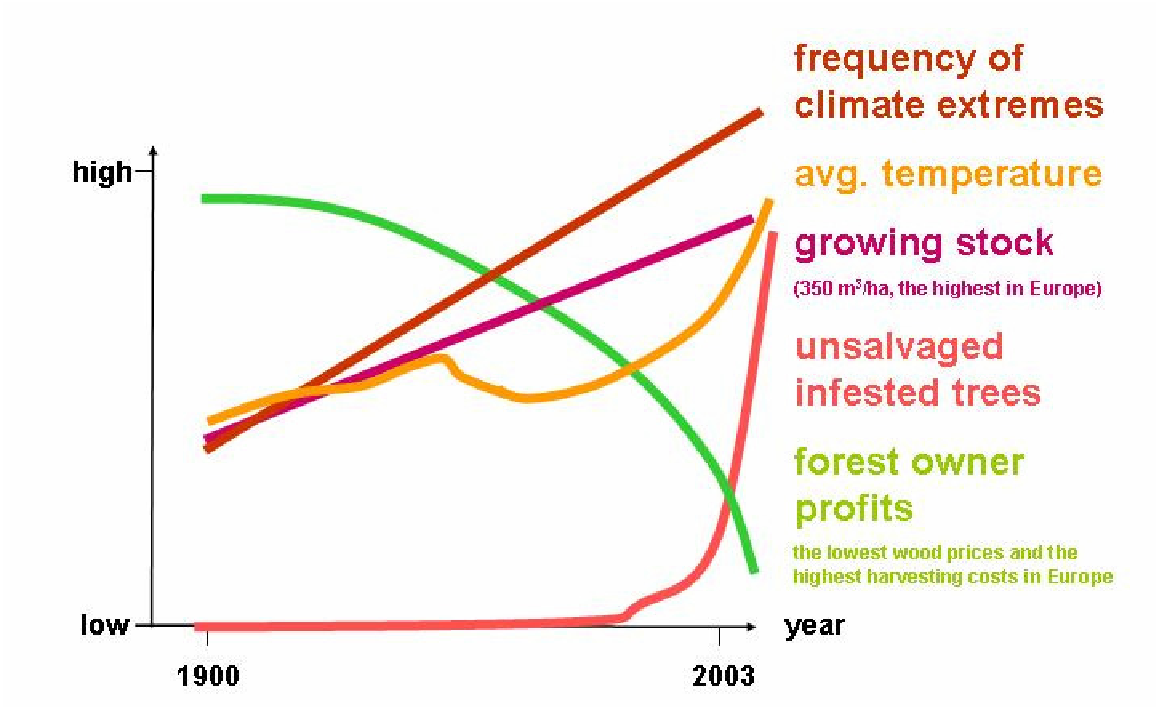

Fig. 5: Influences on bark beetle epidemiology.

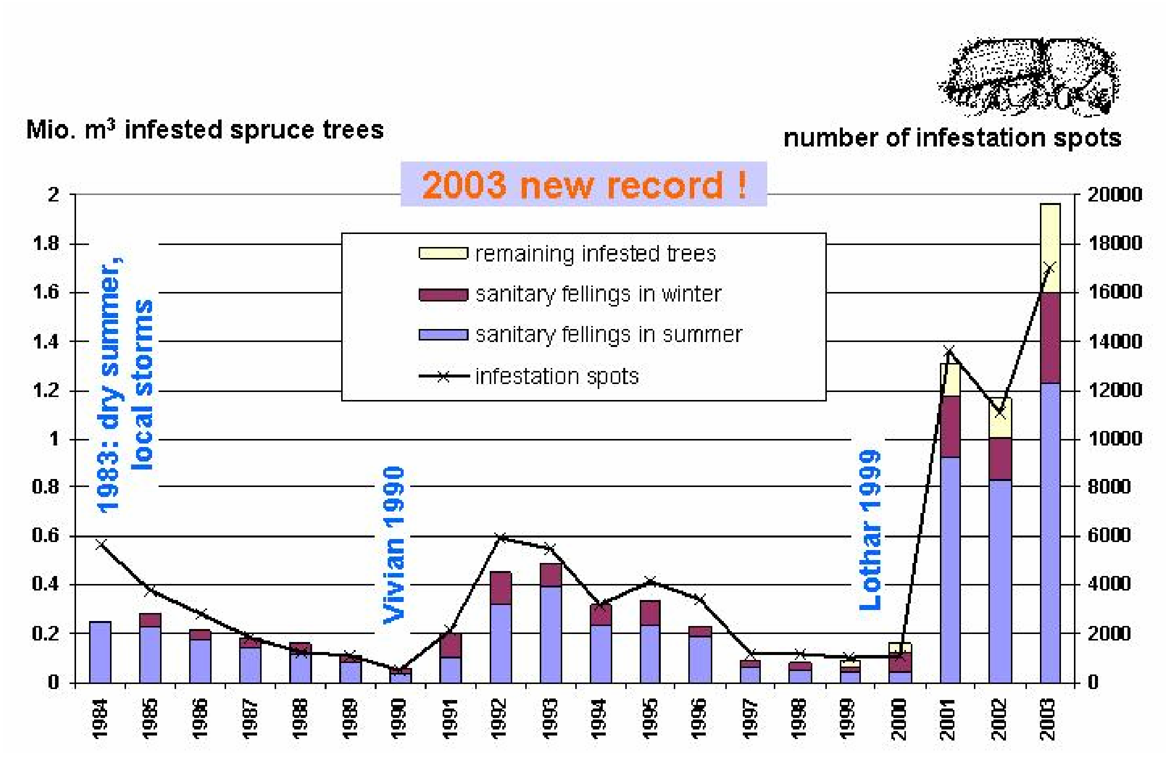

Fig. 6: Yearly attack of *Ips typographus* in Switzerland between 1984 and 2003.

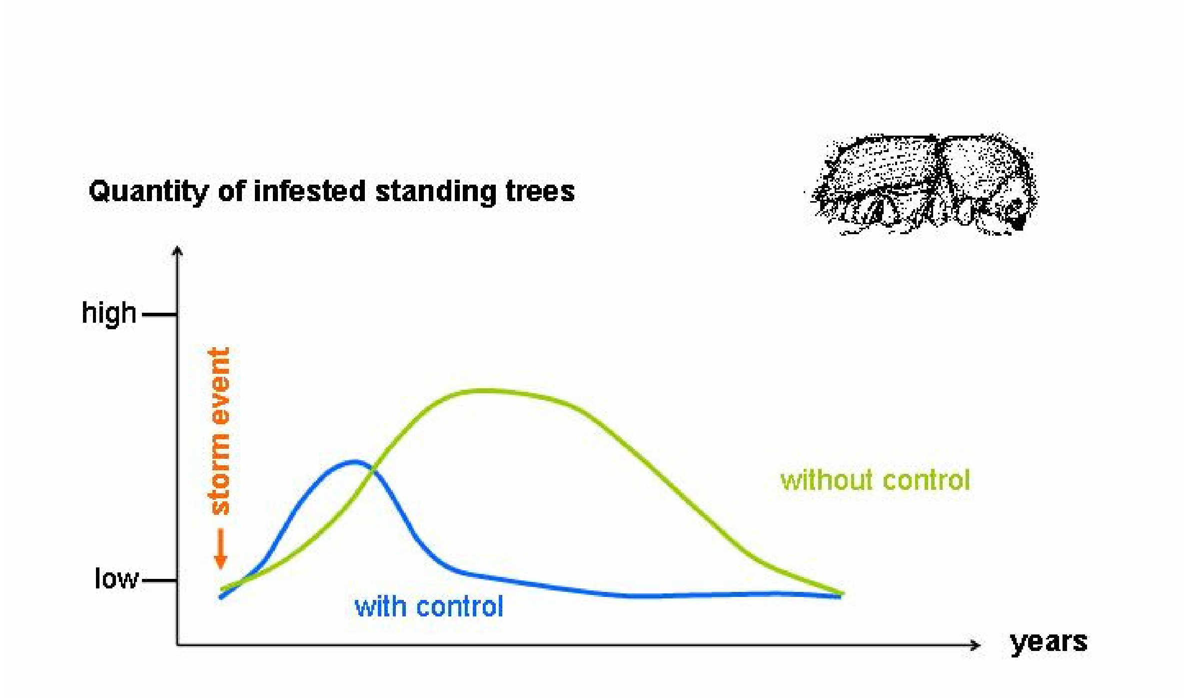

Fig. 7: Course of bark beetle gradations with and without control.

Fig. 8: Growing *Ips typographus* infestations in area without control.

Fig. 9: Large *Ips typographus* infestation in a mountain spruce stand.

Fig. 10: Changing landscape after uncontrolled spreading of *Ips typographus.*

Response of forest insects

Also in the past, favorable weather conditions and storms lead to subsequent mass attacks of the eight-toothed spruce bark beetle (*I. typographus*) (MEIER et al. 2003). But after the storm "Lothar" in 1999 and the summer drought of 2003, the attacks reached an annual 2 million cubic meters of standing spruce, a figure that had never been recorded before (Fig. 6) (Meier *et al* 2004).

Since "Lothar" in 1999, a total of about 3.5 million cubic meters of standing spruce has subsequently been killed by *I. typographus*. Additionally, 1 million cubic meters of attacked spruce are probably the consequences of the summer drought of 2003. Severe attacks occurred mainly on soils with low water retaining capacities or in stands where the beetle populations were already high in previous years. Even if the bark beetle attacks on a national level probably reached its peak in 2003, the gradation is far from over. We expect more considerable attacks for 2004 and the coming years.

Scattered storm damage and weakened standing trees were very favorable habitats for bark beetles (Fig. 11). Very often, mass attack started from scattered windthrows and not from totally devastated areas. The reduced host tree resistance of the remaining trees was considered as a key factor to build up bark beetle gradations (Gall *et al* 2003).

Not all bark beetle species reacted the same way to storms and droughts. The well-known subsequent gradations of *I. typographus* after storm events could not be carried forward to *Pityogenes chalcographus* and *Pityokteines curvidens*, probably the second and third important bark beetle species in Switzerland. Even when there was plenty of suitable breeding material, no large attacks on standing spruce or fir trees could be observed (Table 2). Quite different behavior could be seen after the drought. Here also *P. chalcographus* and *P. curvidens* started to cause considerable standing attack (Fig. 12, Fig. 13). However *I. typographus* still played the most important role (Table 3). In some localities with deficits of precipitation, *Ips cembrae* on larch, and several bark beetle species on pine, also started to proliferate.

The drought also favored the development of many other forest insect species (Phytosanitärer beobachtungs- und meldedienst 2004, Engesser *et al* 2004). Many defoliators or invasive pests could also build up their populations, but they never reached the level of the bark beetle damage.

Insects	**Influence of storm events**	**Influence of warm and dry weather**
Ips typographus	+++	++
Pityogenes chalcographus	(+)*	++
Pityokteines curvidens	+	+++
defoliators		++

+ slightly favorable for attack of standing trees
++ favorable for attack of standing trees
+++ very favorable for attack of standing trees
* gradation in wind-thrown spruce, but almost no attacks on standing trees

Table 2: Response of forest insects to storm and drought.

Bark beetle species	**% of damage**
Ips typographus	87 %
Pityogenes chalcographus	7%
Pityokteines spp.	4%
others (mainly *Ips cembrae* and pine bark beetles	2%

Table 3: Proportion of bark beetle damage in 2003.

Fig. 11: Scattered storm damage increase the risk of *Ips typographus* infestations.

Fig. 12: *Pityogenes chalcographus*: Increasing attack after drought in 2003.

Fig. 13: *Pityokteines curvidens* on silver fir: Increasing attack after drought in 2003.

Experiences and strategies

Today, forest protection problems are treated by risk management, based on the future functions of the stands. If the long term functions, mainly economy and protection, do not justify an intervention, or if the costs of the intervention are far too high relative to the benefit, control measures should be called into question. Also the means, such as finance, staff, machinery, logistics, and the timber market have to be considered.

If we leave a stand to nature's dynamics, uncontrolled and unpredictable processes must be accepted. Experience shows, that in regions where storm areas have not been cleared, the amount of subsequent *I. typographus* attack is approximately **double** that of other regions with thoroughly cleared storm areas and infestation spots (Forster *et al* 2003a).

If economic, ecological or logistic reasons force the owners to renounce a certain part of the sanitary measures against bark beetles, priorities have to be set on a level of landscape compartments (FORSTER et al. 2003b). To optimize the effect of the control measures, the interventions should be adapted in extension, intensity and time. We still work on these questions but we have some preliminary results. Landscape compartments with the same control strategy should be selected by natural borders like mountain chains, grassland, settlements, stand composition and so on. A compartment should have a size of 200 hectares at least. The larger a compartment the greater is the success of compulsory felling, because a large size minimizes the effect of beetle migration from outside. Punctiform interventions do not often show the desired control effect and the edges of cleared infestation spots will be re-infested (Fig. 14, Fig. 15). By intervention, the regional "beetle pressure" has to be sufficiently lowered. To accomplish this goal, at least 80% of the wind-thrown timber and of the attacked trees have to be removed or debarked within the initial two bark beetle generations. This means within one year in lower elevations and two years in the Alps.

It cannot always be avoided that stands with different forest protection strategies will border each other. In so called "buffer zones" between controlled and uncontrolled units, there is a high risk of concentrated bark beetle attack (Fig. 16). Along such buffer zones, infested trees are generally harvested. Because of the "beetle pressure" from the uncontrolled area, there is a high probability that the new edges along the cleared infestation spots will be re-infested.

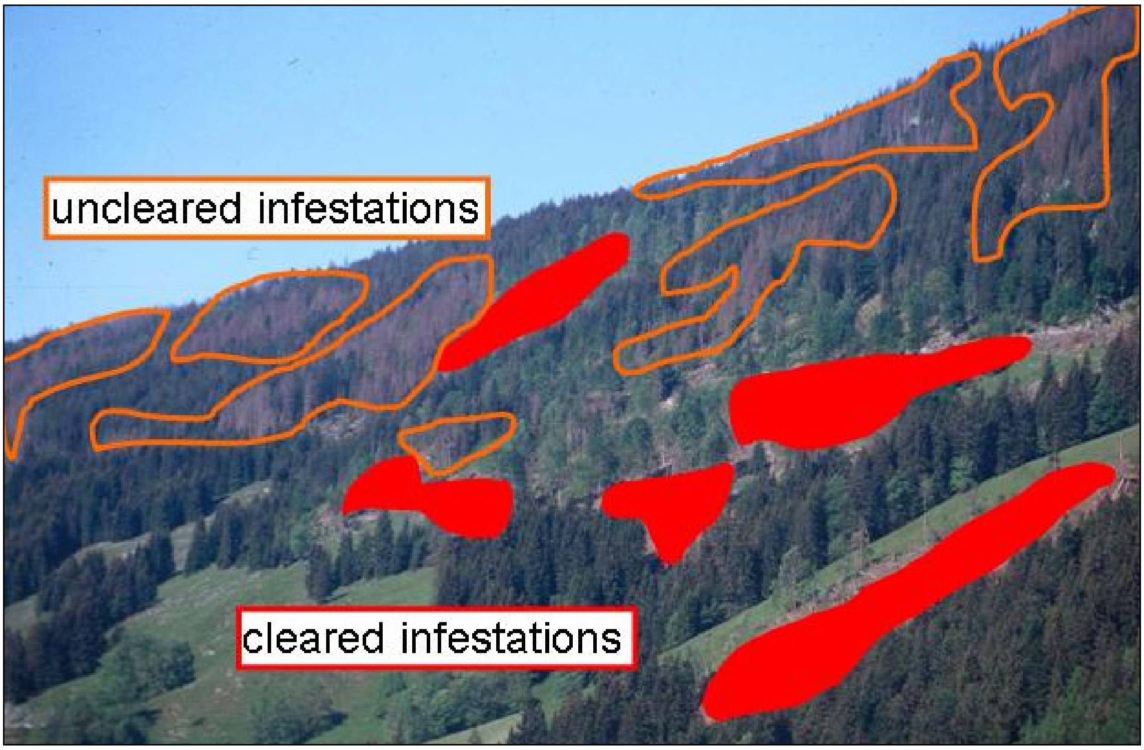

Fig. 14: Mosaic of cleared and uncleared Ips typographus infestations. That way, the “beetle pressure” can not be sufficiently lowered – there is a high risk for continuing attack.
(see also Fig. 15)

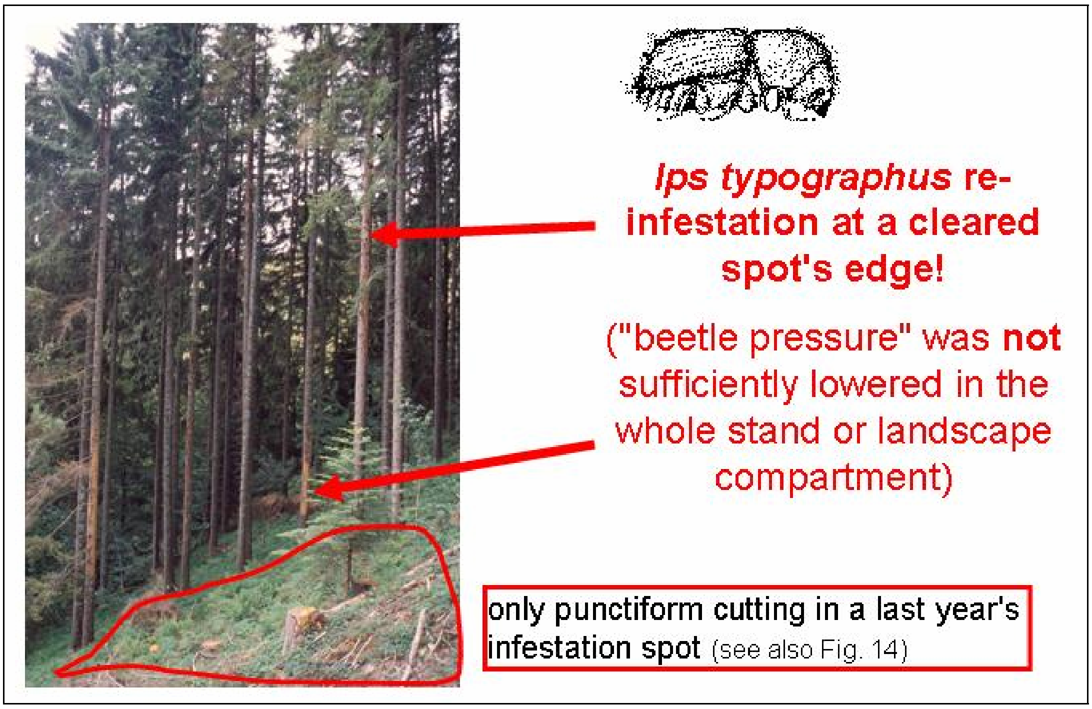

Fig. 15: *Ips typographus* infestations continue along the stand’s edge if the “beetle pressure can not be sufficiently lowered in the whole area.

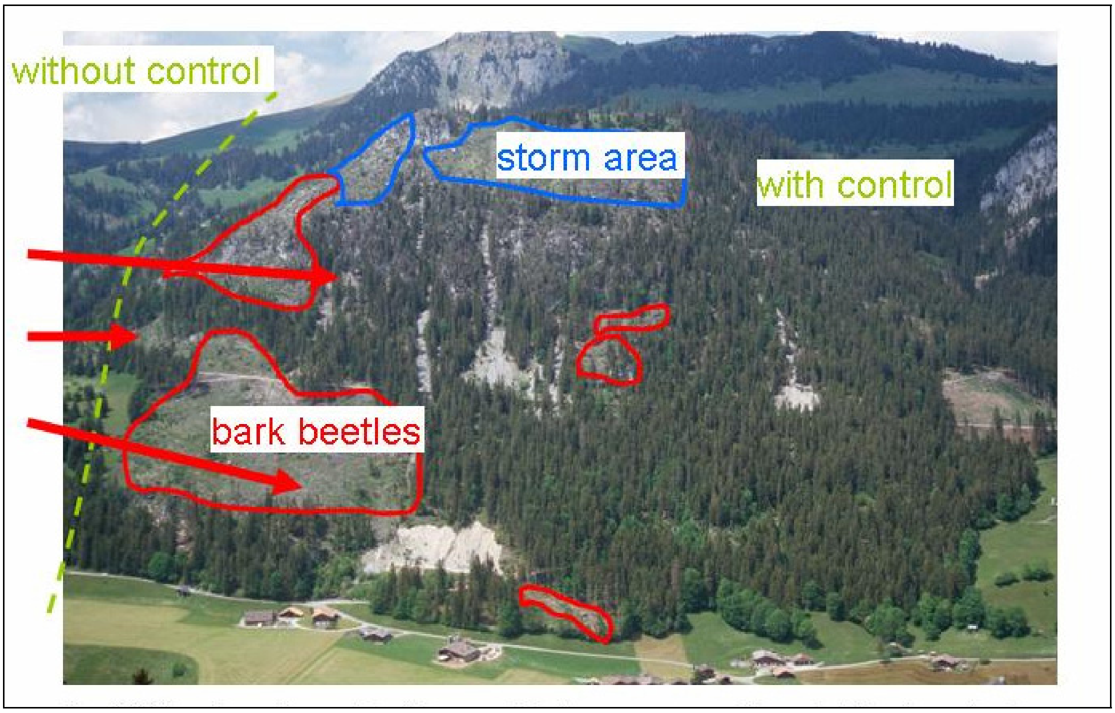

Fig. 16: Stand serving as "buffer zone" between areas with and without control: High risk of (re-)infestations by migrating bark beetles (*Ips typographus*).

Conclusion

Climate extremes, storm damage and changing forest management practices in Switzerland create favourable habitats and breeding conditions for forest insects. Mass attacks of bark beetles, mainly of the eight-toothed spruce bark beetle (*Ips typographus*) will occur more frequently, especially in regions with high stocks of spruce. Forest owners, forest services and politicians will have to adapt their forest protection policies.

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Oral presentation

Developing a Central European database and map on major forest pests: towards the wider look on forest protection problems

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Abstract

The progress in the building of the Central European database and map concerning forest protection problems is presented in the paper. The spatial analysis of the infestations of the spruce bark beetles in the joint territory of Czech Republic, Lithuania, Poland and Slovakia in 2002 and 2003 is done using digital maps and geostatistical methods. The needs and directions of future development of the system are briefly discussed.

Keywords: forest pest, database, Central Europe

Introduction

Since 1997 the specialists involved in the forest insect and disease survey in some Central European countries meet together and exchange the information about the situation in the forest protection in individual countries. This information is fragmented, and sometimes the comparison of the data from adjacent countries is difficult or even impossible. On the other hand everybody know, that the natural phenomena, including insect outbreaks or epiphytoses, develop in the areas lying on the territory of more than one country, often across the state borders. The European integration encourages us to join our knowledge and to start the data management and analysis on a level higher than national. This is the basis of our idea presented in this paper.

The general overview of the situation in European countries was presented during the first 3 workshops of the IUFRO Unit 7.03.10. (in 1998, 1999 and 2000). The output from our workshop in Sion in 1999 is the list of species monitored in individual countries - to be used as a base for future data joining (Forster *et al* 1999). Some ideas about the use of GIS were expressed in Busteni 2000 (Grodzki and Jachym 2001). During the meeting in Prague in 2001 the general approach to such joining of knowledge was discussed, and the base for future data joining and analysis was defined (Grodzki 2001).

The digital maps and associated databases are in use in several countries (Maresi *et al* 2001, Meshkova 2001, Otto 2001) for particular purposes related to forest protection. Nevertheless, the spatial analysis of the insect/disease distribution on transboundary level does not exist. The presented study is the first attempt to define the spatial distribution of an economically important insect in the continuous large area.

This work was possible in frame of the activity of the Centre of Excellence PROFOREST – a project funded by European Commission within the 5 Framework Programme. The PROFOREST Centre of Excellence at the Forest Research Institute in Warsaw (FRIW) has as its aim to launch, pursuit and stimulate the process of integration of forest scientists in Central European countries and EC Member States, in protection of forest resources in Central Europe. The PROFOREST serves integration of researchers in formulating joint grants, strengthening personal contacts and ever closer Europe-wide cooperation.

The main goal of presented work is joining the entomology knowledge to build a common, Central-European database and map on the occurrence of major forest insects, which should enable the spatio-temporal analysis and prediction of processes caused by biotic factors in large areas.

Materials and methods

For the initial phase of the building of the Central-European database and map on forest protection problems, the area of three adjacent countries: Poland, Slovakia and Czech Republic, was selected. Lithuania was added at later phase. The reasons for such selection were as follows:

- common problems occurring in montane forests in the zone adjacent to the borders of these countries (Norway spruce decline, fungal root diseases, bark beetles);
- long-term effective co-operation between the Institutes dealing with forest protection in these countries;
- supposed easy joining of maps.

For the presented stage of our work, the data on the occurrence of spruce bark beetles, expressed by the volume of infested/felled trees, were selected. The data covering the 2-years period (2002-2003) are used.

In Poland the Forest Inspectorates are the basic area units; in Slovakia and Czech Republic the finest state administration units (okres) are used, consequently to the systems of evidence of forest protection problems functioning in those countries (Kapitola and Knížek 2003; Zubrik 1998).

The basic maps covering individual countries, with the basic area units as polygon themes (or – exceptionally as bitmaps), have been kindly supplied by colleagues from Forest Research Institute or Forest Protection Services from Czech Republic, Lithuania and Slovakia. The maps in bitmap form have been digitised. In order to enable the joining of maps, one common system of coordinates (WGS-84) was selected, and some maps had to be transformed to this system from national systems (e.g. S-JTSK). After the joining and adjustment of the borderlines, the separate maps from individual countries have been merged in one polygon theme. The layer representing the terrain configuration, as the simple grid theme, was then added.

The data about sanitary felling in individual countries in the years used for analysis, organised by basic units, have been kindly supplied by the institutions responsible for the forest insect and disease survey in individual countries. The data were then joined in one simple database, which served for the building of thematic layers using prior developed digital map.

Based on the quantitative analysis of the data on the volume of infested trees, 7 infestation classes have been created for the ranking of infestation intensity in individual area units. These classes are as follows (in m^3): 0-500, 501-1000, 1001-5000, 5001-10000, 1001-30000, 30000-50000, >50000.

The first developed thematic layer represented the volume of trees infested by bark beetles in basic territory units of individual countries in 2002 and 2003. At this stage we assumed that the value assigned to an area unit represents its whole territory, regardless the distribution of the forest stands inside.

In order to make the infestation map more realistic, the delimitation of the areas covered by coniferous forests was done using the data available in the Corine Land Cover (CLC 90) dataservice. The grid theme representing the different types of the land cover in 250 m resolution was used, and the areas covered by coniferous forests were delimited by the extraction of such areas from the grid. The resulting grid theme was then converted to polygons, newly delimited in each basic area unit.

The polygon theme representing conifer forests was then combined with the data on the volume of infested trees, and a new layer representing the distribution of forest complexes ranked to individual classes of bark beetle infestation was developed.

The volume of infested trees per 1 ha of the spruce stands was also used for the analysis, but as a trial in limited scale of 2 countries.

For the spatial analysis of the distribution of the bark beetle infestation intensity in the studied area, the geostatistical methods were used (Gilbert 2001). The data from polygons (area units) have been assigned to points representing the centroids of individual polygons. Such transformed data (coordinates of individual points and related valued) were tested regarding its spatial structure by the variograms and correlograms. The surface interpolation was done using Kriging method.

For the data management Excel for Windows was used, and for the maps and geostatistics ArcView GIS 3.2 and Golden Software Surfer 8 were used. The geostatistical analyses were performed in co-operation with dr. Marius Gilbert (Université Libre de Bruxelles).

Results

The joined maps, representing the volume (m^3) of Norway spruce trees infested by bark beetles in 2002 and 2003 in individual area units in Czech Republic, Lithuania, Slovakia and Poland, are presented in Fig. 1.

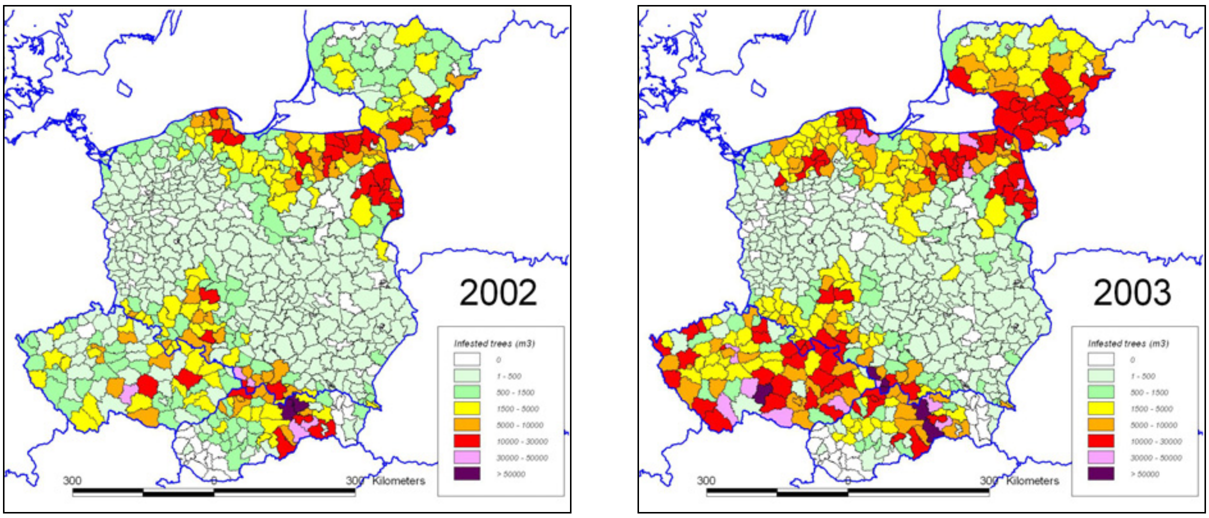

Fig. 1: The volume of trees infested by bark beetles in 2002 and 2003 in individual basic area units in 4 adjacent Central European countries

Even taking into account that the distribution of spruce forests remains stable, the increase in the volume of trees infested by bark beetles in individual area units of some European regions indicate the fast building of the bark beetle populations, which indicates the development of local outbreaks.

Similar conclusion can be made based on the maps developed with the use of the Corine Land Cover data (Fig. 2). Even in the areas with relatively low share of conifer forests the visible increase in the volume of infested trees indicate the general positive trend in the bark beetle population level.

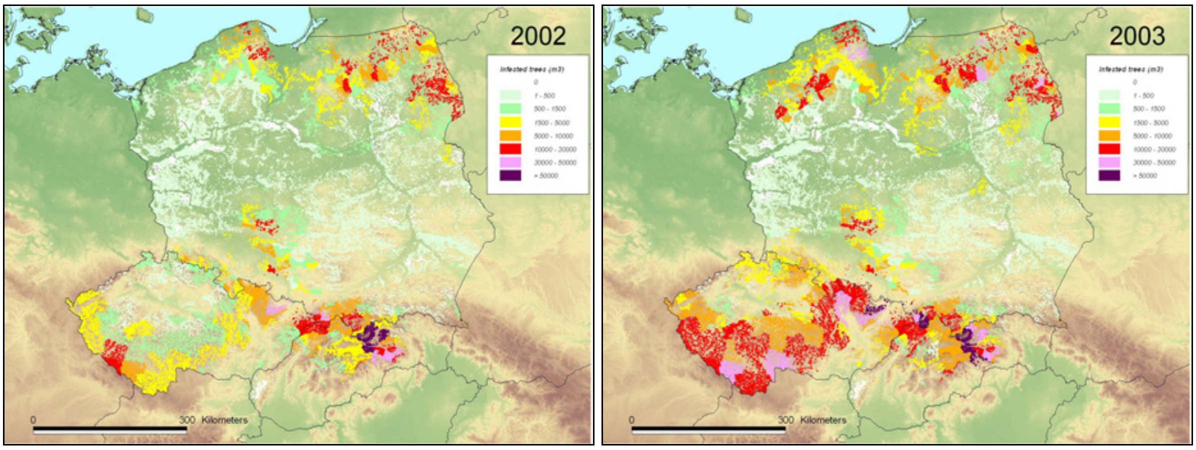

Fig. 2: Volume of trees infested by bark beetles in 2002 and 2003 in the conifer forest covered areas of basic area units of 3 adjacent countries. Maps developed using the Corine land cover.

The correlograms representing the data from 2002 and 2003 (Fig. 3) show very distinct spatial structure of the analysed data. The spatial distribution of analysed values fit very well into the spherical model (r^2 >0.9 in both cases), which enables the surface interpolation. The results of such interpolation by Kriging are presented on Fig. 4.

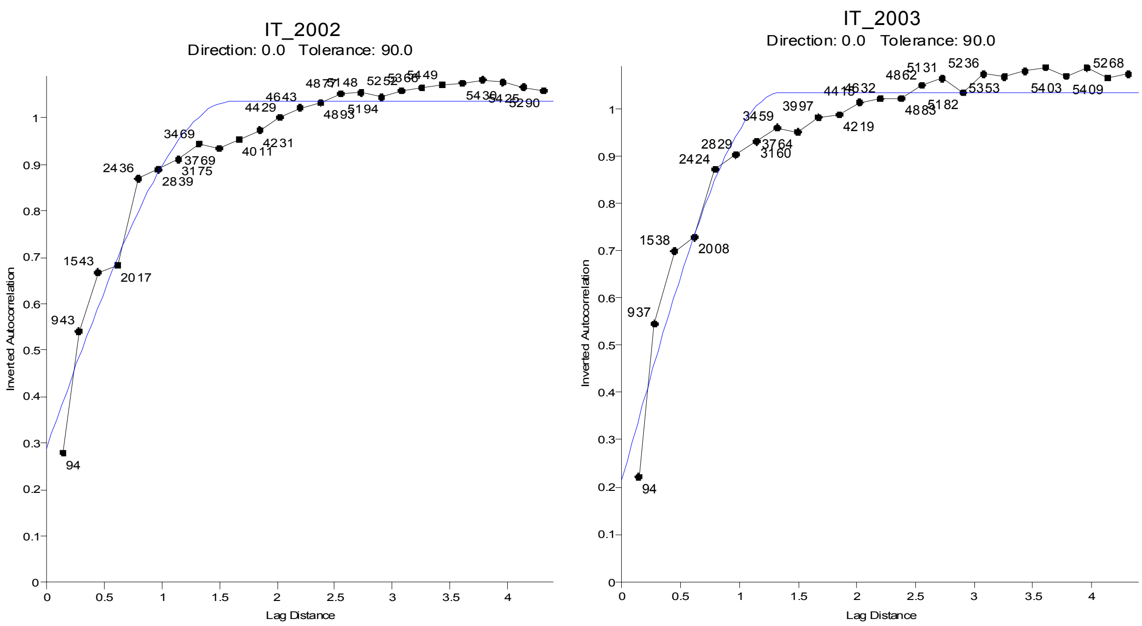

Fig. 3: Correlograms demonstrating the spatial structure of the bark beetle infestation intensity in the area of 3 adjacent countries, based on the volume of infested trees in basic area units. Theoretical spherical model is marked by blue line.

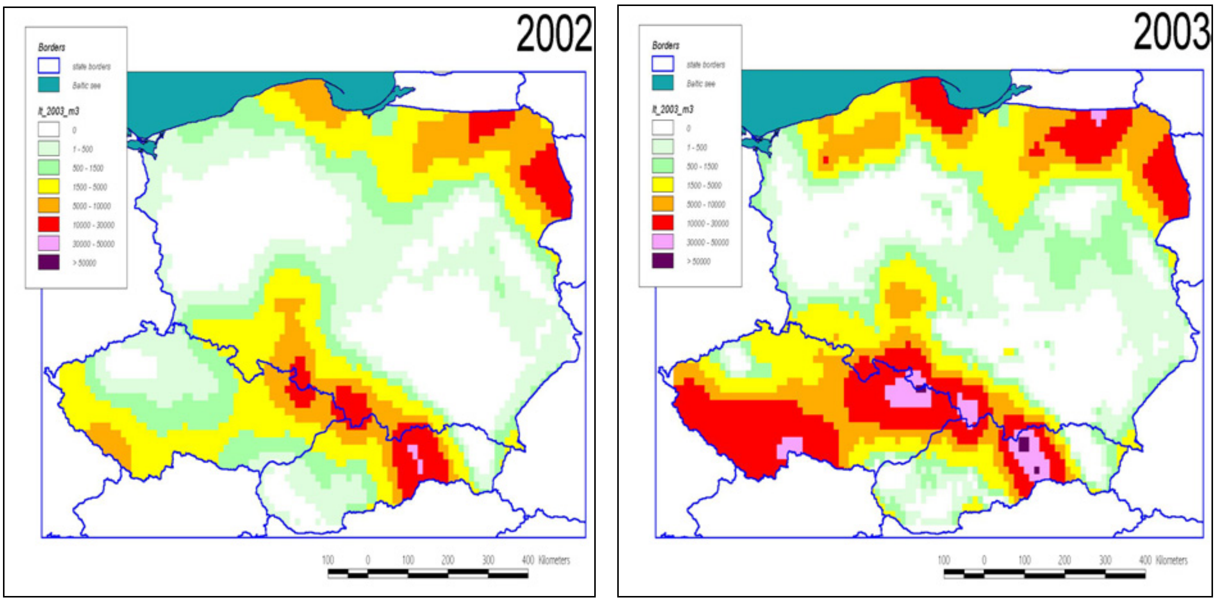

Fig. 4: Distribution of the areas with heavy bark beetle infestations in Czech Republic, Poland and Slovakia, as the interpolated grid obtained using Kriging method.

The comparison of interpolated maps from 2002 and 2003 (Fig. 4) reveals the development of the dramatic bark beetle outbreaks in some European regions. The fast increase in both infestation intensity and area of heavily attacked units is observed in several European regions. It concerns both the mountains (central and eastern Slovakia, southern Poland, north-eastern and southern part of the Czech republic), and the lowland in northern and north-eastern Poland, as well as southern Lithuania (Fig. 2).

Discussion

The presented work remains still in the initial phase. We aimed to present the ambitions and the ideas being continuously realised. However there are already some remarks and preliminary conclusions to be expressed here.

The complete data covering the whole studied area and at least 5-years period are needed for the definition of the development of bark beetle populations and its outbreaks in the scale of Central European forests. It should help the building of a spatial model of the development of bark beetle outbreaks in Central European conditions (both in lowland and in the mountains).

The digital map should be further developed by involvement of additional countries, in order to cover larger areas, e.g. the whole mountain range (Sudeten, Carpathians). The countries to be included in the next future are Germany (at least Saxony), Austria, Ukraine. The other countries are also invited to join the work. The major problem for further spatial analysis on a continuous area is the lack of data from Belarus and Russia (Kaliningrad District).

There is a possibility to derive more data from the Corine Land Cover (e.g. the fragmentation of conifer forests, which can influence the spatial distribution of the bark beetle populations). These data should be included in multifactorial and geostatistical analyses in the future.

At the present phase the work is focussed on the problem of spruce bark beetles. It seemed that this subject is the easiest one regarding both the data availability and the distribution in Central European countries. The way we hope to demonstrate should be used for the analysis of the spatio-temporal distribution of the other biotic factors affecting the forests: pine bark beetles, defoliating insects on pine and broadleaves and even fungal diseases. The map and the database should serve as a frame for future activity in forest insect and disease survey on European level.

Acknowledgements

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We thank all the colleagues from the Forestry and Game Management Research Institute Jiloviste-Strnady, Czech Republic, Forest Research Institute Zvolen, Slovakia and Forest Protection Service in Lithuania for their help in data and map acquisition. We thank also Dr. Marius Gilbert (Université Libre de Bruxelles) for his inspiration and help in the data analysis.

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Oral presentation

Fungi causing bark disease of black locust (*Robinia pseudoacacia* L.) **and their predisposing factors**

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Abstract

During an investigation starting from 2000 in Hungary the following fungi species were isolated from black locust trees showing the symptoms of dieback of twigs and canker of bark: *Cucurbitaria elongata* (Fries) Greville, *Camarosporium robiniae* (Westendorp) Saccardo, *Diaporthe oncostoma* (Duby) Fuckel anamorph: *Phomopsis oncostoma* Höhnel *Fusarium avenaceum* (Fr.) Sacc., *Fusarium lateritium* Nees., *Fusarium semitectum* Berk. & Rav., *Fusarium solani* (Mart.) Sacc., *Fusaium sporotrichioides* Sherb., *Fusarium sulphureum* Schlecht. (syn.: *Fusarium sambucinum* Fuckel f. 6 Wollenw.), *Massaria anomia* (Fries) Petrak, *Nectria cinnabarina* Tode ex Fries anamorph: *Tubercularia vulgaris* Tode ex Fries.

Keywords: bark disease, black locust, *Robinia pseudoacacia*, fungi

Introduction

The black locust was introduced to Hungary in the period of 1710-1720. This north-american tree species was planted as an ornamental tree in parks and along the roads. The first *Robinia* stand (300 ha) was planted in 1750 near the fortress of Komárom-Herkály. From the beginning of the 19th century it was widely applied for soil stabilization purposes in the sandy areas of the country. The second wave of the planting began in the twenties of the last centuries and it was carried out mainly in the poor agricultural sites of the Hungarian lowlands. These days this tree species occupies more than 400,000 ha in Hungary, about 22% of the total forested area. The success of the tree is due to a lot of favourable feature (fast growth, good sprouting ability, frequent seed crop, excellent bee pasture, wide usable wood, drought tolerance). One of the causes of the fast spreading was, that it had scarcely any fungi or insect for a long time. For these days this situation has been changed....

Besides the pests penetrating from the home of black locust (*Parectopa robiniella, Phyllonorychter robiniella*) more and more European polyphagous pathogens and pests can adapt to this tree species and cause serious damage from year to year. The fungi causing bark disease, dieback and wilt of trees, canker and necrosis of the stems are excellent examples for latter process.

Material and methods

In order to map the fungi and their predisposing factors playing role in the triggering of the above-mentioned symptoms an investigation continues since 2000 in the black locust stands and treelines situated in north-east part of Hungary. The fungi affecting black locust were indentified on the basis of microscopic, morphological characters of fruit bodies and spores from fresh plant material, and on the basis of cultures growing on PDA media under natural day-night rhythm in the laboratory at 20-22°C, using several identifications works (Bánhegyi 1985, Barr 1978, Grove 1935, Munk 1957, Petrescu 1960, Booth 1971, Gerlach 1982).

Results and discussion

Until this time the following fungi species were isolated:

Diaporthe oncostoma (Duby) Fuckel
anamorph: *Phomopsis oncostoma* Höhnel

The anamorph of this fungus species is the most dominant in the young black locust stands suffering from frost, drought, game damage or ground fire. On the trees damaged by frost the typical symptom of the *Phomopsis* disease is the shield shaped, or sometimes elongated, yellowish brown necrosis with scattered pycnidia around the stipule thorns or at the base of the lateral branches. The fungus prevents the activity of the cambium tissue, so in the course of time cancerous wounds form on the infected stem or branches. Years after the infected tree can defeat the fungus and the wound heals up, but most often the infected trees break at the height of the shield-shaped necrosis, since the fungus attacks the xylem as well. On the twigs and stems of trees weakened by other biotic cause (drought, game browsing, fire) the picnidia of the fungus appear dispersed on the infected bark. The conidia has two types: A-conidia,.hyaline, fusiform, with two oil drops, measure 8-12 x 2.5-3.5 µm. B-conidia hyaline, hook-shaped, 15-22 x 1-1.5 µm. The conidiospores are released from May in wet weather.

The teleomorphic form of the fungus was isolated from older dead trees affected by drought, fire or other injuries. The generative fruitbodies appear in vertical lines on the stem along the cracks of the bark. The eight ascospores of the cylindrical ascus are hyaline, two-celled, 13-17 x3-4 µm.

Nectria cinnabarina (Tode ex Fries)
anamorph: *Tubercularia vulgaris* (Tode ex Fries)

This species is known from many deciduous tree species as a saprophyte or wound parasite pathogen. The fungus was isolated from drying twigs of young black locust trees and bark injuries caused by frost and pruning. The small orange coloured stromata of the vegetative form appear on the surface of the infected twigs in spring. The conidiospores (5.5-8 x1.5-3 µm) spread by wind and infect during the summer. The dark-red generative stromata develop on the dead bark tissue in autumn. The knob-like, cylindrical ascus contains eight bean-shaped, hyalin spores (12-18 x 4-6 µm).

The ascospores are released in autumn or in the mild and wet period of winter infecting the trees through mechanical wounds an injuries caused by frost.

The fungus wasn't observed in large number in the young black locust stands suffering from frost or drought, nevertheless there are records in the Hungarian and American forestry literature, that this fungus can cause serious problem in black locust nurseries and young plantations (Igmándy 1965, Van Sickle 1974).

Fig. 1: The orange coloured stromata of *Tubercularia vulgaris* on a thin lateral branch of black locust.

Cucurbitaria elongata (Fries) Greville
Camarosporium robiniae (Westendorp) Saccardo

This is the most frequent fungus species besides the *Phomopsis oncostoma* living on the drying branches of black locust trees suffering from drought as a weak pathogen or saprobical. The infected bark is dark-grey coloured. Under the infected, dried part of the crown a dense branch formation can often be observed. The black, spherical pycnidia (Ø 0,8 mm) appear in early spring. The conindia (15-17 x 7-8 µm) olive-brown, cylindrical-oval, muriform with 3-4 transversal and 0-3 longitudinal septa. The pseudothecia (Ø 0,3-0.5 mm) black, spherical, often arranged in some cm long lines. The ascospores (22-30 x 8-11 µm)

Massaria anomia (Fries) Petrak

The fungus was isolated from dead twigs being on the litter and dried twigs of young black locust tree affected by game browsing, ground fire or lack of light. The fungus lives as saprobical or weak pathogen. The necks of pseudothecia can be seen as 2-5 black points in the middle of a whitish round spots bordered by thin black line.

In the double walled asci (170-210 x 20-24 µm) develop four ascospores (50-56 x 14-16 µm). They are four celled, initially hyaline, later brown, with a large oil drops in each cells.

Fusarium avenaceum (Fr.) Sacc.

This fungus was the most frequently isolated *Fusarium* species from the young (1-3 year old) black locust stem injured by frost. The cankers mostly occurred around the stipule-thorns and at the basal section of lateral branches as in the case of *Phomopsis oncostoma*. These tissues of black locust are very susceptible for the frost damage, so the fungus probably infects the trees mainly through the lesions caused by frost. The first symptoms are the sunken bark with a brownish-red discoloration. Sometimes some orange coloured sporodochia can occur on the edge of the necrosis and at the base of the lateral shoots. Later on the diseased bark longitudinal splits developed, revealing the xylem underneath. On the surface of the infected wood the pinkish-red mycelia of the fungus rarely can be seen. On the older stems the canker sometimes occurred as a flattened areas but the bark remaining intact. The diseased tree tries to heal up the lesion with the callus tissue year by year, but the fungus prevents it, causing swelling of the stem at the periphery of the canker.

The colony of the fungus is moderately fast-growing, reaching a 35-55 mm diameter in 4 days. The aerial mycelium is abundant loosely, fluffy to cottony. The pigmentation is pink, rose to carmine with yellowish tinges. Sporulation seldom can be seen, mainly after 4-6 weeks from bright orange sporodochia. The mesoconidia are fusoid, 1-3-septate and often very variable in size. The macroconidia are uniform, narrowly fusoid, curved, 4-13-septate and with an elongated apical cell and a well-marked foot cell. They measure 32-110 x 2.5-4 µm. The clamydospores are absent.

Fusarium sporotrichioides Sherb.

The fungus was isolated only once, from a large necrosis of a 3-year old Robinia stem affected by frost. On the necrosis a lot of orange-coloured sporodochia developed. On the revealed xylem abudant, loose pinkish aerial mycelia were found.

The colony of the fungus is very fast growing reaching 75-80 mm diameter in four days on PDA. The abundant, loose aerial mycelium at fist is whitish, later pinkish. The sporulation of the microconidia starts quickly in the aerial mycelium, but sporodochia do not appear. Microconidia have two types:

1. napiform or pyriform, one-celled, sometimes two septate
2. ovoid, fusoid, slightly curved, 0- to-3-septate

Intercalary clamydospores (8-13 µm) abudantly formed in hyphae.

Macroconidia 3- to 5-septate, slightly curved, widest in the upper third, tapering toward both ends.They measure 32-44 x 3,5-5,5 µm. The apical cell is short, strongly bent, the foot cell is indistinct.

Fig. 2: Canker caused by *Fusarium sporotrichioides* with orange coloured sporodochia and the pinkish mycelia.

Fusarium sulphureum Schlecht.(syn.: *Fusarium sambucinum* Fuckel f. 6 Wollenw.)

This fungus occurs often together with the *Fusarium avenaceum*. The canker caused by this species is similar to the canker caused by the aforementioned species, but often affects larger areas of the bark. However this fungus attacks the xylem as well. The characteristic symptoms of the infection are the whitish-yellow mycelia developing on the surface of the infected bark and xylem. This fungus was also isolated from an older tree died shortly after the bursting of buds in the spring. In this case the fungus killed the phloem and the cambium at the base of the stem all around, causing dark brown discoloration of the affected tissues. In the wet chamber also yellowish-white mycelia had grown from the vessels of the xylem of this tree. The bark of this tree was attacked by insect larvae as well.

The culture grows very fast, reaching 58-78 mm in 4 days. The aerial mycelium is very abundant in the beginning, later becomes powdery by the scattered masses of conidia. The pigmentation is whitish, cream, yellowish, peach to ochraceous, finally slightly cinnamon coloured. The sporulation starts very quickly. In the old cultures a few cauliflower-shaped sclerotial bodies may occur. The macroconidia are thin-walled, curved, fusiform, with a curved pointed apical cell and a distinctly pedicellate foot cell, which is mostly 3-5-septate and 24-44 x 3.5-5.5 µm. The clamydospores are not very abundant, mainly intercalary.

Fig. 3: Canker caused by *Fusarium sulphureum* with the characteristic yellowish white mycelia

Fusarium lateritium Nees.

I managed to isolate this fungus only two times. On a dead branch attacked by the *Xyleborus dispar* the orange sporodochia were near the gallery, so I suppose the beetle has a vector role in the spreading of the fungus. In this case the fungus did not cause the sinking and discoloration of the bark. In the other case *Fusarium lateritium* was isolated from a lens shaped necrosis caused by the infection of *Phomopsis oncostoma*. Vajna (1987) proved that *F. lateritiumcan* can occur as a mycoparasite fungus on other plant pathogens.

The culture is slow-growing, reaching only 14-15 mm diameter in 4 days. Pigmentation is beige or pale salmon coloured, but in older cultures also blue pigmentation can occur. The sporodochia develop after two weeks. The macroconidia are very uniform in shape and size, almost straight in the central part, with a hooked apical and a distinct pedicellate basal cell, mainly 3-5-septate and 20-50 x 2.5-4.5 µm.

Fusarium semitectum Berk. & Rav.

This species was isolated from bases of the stems of withered, older black locust trees in all cases. On the surface of the infected bark pinkish-orange coloured fabric of mycelia can often be seen. The diseased phloem had a dark-brown discoloration. The fungus infects the trees probably from soil. It is likely that the wood-boring insects (chiefly long-horn beetle larvae in the wood and moth larvae in the bark) occurring on some of the investigated stem played a central role in the infection.

The culture of the fungus is fast-growing, reaching 52-66 mm in 4 days. The pigmentation is whitish or peach coloured, in older cultures finally buff-brown. The macroconidia are rather thick-walled, straight and spindle-shaped, sometimes slightly curved with 3-5 septa, up to 18-36 x 3-5 µm.

Fig. 4: *Fusarium semitectum* causing wilt of a black locust tree

Fusarium solani (Mart.) Sacc.

Fusarium solani was isolated from older trees and seedlings attacked by other fungus species (*Fusarium avenaceum*, *Fusarium semitectum*). The fungus infects the trees from the soil, so often colonizes frost-damaged trees (sudden considerable cooling can cause the dying of the bark at the base of the black locust stem).

The culture of the fungus is moderately fast-growing, reaching 28-38 mm in 4 days. The aerial mycelium is usually rather sparse, felt-like, sometimes zonate. The pigmentation is predominantly cream or buff coloured, often with bluish-brown tinges. The macroconidia are rather thick-walled, subcylindric, only slightly curved, with a short and blunt apical and an indistinctly pedicellate basal cell. The conidia are often indistinctly septate, predominantly 2-5-septate, 10-48 x 4-6 µm.

Data about pathogenical character of these fungi were published in Hungary (Szabó 2000, Halász 2001) and their pathogenecity was confirmed by inoculation experiment (Halász 2001). The occurrence of *Fusarium sporotrichioides* Sherb. on black locust is a new data.

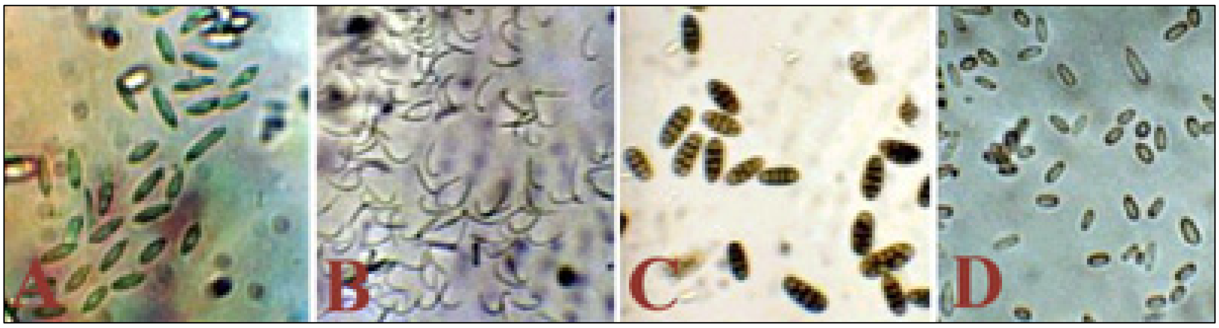

Fig. 5: Conidiospores of A: *Phomopsis oncostoma* (A-type); B: *Phomopsis oncostoma (B-type);* C: *Camarosporium robiniae;* D: *Tubercularia vulgaris*

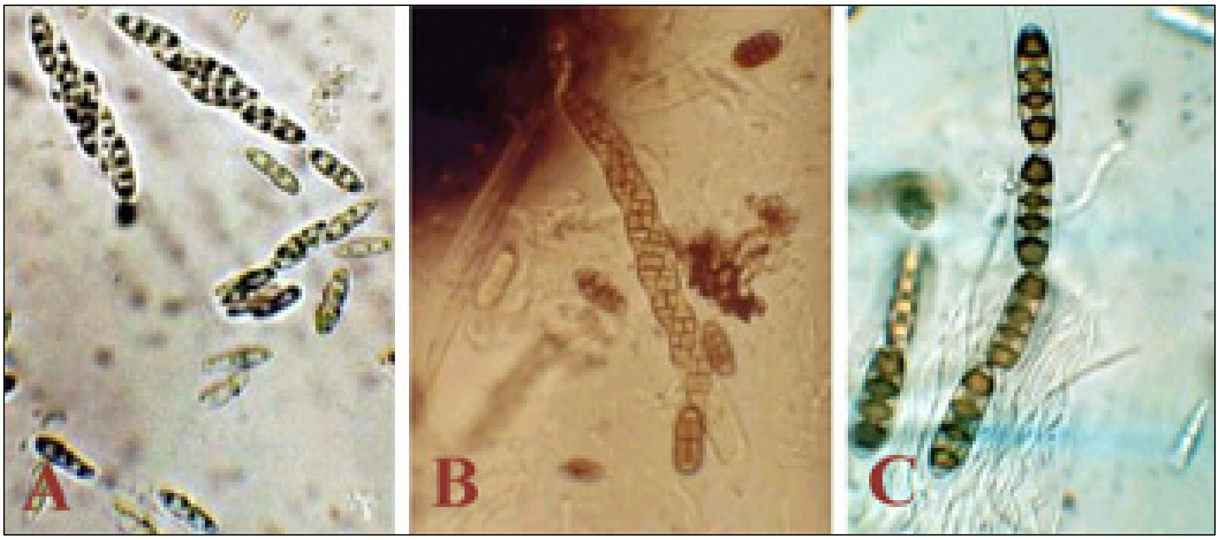

Fig. 6: Ascospores of A: *Diaporthe oncostma;* B: *Cucurbitaria elongata;* C: *Massaria anomia*

Predisposing factors

The incidence of the abovementioned fungi is changed by the age and origin (seed or sprout) of the stands and by the form of the terrain. The dieback of apical shoots infected by *Phomopsis oncostoma* and *Camarosporium robiniae* is the typical problem of the seedling black locust stands growing in the top of the sand hills. In the young coppice stands of sand hills this disease problem does not occur, since they have significant advantage in the drought tolerance due to the well-developed, ramifying root system. In the seedling stands the attack of *Melolontha* larvae can further aggravate the susceptibility of the trees to drought and the above-mentioned pathogens.

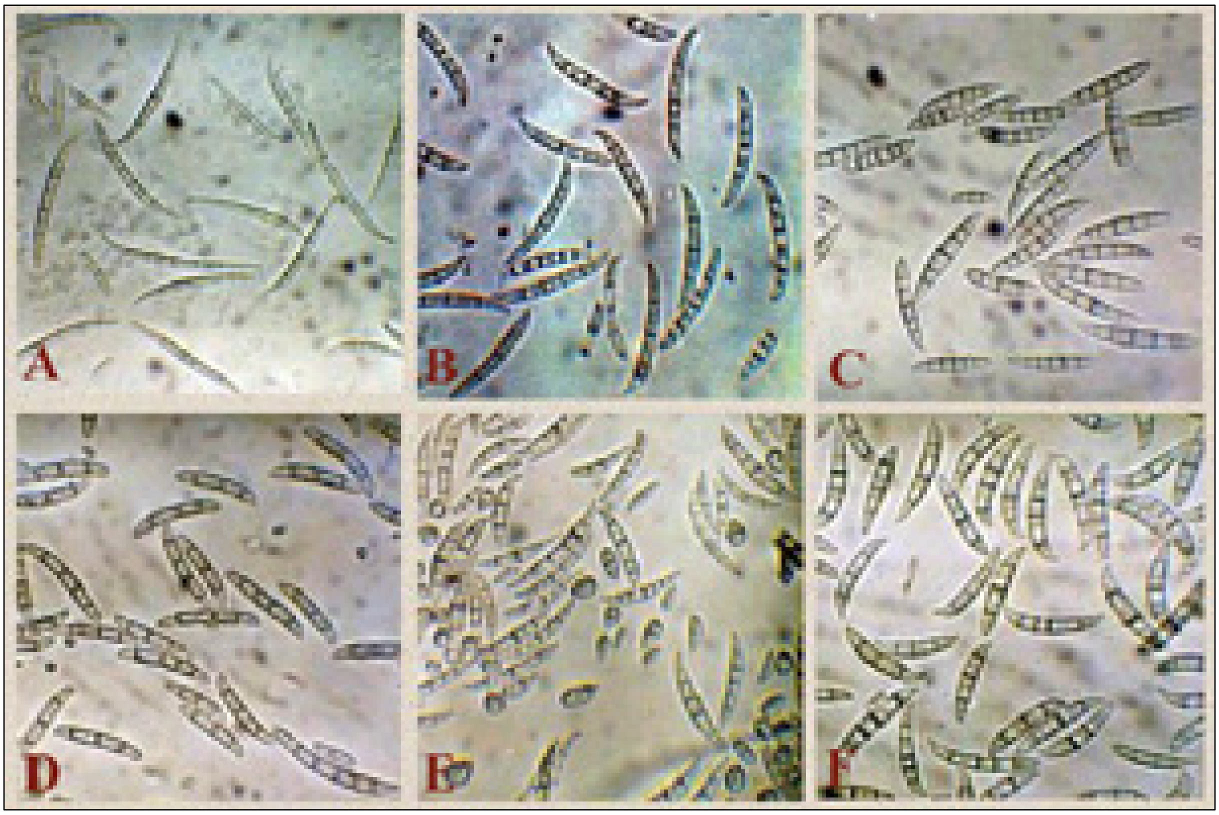

Fig. 7: Conidia of different *Fusarium* species isolated from the diseased barks of *Robinia pseudoacacia* L. (A: *F. avenaceum*, B: *F. lateritium*, C: F. semitectum, D: *F. solani*, E: *F. sporotrichioides*, F: *F. sulphureum*)

In the 2-4 year old black locust stands growing in lower elevation and frost pocket the main problem, that the frost kill the top part of the sprouts and the bark around the stipule thorns. In these frost injured coppice or seedling stands the *Phomopsis oncostoma* is dominant (more than 90%), and in smaller number *Fusarium* species, *Nectria cinnabarina* can also be found. Some years later the bark of the trees thicken at the critical 0-2 m height, where most of the frost lesions occured earlier. The incidence of *Phomopsis oncostoma* and *Nectria cinnabarina* singnificantly decrease, while *Fusarium* species can often be isolated from the wounds caused by pruning and hard winter frost. In the older stands only the hard early- and winter-frost can cause the death of and cambium under the thicker bark, mainly at the base of the stem. The revealed xylem besides and after the infection of *Fusarium* species is attacked by different Basidiomycetes (*Auricularia auricula-judae, Flammulina velutipes, Armillaria mellea, Schizophyllum communae*) as well.

Besides the frost, drought, ground fire, game damage (browsing, antler brushing) and attack of wood boring insects (*Xyleborus dispar, Zeuzera pyrina*) there are some other factors which can influence the development of this complex disease. Visits of *Aphis* species can cause the sudden spreading of mosaic virus in the black locust stands and the virus-infected trees have higher suscebtibility to the frost. Artificial fertilizers or former alfalfa fields on the place of the future black locust plantation may result delayed lignification and high frost susceptibility of the trees due to the high nitrogen content of the soil. The soil of former agricultural lands (potato land) may contain a lot of inoculum of *Fusarium* species causing infections of the seedlings.

The sylvicultural technologies have also important roles. After planting we have to cut back the seedlings under the soil surface. Otherwise the new plantation can be rich in seedlings stems suffering from fungi infection happened during the heeling in or in the previous growing season.

Besides the renewal of the stems we achieve more favourable foliage-root rate, improving the drought tolerance of the seedlings.

In Hungary the most frequently applied 2,5 m interrow spacing promotes the increased forking of the young trees. Through the crack of the fork the *Fusarium* species often infect the black locust. The crack between the stump sprout and the stump gives similar risk. So the pruning of the fork and the thicker lateral branches mainly in the seedling stands and the removing of stump sprouts - helping the root sprouts - in the sprouts stands may have a preventive role.

Fig. 8: Seedling black locust stand suffering from drought on the top of a sandhill (A) and the fruiting bodies of *Camarosporium robiniae* (B) and *Phomopsis oncostoma*(C) growing on the dried twigs.

Fig. 9: Effect of the late frost in a young black locust coppice forest growing in frost pocket.

Fig. 10: The most sensitive parts of black locust trees to frost: A: young apical shoots; B: bark area around the stipule thorns or lateral branches; C: the basal part of the stem (hard winter and early frost).

Fig. 11. The symptoms of *Phomopsis oncostoma* infection predisposed by frost.

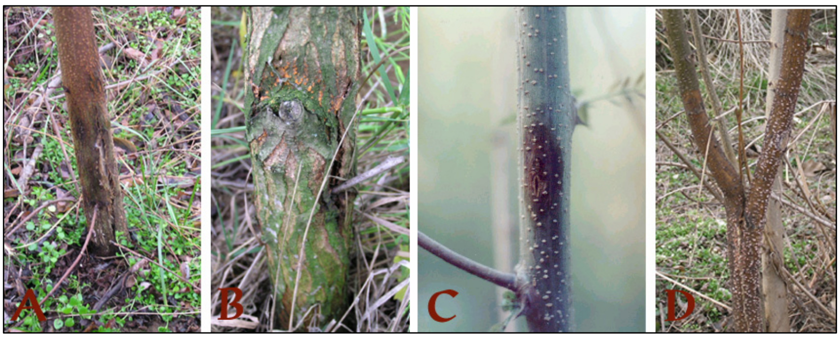

Fig. 12: The most frequent points of *Fusarium* infections: A: frost lesions at the basal part of the stem; B: frost lesions around the stipule thorns or lateral branches; C: lenticells; D: crack in the fork.

Fig. 13: Two years old black locust seedlings were cut back above the soil surface (wrongly) in the spring. The older parts of the stems suffer from *Phomopsis oncostoma*.

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Oral presentation

Possibility of using of virus against bark beetles? Experiences with simulated infection of two bark beetles, *Ips typographus* and *Ips duplicatus*, with three pathogens

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Abstract

In the experiments, 468 beetles of Ips typographus and I. duplicatus were artificially infected by an experimental preparation of *Ips typographus* entomopoxvirus (Biolavirus-IT), and suspensions from beetles with high level of infection expected of *Nosema typographi*, *Chytridiopsis typographi* and baculovirus from tropics rhinoceros beetle. Beetles were infected using several methods: 1. Spraying of the whole log of wood using the experimental preparation of *Entomopoxvirus*, Biolavirus-IT; 2. Dipping the beetles in the suspension; 3. Placing a drop of suspension on the mouthparts of beetles (through drinking); 4. The beetles' penetration through the bit of phloem or paper saturated by pathogen suspension. Beetles were reared during 14 days under little plastic hats (diameter 2 cm, height 2 cm) that were placed on a half log of wood (length 0.5m) using pins. Apart from a single specimen of *I. typographus* containing *Nosema typographi*, no specimen, either alive or dead, was infected by *Entomopoxviru*s and *Chytridiopsis typographi* in the results of these experiments

Keywords: *Ips typographus*, *Ips duplicatus*, bark beetle, virus

Introduction

The bark beetles of the genus *Ips* belong to very important and common pests of spruce forests in Central and Northern Europe, producing outbreaks initiated by snow- and wind- falls of spruce (Skuhravy 2002). The forest protection is based mainly on using of tree traps and cutting of infested trees. The new methods based on using of artificial pheromones are widely employed in forests now (Svestka *et al* 1996). These methods are useful only in the case of *Ips typographus* (Linne, 1758), but they are ineffective in *Ips duplicatus* (Sahlberg 1836) (Knizek and Holusa 2001). All control methods have some disadvantages, mainly the application of insecticides and use of heavy machines. The best way would be a combination of classical indirect methods and the use of biological formulations in the progradation of insects. Biological formulation has to be specific only to the pest. Virus formulations have these features and their specificity has been proved by many experiments with other pests (Gebhart *et al* 1997).

The pathogens of *I. typographus* have recently been investigated by several authors (Weiser 1954; Purrini 1978; Mills 1983; Bathon 1991) and mutual infectivity of *I. typographus* pathogens to other bark beetles in spruce were the subject of the studies by Händel *et al* (2003) and Haidler *et al* (1999). *I. duplicatus* was not included in this material collected in Austria, but new data from the eastern part of the Czech Republic are already known (Holusa and Weiser 2004 a,b).

In 1995, a virus in *Ips typographus* was described as *Poxvirus typographi* Wegensteiner and Weiser, 1995 in the gut of beetles. It damages beetles and shortens their lives (Wegensteiner and Weiser 1995). The level of infection by this *Entomopoxvirus* in nature is commonly low, it varies between 0-12% (Weiser and Wegensteiner 1994, Wegensteiner *et al* 1996, Weiser *et al* 1999) although the occurrence of the infection in 9-45% of beetles has been found in some very old focuses in the Sumava Mts., always in the mature, black coloured beetles, but never in immature, yellow-coloured ones or in the larvae. Preliminary field experiments showed that at least *Entomopoxvirus typographi* is a potential pathogen, useful in introduction by spraying ($1.68x10^3$ virus inclusion per 1 ml, e.g. $3,5x10^5$ inclusion per $1m^2$ of bark) of logs fleshed by pheromone. The rate of infection has increased twice on the level found in focus with development infection. Authors propose spraying of trap trees with pathogens as the most effective method for prevention in the forests at the basal level of pest to reach the increased level of infection (Pultar and Weiser 1999, Weiser *et al* 2000, Pultar and Weiser 2004). Kirchhoffer *et al* (2003) have tested the possibility of infection of *Malamoeba scolyti* Purrini, 1978 by drinking and eating. All bark beetle species tested were found to be sensitive to *M. scolyti* infections in the laboratory.

In this work, we studied the possibilities of direct infection by *Entomopoxvirus* and two other pathogens to infect the beetles of *I. typographus* and *I. duplicatus*.

Material and methods

Two species of bark beetle were used: *Ips typographus* and *Ips duplicatus*, the uninfected (as noted above), early emerged, immature, yellow coloured beetles from the field. We used only beetles with very good fitness; it means they were active without visible damage.

We placed two or three beetles under little plastic hats (diameter 2 cm, height 2 cm) that were placed on a half log of wood stem (length 0.5m) fixed by a pin. The edges of the hats were covered with water-soluble glue. The beetles were used in two member groups. We placed a piece of phloem under the hats to stimulate the maturation feeding. After two weeks the beetles were taken from the bark.

Beetles were infected using four species of pathogens:

1. *Ips typographus entomopoxvirus (ItEV, ItEPV)*
   a) Experimental WP preparation Biolavirus-IT; made by ZD Chelcice. Lot: 0300529-2, prepared: 2003-05-29; density: $2.58x10^6$ virus inclusion/g; inactive ingredients: 79% (amorphous SiO_2). Using this volume of inclusions, 28 inclusions covered $1mm^2$ of bark. It means that the beetle consumed more than 100 inclusions by the boring of an entry hole (e.g. the area ca 4 mm^2).
   b) Suspension from beetles with high level of infection expected from the locality Spindlerův Mlyn, volume 1.50×10^3 virus inclusions/ml);

2. *Nosema typographi* (Weiser, 1955) (suspension from beetles of *Ips typographus* with high level of infection expected from the locality of Dobra Voda; volume 8.00×10^3 spores/ml);

3. *Chytridiopsis typographi* (Weiser, 1954) (suspension from beetles with high level of infection expected in the locality of Pusta Polom, 1.00 x 10^3 cysts/ml);

4. *Baculovirus* sp. (suspension from tropic rhinoceros beetle which died in rearing with high level of infection).

The concentration of pathogens in suspension were calculated on the basis of preliminary determination of infections in per cent in 50 beetles of the same lot as used for grinding and preparation of suspensions. In rhinoceros beetle suspensions, the mid-guts of dead beetles were prepared, one gut in 10 ml of water.

Beetles were infected using several methods:

1. Spraying of the whole log using the experimental preparation of *Entomopoxvirus*, Biolavirus-IT;

2. Dipping the beetles into the suspension;

3. Placing the drop of suspension on the mouthparts of beetles (through drinking);

4. The beetles' penetration through the piece of phloem or paper saturated by pathogen in the Petri dishes over several hours (through eating).

The combination of species of pathogens and ways of infection is shown in the Tables 1-2.

	method of infection				
Pathogen	dipping	eating	drinking	spraying	total
Nosema typographi	0	0	0	0	0
Chytridiopsis typographi	0	12	49	0	61
Baculovirus	0	0	0	0	0
Entomopoxvirus	8	30	54	0	92

Table 1: The number of *Ips typographus* beetles used in experiments of application.

	method of infection				
Pathogen	dipping	eating	drinking	spraying	total
Nosema typographi	39	16	0	0	55
Chytridiopsis typographi	0	0	38	0	38
Baculovirus	0	0	34	0	34
Entomopoxvirus	27	0	0	84	111

Table 2: The number of *Ips duplicatus* beetles used in experiments of application.

Experiments were performed in three periods that began on Sept.-24., Oct.-22., and Nov.-18 2003. The beetles were reared during two weeks in the laboratory under 20°C temperature and normal light periods.

The beetles were dissected and their mid-guts were extracted, with the last abdominal segment. According to the method described by Wegensteiner *et al* (1996), all beetles were decapitated on a slide and dissected in a drop of water. The whole gut, the Malpighian tubules, the gonads and parts of the adipose tissue were removed from the carcass together with the last abdominal segments. All tissues were examined for the presence of pathogens under light microscope at 150x and 500x magnifications. Positive smears were dried, fixed with methanol and stained with Giemsa. Part of the material was fixed in 2.5 % glutaraldehyde and prepared for TEM as indicated in Weiser *et al* (1998).

Results and discussion

In the experiments, 468 beetles were studied. Total of 67 *Ips typographus* entered under bark and followed in maturation feeding. They were taken from the galleries. We found 86 dead beetles in the hats (Fig. 1). No infection by *Entomopoxvirus* and *Chytridiopsis typographi* was present in any of the specimens, whether alive or dead. In the *Chytridiopsis* series one case of *Nosema typographi* was found, probably as a result of transovarial infection. In *Ips duplicatus*, 93 beetles have been found in maturation feeding and 145 beetles have stayed under hats without trying to bore (Fig. 2). No infection by *Entomopoxvirus*, *Chytridiopsis typographi* and *Nosema typographi* occurred in both alive as well as dead infected specimens and in 20, 37, 16 (in each period) uninfected control beetles.

As summary we may conclude that our experiments have shown that introduction of the tested infections in *Ips typographus* and *Ips duplicatus* is not an easy process, as expected after results of Pultar and Weiser (2004). This may be an effect of inadequate presentation of the infective doses to beetles in experiments or the inadequate behaviour of beetles in laboratory rearing. There was no transmission even in cases where the mutual transmission of pathogens is evident, such as *Chytridiopsis typographi* that infects *Ips typographus* as same as *Ips duplicatus*. Perhaps the incubation period, or the stage when the beetle is ready to receive the infection, was not reached in our tests.

From dissections of *Ips duplicatus* collected from a large territory of Central Europe it is evident that there is no natural occurrence of *Entomopoxvirus* in these beetles.

The negative reaction of both bark beetles to suspensions of guts of rhinoceros beetles with Baculovirus was expected and the test was only the evidence of a chance. But in connection with negative effects of both other infections it may be repeated with other material for further perfect evidence.

In all the experiments, and this is also the experience from dissections of forest materials, there is no difference in frequencies of infections in dead beetles and in the surviving lot in transporting containers. The same is the experience with infections with Nematodes, which have their active way of transfer from dead and live beetles in frass and faeces in the galleries.

The effort of transmission and inoculation of pathogens in clean populations of bark beetles will be continued with further modifications.

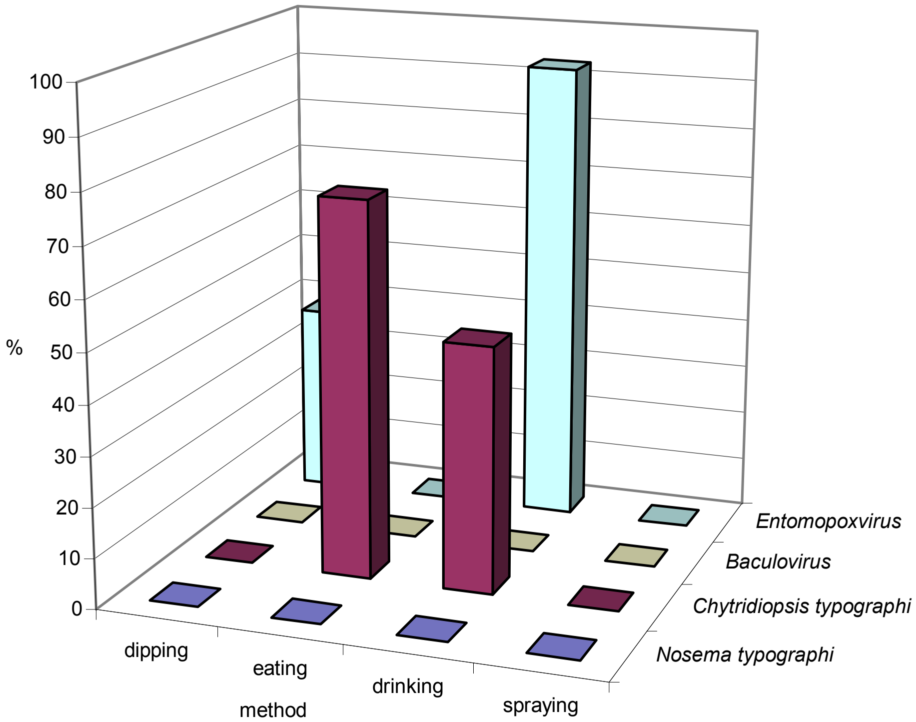

Fig. 1: Mortality of *Ips typographus* in the hats during experiments (%).

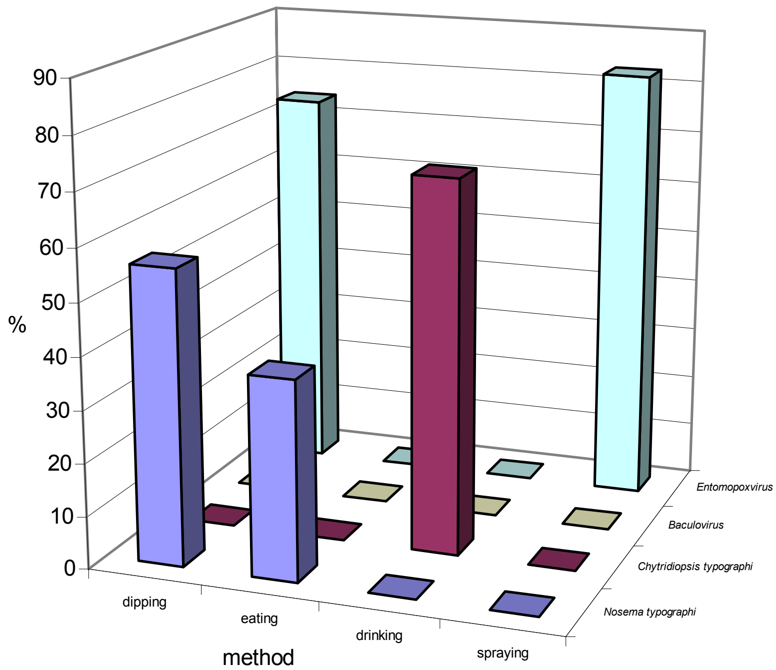

Fig. 2: Mortality of *Ips duplicatus* in the hats during experiments (%).

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Oral presentation

Results of a "push" and "push-pull" semiochemically mediated experiment targeting oak ambrosia beetle (*Xyloterus signatus* Fabricius)

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Abstract

The use of "push" and "push-pull" strategy of semiochemicaly mediated protection strategy in the case of oak ambrosia beetle species *Xyloterus signatus* Fabricius was tested in Croatian lowland forests. "Push" part of the experiment implemented the use of non host volatile alphapinene as a masking or "pushing" agent reducing the attack density on exposed oak timber by 27% (versus control). In "push-pull" part of the experiment an addition of general aggregation semiochemical, Lineatin and general kairomonal semiochemical ETOH were used to distract the beetles from the exposed oak timber. Respective reduction of ambrosia beetle attack in this experiment amounted 75% in comparison with control. In four of the five paired replications the number of successfully bored beetles was significantly lower in treatment group versus unprotected control group.

Keywords: ambrosia beetle, *Xyloterus signatus*, semiochemicals

Introduction

Not too many research has been done in the field of semiochemical research targeted toward the development of biotechnical management of hardwood attacking ambrosia beetles. Much more has been researched and is known for some species that attack conifer wood, even the development of semiochemicaly mediated control methods (Borden 1997, Borden *et al* 1997, Deglow and Borden 1998, Borden *et al* 2001, Lindgren and Borden 1983, Tommeras and Mustaparta 1989). On the basis of known behavioral and semiochemicaly related facts for the conifer wood attacking ambrosia bark beetles (basically *Xyloterus lineatus* L.) assumption was made that a very similar principles should exist within the oak attacking ambrosia beetles, namely *Xyloterus signatus* Fabricius. The idea was to test the potential development of damage reduction methods involving non host volatile (NHV) treatment of exposed oak timber and a more "intensive" method of an addition of pheromone traps baited with attractive volatiles of a blend of generic aggregation pheromone and kairomonal component.

Materials and methods

Experimental sites were chosen in the wider area of naturally growing pedunculate oak forests in central and eastern parts of Croatia. Both sites were placed in the area of regularly harvested forests to get the representative experimental results in real managed forest conditions. "Push" part of the experiment, situated in the vicinity of Vinkovci, consisted of 5 pairs of 1m long oak logs stacked in 1m wide and 1m high piles. On treatment piles 6 dispensers of alpha pinene were placed positioned equally over the surface of the log piles. After the exposition period, during February and March, all the logs were debarked and pin holes of *X. signatum* were counted (Fig. 1-2).

Second plot, situated in the vicinity of Karlovac, consisted of 5 pairs of oak log piles alternately distributed throughout the forest in geometrical order. Treatment group had the same alpha pinene dispensers and were surrounded by 6 pheromone traps of the vertical cross-vane type (IPM Tech.®) baited with the composition of synthetic pheromone Lineatin plus ETOH in separate dispensers. Traps were emptied in weekly intervals and beetles were counted and sexed during the exposition period. All the logs were debarked and pin holes of *X. signatum* were counted after the end of exposition by the beginning of April (Figures 3,4).

Fig. 1: Experimental design of the “push” part of the experiment.

Fig. 2: Alpha pinene “bulb” used in both “push” and “push-pull” part of the experiment.

Fig. 3: Experimental design of the “push-pull” part of the experiment (red circles symbolize the “pushing” effect of alpha pinene and green circles symbolize the “pulling” effect of flight barrier traps lured with Lineatin + ETOH.

Fig. 4: Debarking at the end of the exposal period (insert shows counted and marked pinholes on oak logs of the control group).

Results

In the first part of the experiment, there was a clear reduction of beetles entering "treated" log piles. In total, the difference between the number of successful attacks amounted 135 pin holes which presents a 27% difference in favor of treated versus control group (Table 1).

55 logs in “treatment” group 61 logs in “control” group 15211 cm3 – total “treatment” logs 16850 cm3 – total “control” logs 276 cm3 – average “treatment” log 276 cm3 – average “control” log 626 pin holes – “treatment” group 861 pin holes – “control” group pin holes STDEV “treatment” – 29,04 pin holes STDEV “control” – 26,39

Table 1: Quantitative descriptors of the “push” part of the experiment.

The results of the second part of the experiment were significantly higher in favor of the treatment group of oak logs. In total, the difference between the number of successful attacks amounted 1,296 pin holes which presents a 75% difference in favour of treated versus control group (Table 2).

85 logs in "treatment" group 80 logs in "control" group 14592 cm3 – total "treatment" logs 14681 cm3 – total "control" logs 172 cm3 – average "treatment" log 184 cm3 – average "control" log 431 pin holes – "treatment" group 1727 pin holes – "control" group pin holes STDEV "treatment" – 6,58 pin holes STDEV "control" – 32,73

Table 2: Quantitative descriptors of the "push-pull" part of the experiment.

Discussion

The results of the described experiment reveal a clear semiochemical response of ambrosia beetle *X. signatus* to both a non host volatile (alpha pinene) as well as lineatin and ETOH, both being known as attractive volatiles among species in this genus. The "push" part of the experiment showed that though there is a repelling or masking effect of an arbitrary chosen NHV compound, this is not even close to what could be called a potentially promising damage reduction approach. Further testing of various other NHVs and their respective concentrations is needed to get more consistent data. The "push-pull" part revealed a much higher impact on the "seeking" beetles. Quite high reduction (by three quarters) of the ambrosia beetle attack supports the idea to test this method further. In spite of being far from acceptable levels considering damage classes of oak timber (and their respective price per cubic meter) obtained results demonstrate a very strong potential and probable way of shaping the future operational semiochemical suppression tactic.

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Oral presentation

Bark beetle outbreaks during the last decade with special regard to the eight-toothed bark beetle (*Ips amitinus* Eichh.) outbreak in the Alpine region of Slovenia

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Abstract

This paper presents a chronological overview of gradations of spruce, fir, and pine bark beetles in Slovenia from 1945 onwards. In the past 18 years in Slovenia, the greatest number of sanitary fellings have been due to catastrophic weather events (42%), followed by fellings for other reasons (24%) and insects (19%). Since 1999, fellings due to insects have been increasing (1999 - 102,590 m^3 wood, 2000 - 118,843 m^3, 2001 - 132,732 m^3, 2002 - 169,382 m^3 wood). In 2001 and 2002, fir bark beetles (*Pityokteines spinidens*, *P. curvidens*, *Cryphalus piceae*) and spruce bark beetles (*Ips typographus, Pityogenes chalcographus*) have increased, particularly in the S and SW parts of Slovenia. In the spring of 2003, there was an outbreak of *Ips amitinus* in a 70–80 year old stand of Norway spruce in the Alpine region. The outbreak occurred at an altitude of 1,270 m above sea level, over an area of 25 ha, at the heart of snow-breaks from 2002. The entomofauna found under 10 x 10 cm pieces of bark removed from the trunks of this Norway spruce was examined. Three species of insects were discovered: *I. amitinus* (mostly as larvae and unchitinized imagos) and two species of parasitic wasp (fam. Pteromalidae: *Rhopalicus tutela*, *Roptrocerus mirus*), mostly in the colored and uncolored pupal stage. Statistical analysis has confirmed a linkage between the appearance of different developmental phases of *I. amitinus* and parasitic wasps. We conclude that the gradation of *I. amitinus* was halted due to the large number of parasitic *Rhopalicus tutela* wasps.

Key words: bark beetles, outbreaks, *Ips amitinus*, parasitic wasps, *Rhopalicus tutela*, Norway spruce, Alpine region, Slovenia

Introduction

Bark beetles are typical dendrobionts, which usually colonize habitats of conifer forests. They can also be defined as primary saproxylic species which participate in the colonization of trees and the decomposition of wood (Harmon *et al* 1986, Edmonds and Eglitis 1989, Speight 1989). One group feeds on the cambial zone directly under the bark, while another feeds on fungi that the adults grow in galleries. The first mentioned group of bark beetles are serious pests in cultures and stands in unnatural habitats where trees are weakened. In European forests with a large percentage of conifers on unsuitable sites, bark beetles are the most important harmful biotic factor for such hosts (Vité 1989, Eidmann 1992).

Bark beetles are also an important factor in forest management practices, especially for conifers, in Slovenia. With 57% forest cover Slovenia is the fourth most forested country in Europe. The most recent studies show that forest covers 1,227,832 ha or 60% of Slovenian territory (Hočevar 2003). The last forest inventory showed that deciduous forests make up around 39%, conifer forests 22%, and mixed forests around 39%. The percentage of conifers in the wood stock is around 48%, of which Norway spruce (*Picea abies* (L.) Karst.) is around 33%, Silver fir (*Abies alba* Mill.) around 8%, followed by pines (*Pinus sylvestris* L., *Pinus nigra* Arn.) (*ibid*.). In Slovenia, the Norway spruce has colonized 32% of the surface area although its natural habitat only covers 8%, therefore this tree species mostly occurs in unnatural habitats (National Forest Development Program 1996). This fact is linked to damages to Norway spruce due to abiotic (mechanical instability, reduced vitality, etc.) and biotic factors (mostly bark beetles). In Slovenia, the Silver fir is mostly found in its natural habitat, although it is not very hardy for a number of reasons (Bončina *et al* 2003). Pines (mostly *Pinus nigra* Arn. and *Pinus sylvestris* L.,) cover 6% of the surface area, while their natural habitat is only around 2% of the territory (National Forest Development Program 1996). Planted Austrian pine, which mostly covers the Slovenian Karst region, has not been renewing itself and has been withering over the past 10 years mostly because of diseases (Jurc 2003).

A preliminary catalogue of bark beetles in Slovenia shows that there are 88 species from the family Scolytidae (Jurc 2003b) and around 56% of these species are connected with conifers. The data show that the species of bark beetles which have proceeded in gradations are mostly linked with Norway spruce (*Ips typographus* (L.), *Pityogenes chalcographus* (L.)), Silver fir (*Pitykteines spinidens* (Reit.), *P. curvidens* (Germar), *Cryphalus piceae* (Ratzeb.)), and occasionally pine (*Tomicus* sp.) (Statistical Yearbook of the Republic of Slovenia, 1998, 2002, Titovšek 1994, Annual Reports - Slovenian Forest Service, 1995–2002).

Bark beetle outbreaks in Slovenia

Data on sanitary fellings in Slovenia are available from 1985 and show fellings due to abiotic (catastrophic weather conditions - wind, sleet and snow, fires, emissions, and landslides) and biotic factors (insects, diseases-fungi, game). In the past 18 years in Slovenia, the greatest number of sanitary fellings were carried out due to catastrophic weather conditions (42% or 5,069,307 m^3), followed by fellings due to other reasons (24% or 2,863,105 m^3), and insects (19% or 2,233,303 m^3) (Statistical Yearbook of the Republic of Slovenia 1998, 2002, Annual Reports - Slovenian Forest Service 1995–2002, Jurc *et al* 2003).

Data on felling of trees in forests due to insects (particularly bark beetles) have been recorded from 1945 onward. Table 1 shows sanitary fellings due to insects for various areas of Slovenia.

Larger scale sanitary fellings due to catastrophic weather conditions were carried out in 1986, 1995/1996 and 1996/1997. Fellings due to insects have increased since 1999 (1999 - 102,590 m^3 wood, 2000 - 118,843 m^3, 2001 - 132,732 m^3, 2002 - 169,382 m^3 wood). In 2001 and 2002, fir bark beetle (*Pitykteines spinidens*, *P. curvidens*, *Cryphalus piceae*) and spruce bark beetle (*Ips typographus*, *Pityogenes chalcographus*) populations increased, mostly in the south and southwestern parts of Slovenia (Jurc *et al* 2004, in press).

Year	Region	m^3
1945-1952	Majority of the Slovenian territory	273,000
1983-1985	Regional gradation, Gorenjska region (spruce bark beetles: *Ips typographus*, *Pityogenes chalcographus*)	500,000
1991-1992	Majority of Slovenian territory	174,783
1994	FMR* Maribor, Kranj, Ljubljana, Celje (spruce bark beetles: *I. typographus*, *P. chalcographus*), FMR Kočevje (fir bark beetles: *Pitykteines spinidens*, *P. curvidens*, *Cryphalus piceae* and spruce bark beetles)	116,700
1995	FMR Ljubljana, Kočevje, Maribor, Bled, Kranj (spruce and fir bark beetles)	164,000
1996	Majority of Slovenian territory	88,000
1997	Majority of Slovenian territory	81,000
1998	Majority of Slovenian territory	166,700
1999	FMR Bled, Kranj, Ljubljana Kočevje (spruce and fir bark beetles)	102,500
2000	FMR Kranj, Bled	118,843
2001	FMR Ljubljana, Novo mesto (fir bark beetles: *Pitykteines spinidens*, *P. curvidens*, *Cryphalus piceae* and spruce bark beetles: *I. typographus*, *P. chalcographus*)	132,732
2002	FMR Kočevje, Ljubljana, Novo mesto (fir bark beetles: *Pitykteines spinidens*, *P. curvidens*, *Cryphalus piceae* and spruce bark beetles: *Ips typographus*, *Pityogenes chalcographus*)	169,382

* FMR - Forest Management Region

Table 1: Sanitary cutting of Norway spruce, Silver fir, and pines due to bark beetles from 1945–2003 (Statistical Yearbook of the Republic of Slovenia 1998, 2002, Titovšek 1994, Annual Reports - Slovenian Forest Service1995–2002).

Outbreak of the eight-toothed small spruce bark beetle

About the eight-toothed spruce bark beetle - Ips amitinus (Eichhoff, 1871)

The species *Ips amitinus* is generally found in the mountains of central Europe 1000 m above sea level (in Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Finland, continental France, Germany, Hungary, Alpine Italy, Latvia, Macedonia, Poland, Romania, Russia (only Kaliningrad), Slovakia, and is also likely to be found in Spain, Switzerland, Ukraine and Yugoslavia). In great Britain and the Netherlands the species is registered, but not confirmed. There is also a doubtful record of the species in Africa (Smith *et al* 1997). Data for the location of finds of this species in Slovenia is in the collection of the Natural History Museum of Slovenia (PMS), which has data on a location in Pohorje (coll. Peyer) and a location in Peca (Pavlin 2001), in addition to our finds at Košenjak (Jurc 2003a).

In northern areas of Europe the two most important hosts of *I. amitinus* are Norway spruce (*Picea abies*) and Scotch pine (*Pinus sylvestris*). In central hilly regions other species of the genus *Pinus*, such as stone pine (*P. cembra*) and mugo pine (*P. mugo*), are attacked. Galleries have also been found in Silver fir (*Abies alba*) and larch (*Larix decidua*) (Smith *et al* 1997).

The eight-toothed spruce bark beetles are dark brown and 3.5 to 4.5 mm long. The club of the antenna is made up of 5 sections, the club's suture are almost completely flat (Fig. 1-2.).

The flight begins in May-June. The males begin to make entrance holes in weakened, withered, or weather damaged trees, and produce pheromones made up of *ipsenol*, *ipsdienol* and *trans-2-methyl-6-methylene-3,7-octadiene-2-ol* (*amitinol*) (Francke *et al*. 1980). The new generation appears from June to August, dependent on the geographical latitude and altitude. Sister generations sometimes appear. At lower elevations there may be two generations per year. They spend the winter in dead trunks or in the soil litter.

This species likes to brood in young material, often in the upper parts of weakened trees or trees withered for other reasons, such as attack by the species *Ips typographus*. The shape of the gallery system is star-like with 3 to 7 mother galleries coming from a central mating chamber (Fig. 3).

Fig. 1: Male *I. amitinus* – lateral view.

Fig. 2: Male *I. amitinus* – dorsal view.

Fig. 3: The shape of the gallery system of *I. amitinus* is star-like with 3 to 7 mother galleries coming from a central mating chamber.

The species is secondary. Its colonizes mostly weakened hosts. Under favorable weather and trophic conditions it can become dangerous, particularly on plantations (Mihalciuc *et al* 2001, Novotny *et al* 2002, Knižek 2001). Since *I. amitinus* mostly appears at higher altitudes its economic impact on stands is limited. It frequently appears together with the species *I. typographus* and can lead to withering of hosts if both species multiply at the same time. This species has been on the European A2 quarantine list since 1981 (OEPP/EPPO, 1981). It was taken off the A2 list a short while ago due to the small likelihood of causing large economic damages on the territory of EPPO (Smith et al. 1997).

Outbreak of the eight-toothed spruce bark beetle

A gradation of *I. amitinus* appeared from 2002-2003 in the Alpine region of Slovenia in the northern section of FMR Slovenj Gradec at an altitude of 1270-1500 m above sea level, where there are stands of Norway spruce from 70 to 80 years old. High levels of damage to spruce (withered crowns, bark falling off) and withering of the entire tree were observed 18. 4. 2003 over approx. 25 ha. In the past few years this region has recorded snow-breaks (8. 12. 2002, 150 ha area) and extreme drought and warm weather. The core area showing withering of Norway spruce were near the snow-break affected area. At locations with withered spruce the soil was shallow, with the substrate sometimes just below the roots of the spruce.

Analysis of entomofauna present under the bark of the host

Method of collecting entomofauna

On 10.5.2003 at Košenjak we chopped 5 small trunks (diameter approx. 20 cm) around 20 year old Norway spruces with visible symptoms of bark beetle attack. The small trunks were cut into pieces approx. 60 cm long, for a total of 15 segments, which were brought to our laboratory at the Biotechnical Faculty-Forestry Department and the Phytopathology laboratory of the Slovenian Forestry Institute, where we analyzed and took pictures of the samples. From each piece of trunk we removed three 10 x 10 cm pieces of bark (for a total of 25 pieces) and analyzed the entomofauna present.

Statistical analysis

The basic statistical parameters, correlation analysis, and Principal Component Analysis (PCA) were carried out using Statgraphics (Statistical Graphics Corporation, USA, 1991). The PCA was done on the basis of the quantitative content of the nine analyzed developmental phases of insects on 25 pieces of bark (from 5 trees) (Table 2). The PCA was used as a descriptive multivariate method capable of suggesting the structure and tendencies of the data set, particularly in order to analyze the relationship between the studied characteristics. A total of nine characteristics were analyzed in 25 plots: (1) number *Rhopalicus tutela*-pupa-unchitinized, (2) number *Rhopalicus tutela*-pupa-chitinized, (3) number *Rhopalicus tutela*-imago, (4) number *Ips amitinus*-larva, (5) number *Ips amitinus*-imago-unchitinized, (6) number *Ips amitinus*-imago-chitinized (7) number *Roptrocerus mirus*-pupa-unchitized, (8) number *Roptrocerus mirus*-pupa-chitinized and (9) number *Roptrocerus mirus*-imago.

Results

Analysis of the entomofauna showed that only three species of insects were found: *I. amitinus* (Grüne 1979, Jelínek 1993, Pfeffer 1995) and two species of wasps (*Rhopalicus tutela* (Walker, 1836) and *Roptrocerus mirus* (Walker, 1834)) from the family Pteromalidae (Hymenoptera), (Escherich 1942). In average we collected 6.7 unchitinized pupa of wasp *Rhopalicus tutela* individuals, 8.7 chitinized pupa *Rhopalicus tutela*, 5.0 adults *Rhopalicus tutela*, 19.0 larvae *Ips amitinus*, 36.6 unchitinized imagos *I. amitinus*, 12.1 chitinized imagos *I. amitinus*, 0.25 unchitinized pupa *Roptrocerus mirus*, 1.5 chitinized pupa *Roptrocerus mirus*, and 1.05 imagos *Roptrocerus mirus* to one 10 x 10 cm piece of the bark.

Rhopalicus tutela (Walker, 1836), Pteromalidae, Hymenoptera

Ectoparasitoids of bark beetles from the family Pteromalidae (order Hymenoptera) were found in puparium of the species *I. amitinus* both in the field and in the laboratory. The size of the imago is 2.0 to 4.8 mm (Fig. 4). The development of the ectoparasitoid takes place under the bark of the trunk where it has been attacked by bark beetles. Oviposition is carried out by the female wasp either through the bark of the trunk or by depositing the eggs directly in the vicinity of the bark beetle larvae in the larval galleries (Fig. 5). The wasp prefers larvae which are in the third larval stage or pupae. *Rhopalicus tutela* mostly parasitizes *I. typographus*. This wasp pupates in the larval galleries and parasitizes larvae or parasitizes pupae in the puparium. Eclosion of adult wasps takes place through an opening in the bark of the trunk. We observed a high degree of parasitism in larvae of *I. amitinus* in the field, and these ectoparasitoids were later identified in the laboratory. One of the very likely reasons for the halt in the outbreak of *I. amitinus* in the environs of Košenjak was the very high population density of the ectoparasitoid *Rhopalicus tutela* (Fig. 6).

Fig. 4. Imago of the ectoparasitoid *Rhopalicus tutela.*

Fig. 5: Pupae of the ectoparasitoid *Rhopalicus tutela* in the host puparium. All that remains of *I. amitinus* are the heads of the larvae.

The basic statistical parameters for the five analyzed trunks of Norway spruce are presented in Tables 2 and 3. Trunk 5 contained the greatest number of adult *Ips amitinus*. The PCA was done on the basis of the quantitative content of the nine analyzed developmental phases on 25 plots (in 5 infested trees) (Fig. 7). The PCA revealed that the first two axes represent more than 49 % of the total data. Characteristics are mostly positively correlated. With increasing number of different developmental phases in *I. amitinus* the number of different developmental phases of its natural enemies also rises (*Rhopalicus tutela* and *Roptrocerus mirus*).

An increase in the number of *Ips amitinus*-larvae accompanies an increase in the number of *Roptrocerus mirus* -pupae-chitinized (r^2 = 0.41, n = 25, significant at $p<0.05$). An increase in the number of *Ips amitinus*-imago-unchitinized accompanies an increase in the number of *Rhopalicus tutela*-pupae-unchitinized (r^2 = 0.58, n = 25, significant at $p<0.05$). An increase in the number of *Ips amitinus*-imago-chitinized accompanies an increase in the number of *Roptrocerus mirus*-pupae-unchitinized (r^2 = 0.78, n = 25, significant at $p<0.001$).

The appearance of the wasps *Rhopalicus tutela*-imago and *Roptrocerus mirus*-imago is in weak but negative correlation with the number of adult *Ips amitinus* (*Ips amitinus*-imago-unchitinized and *Ips amitinus*-imago-chitinized) (Fig. 7). Therefore, an increase in the number of adult wasps leads to a fall in the number of adult *Ips amitinus*. The largest negative correlation is recorded for the number of *Rhopalicus tutela*-imago and *Ips amitinus*-imago-unchitinized. With increasing numbers of *Rhopalicus tutela*-imago the number of *Ips amitinus*-imago-unchitinized decreases, however the correlation is on the borderline of statistical significance at 0.05 (r^2 = -0.39, n = 25).

Fig. 6: Logs from sanitary felling of stands in 2002/ 2003 following gradation by *Ips amitinus.*

	(1) *Rhopalicus tutela*-pupae-unchitinized	(2) *Rhopalicus tutela*-pupae-chitinized	(3) *Rhopalicus tutela*-imago	(4) *Ips amitinus*-larva	(5) *Ips amitinus*-imago-unchitinized	(6) *Ips amitinus*-imago-chitinized	(7) *Roptrocerus mirus*-pupae-unchitinized	(8) *Roptrocerus mirus*-pupae-chitinized	(9) *Roptrocerus mirus*-imago
tree 1	0.80	1.60	0.80	3.40	3.60	1.20	0	0.80	0.20
tree 2	0.80	1.60	0.40	3.60	6.80	1.20	0	0	0.20
tree 3	1.20	2.80	2.00	5.80	8.80	2.60	0	0	0.40
tree 4	1.60	1.20	0.80	3.20	5.60	1.80	0	0.20	0
tree 5	2.30	1.50	1.00	3.00	11.8	5.30	0.25	0.50	0.25
Sum	6.70	8.70	5.00	19.00	36.60	12.10	0.25	1.50	1.05
Mean	1.34	1.74	1.00	3.80	7.32	2.42	0.05	0.30	0.21
S.D.	0.63	0.61	0.60	1.14	3.14	1.71	0.11	0.35	0.14

Table 2: Median values for each developmental stage taken for each column individually and totaled for all 5 columns using standard deviation (SD = standard deviation).

	Rhopalicus tutela-pupae-unchitinized	*Rhopalicus tutela*-pupae-chitinized	*Rhopalicus tutela*-imago	*Ips amitinus*-larva	*Ips amitinus*-imago-unchitinized	*Ips amitinus*-imago-chitinized	*Roptrocerus mirus*-pupae-unchitinized	*Roptrocerus mirus*-pupae-chitinized	*Roptrocerus mirus*-imago
Rhopalicus tutela-pupae-chitinized	0.20								
Rhopalicus tutela-imago	0.07	0.11							
Ips amitinus-larva	0.04	0.31	0.01						
Ips amitinus-imago-unchitinized	0.47	0.25	-0.39	0.38					
Ips amitinus-imago-chitinized	0.29	0.30	-0.23	0.06	0.58				
Roptrocerus mirus-pupae-unchitinized	0.11	-0.08	-0.14	-0.22	0.19	0.78			
Roptrocerus mirus-pupae-chitinized	0.18	0.25	-0.22	0.41	0.27	0.10	-0.06		
Roptrocerus mirus-imago	-0.24	0.32	0.21	0.13	-0.03	-0.04	-0.10	-0.17	-0.17

Table 3: Simple correlation matrix of studied characteristics.

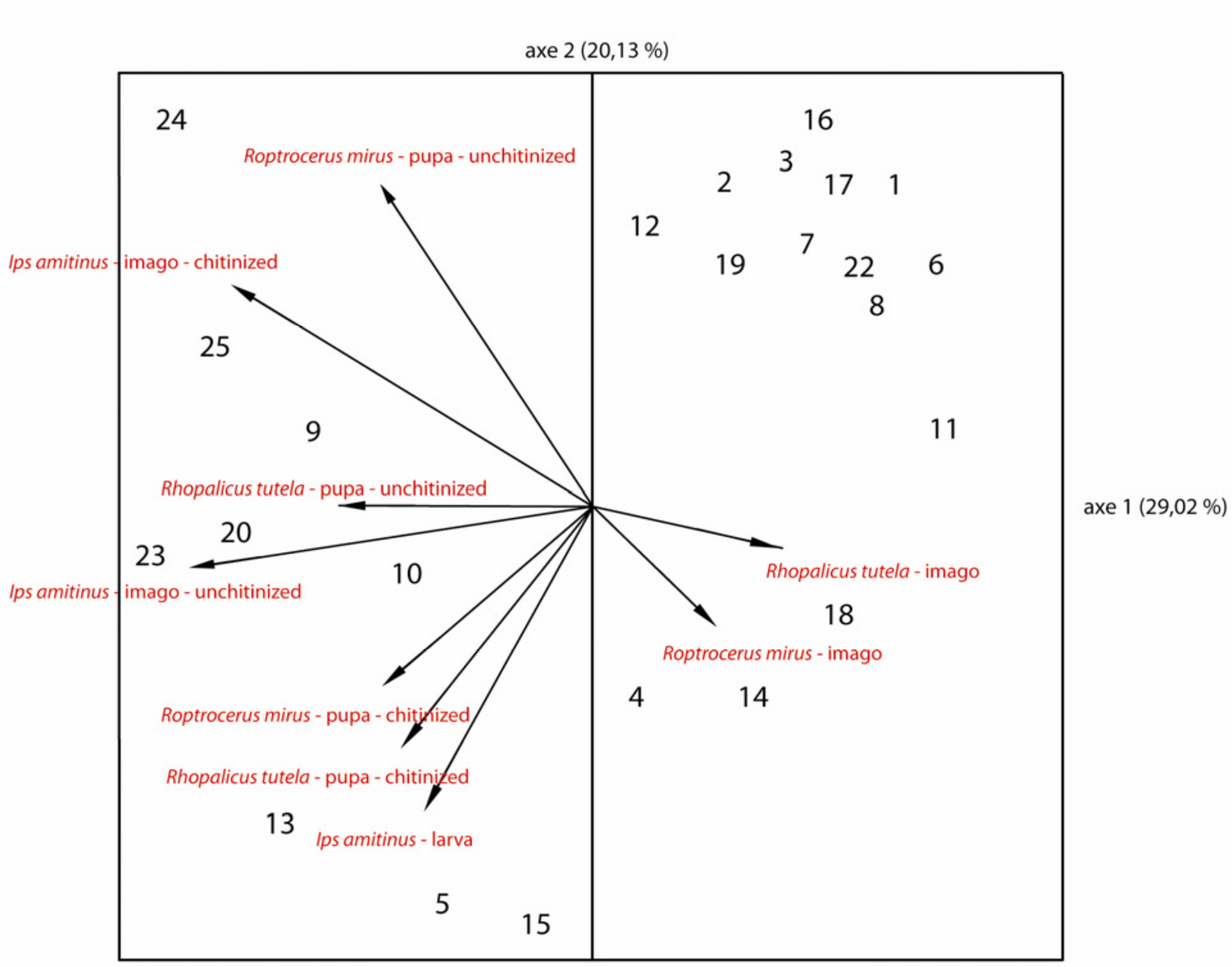

Fig. 7: PCA – graphical review of observations grouped in characters and plots in the plan of the first two axes.

Conclusions

Sanitary fellings due to damages caused by abiotic (wind, sleet and snow, fires, emissions, landslides) and biotic factors (insects, diseases-fungi, game) are increasing in Slovenia. In the last 18 years the greatest number of sanitary fellings have been undertaken due to catastrophic weather conditions (42%), followed by fellings for other reasons (24%) and insects (19%). Since 1999 fellings due to insects have increased (1999 - 102,590 m^3 wood, 2000 - 118,843 m^3, 2001 - 132,732 m^3, 2002 - 169,382 m^3 wood). In 2001 and 2002, fir bark beetles (*Pitykteines spinidens*, *P. curvidens*, *Cryphalus piceae*) and spruce bark beetles (*Ips typographus, Pityogenes chalcographus*) have been multiplying, mostly in the S and SW parts of Slovenia.

Gradations of the small eight-toothed spruce bark beetles (*Ips amitinus*) have not been recorded in Slovenia up to the present. However, *Ips amitinus* appeared in 2003 in the Alpine region of Slovenia at altitudes between 1,270 m and 1,500 m above sea level over an area of 25 ha, in an area with snow-breaks from the previous year. The appearance of a gradation of *I. amitinus* at higher altitudes and under extreme habitat conditions is connected to the extreme drought and warm period experienced in 2002. Global warming with changed ecological conditions can thus influence the biology of specific species, in our case bark beetles.

With increases in the numbers of individual developmental phases of *Ips amitinus*, the number of individual developmental phases of its natural enemies (Hymenoptera, fam. Pteromalidae:

Rhopalicus tutela, *Roptrocerus mirus*) also increases. The high degree of parasitism of pupae of the small eight-toothed spruce bark beetles with parasitic wasps (*Rhopalicus tutela* and *Roptrocerus mirus*) contributed to halting the outbreak of *Ips amitinus* in a natural way.

Acknowledgements

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Oral presentation

Phytophthora disease of alder (*Alnus glutinosa*) in Hungary

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Abstract

The *Phytophthora* caused alder decline was first recorded from Hungary in 1999. Typical symptoms were the thinned crowns, gradual death of the sapwood and presence of tarry spots on the trunk and the root collar. We started a long term monitoring project in 2001 in order to study to determine the importance of the disease, the extent of the damage and severity of infection at different regions of the country. We found that the typical symptoms all over Hungary both in riparian and fen-type alder forest of all age classes. The disease was present in 75% of the 228 stands investigated. Only 17.6% of the plots showed more than 10% frequency of the diseased trees. The highest frequency observed was 78%. Incidence of the disease was fond slightly higher on trees belonging to lower social classes.

Keywords: *Phytophthora*, alder, *Alnus glutinosa*

Introduction

Common alder (*Alnus glutinosa*) covers 2.9% (47,000 hectares) of the forested area of Hungary. Majority of alder forests can be found in Transdanubia (West of the river Danube) and belong to the lowland fen type. Mountain riparian alder forests are less important from economical point of view (Fig. 1).

Alder declines of different scales caused by several different factors were recorded in Hungary during the last 10-15 years. The long dry period was considered most often as the primary factor of the tree mortality.

The *Phytophthora* caused alder decline - which was already observed in several European countries - was first recorded in Hanság (NW Hungary), close to the Austrian border in 1999. Typical symptoms were the thinned crowns, gradual death of the sapwood and presence of tarry spots on the trunk and the root collar (Fig. 2- 4).

Methods

Department of Forest Protection of the Hungarian Forest Research Institute has started a long term monitoring project in 2001 in order to study the *Phytophthora* caused alder decline, particularly to determine the importance of the disease, the extent of the damage and severity of infection at different regions of the country.

During 2002 and 2003 228 sub compartments were investigated all over Hungary. In the stands investigated we counted the infected trees on randomly selected 0.25-0.5 hectares plots. The main symptom considered was the presence/absence of tarry spots on the stem and the root collar.

In addition to the country-wide survey, 22 experimental plots were established in 2002 in different alder stands in order to carry out a more detailed study on the process and other characteristics of the disease in. (Fig. 1.)

Stands with more than 3% of infected trees and belonging to different age classes and origin (seed/coppice) were selected as experimental plots. All plots contain 50 sample trees except two containing 100. The plots were examined once in 2002, and twice in 2003 (late spring and late autumn).

On top of the monitoring we have started to identify the *Phytophthora* collected at our plots in different regions of Hungary. The identification has been done in the laboratories of the Plant Protection Institute of the Hungarian Academy of Sciences.

Results

- *Phytophthora* and its typical symptoms were found all over Hungary, both in riparian and fen type alder forests (Fig. 5).
- Alder decline caused by *Phytophthora* can be observed in all age classes.
- Incidence of *Phytophthora* infection is slightly higher on trees belonging to lower social classes (suppressed, intermediate) (Table 1).
- Measure of infection and its distribution are very heterogeneous in Hungary. We found both heavily infected and healthy alder stands in each region.
- According to the data gained from the 228 plots investigated, symptoms of *Phytophthora* were found in 75% of stands.
- Ratio of the infected trees on the 76.6% of the 228 countrywide survey plots is less than 5%.
- In 38.2% of the plots with *Phytophthora* present the infection rate is lower than 1%. In 19.3% the infection rate is between 1 and 10%, and in 17.6% of the plots the infection rate is higher than 10%. (Table 2) The heaviest infection - where tarry spots were found on 78% of the sample trees - was recorded in Hévíz (near the lake Balaton).
- Presence of tarry spots on trunk does not cause the crown decline immediately. The crown usually looks healthy for 1 or 2 years after the tarry spots appeared. The rate of the crown decline depends on the progress rate of the sapwood necrosis.
- Increasing number of *Phytophthora* infected trees with tarry spots on the 22 detailed investigation plots show the rate of spreading of Alder decline. In autumn 2002 23.6% of trees had tarry spots, in spring 2003 ratio of trees with tarry spots were 26.2%. In autumn 2003 this value reached 30.8%. The yearly increase rate was higher than 7%.
- The high value of infection rate on the 22 detailed investigation plots compared the countrywide average is due to the fact that these plots were established deliberately in infested stands. Therefore the country wide average is lower than average on these plots.

However the data presented above indicate that alder decline caused by *Phytophthora* needs more detailed investigation in order to take appropriate control measures to save our alder stands.

Rate of infected trees %	Height class 1	2	3	4	Sum
2002	9.9	61.8	20.5	7.8	100.0
2003 May	11.1	62.1	19.1	7.6	100.0
2003 Sept.	10.8	62.6	18.7	7.9	100.0
Rate of all trees	12.8	67.0	14.8	5.4	100.0

Table 1: Rate of *Phytophthora* infection by height class of trees

Rate of Phytophthora Infection (%)	Investigated Alder Forests 2002-2003	
	number	%
0	57	25,0
>1	87	38,2
1-10	44	19,3
11-20	17	7,5
21-30	12	5,3
31-40	5	2,2
41-50	0	0
50 <	6	2,6
Sum	228	100,0

Table 2. Rate of *Phytophthora* infection in investigated 228 alder forests

Acknowledgement

These investigations were supported by the Hungarian Science Foundation (OTKA T 038309).

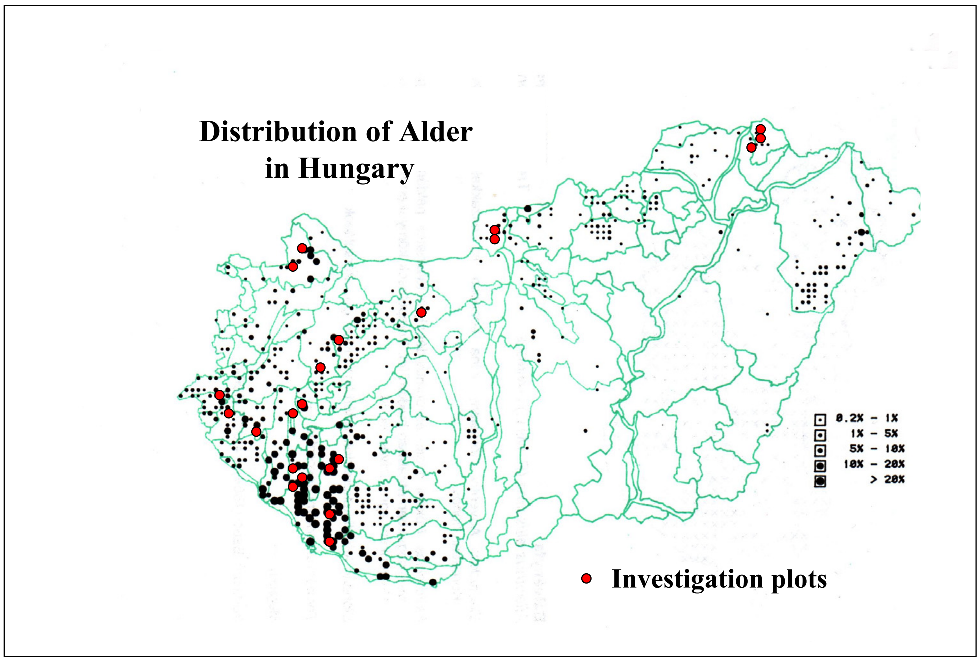

Fig. 1: Distribution of alder in Hungary.

Fig. 2-4: Symptoms of *Phytophthora* disease on alder

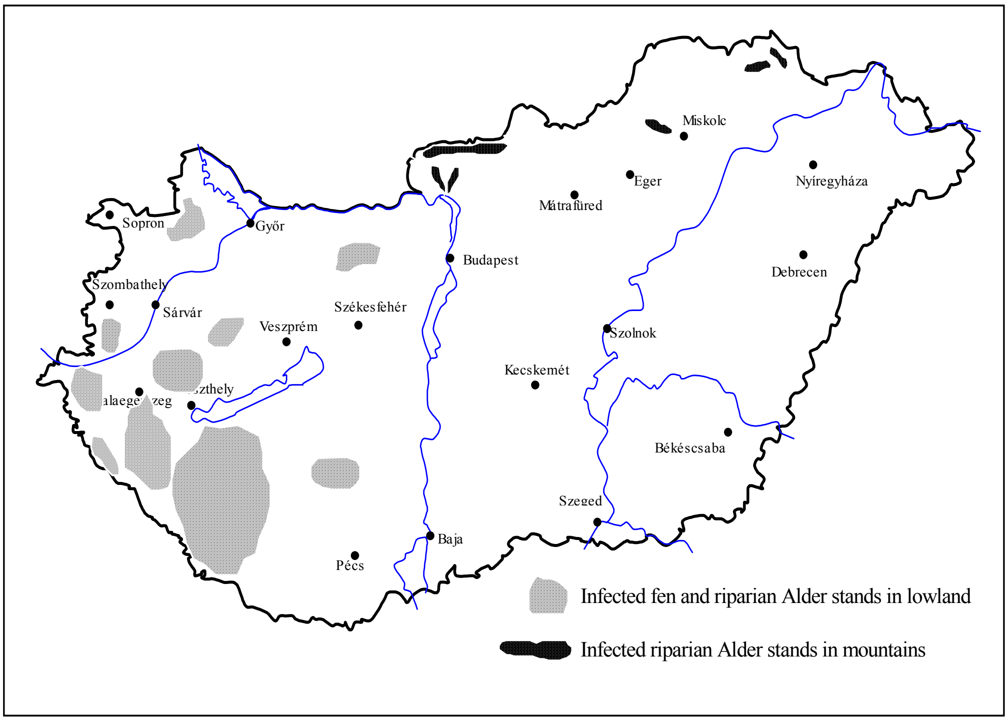

Fig. 5: Occurrence of *Phytophthora* disease of alder in Hungary (2002-2003)

Oral presentation

Phytosanitary problems with introduced pests

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Abstract

The most frequent reasons for introductions of foreign forest pests and diseases to Austria (Europe) were

- import of infested wood packaging material,
- import of wood from Siberia and
- transport of plants (fruits) from European nurseries and producers.

Sometimes also active or passive immigration occurs (e.g. *Cameraria ohridella*).

One of the most dangerous introduced pests is the Asian Longhorn Beetle *Anoplophora glabripennis*, which was first discovered in July 2001 in Austria (Braunau/Inn). Until September 2004, 95 infested trees with living stages of larvae or eggs were cut, chipped and burnt and 117 adult beetles were collected in the area of Braunau. Maple, Plane, Beech, Horse Chestnut and Birch are the preferred host trees of ALB.

According to the eradication-program, a monitoring programme for symptoms on every potential host tree within a radius of 1,000 m of infested trees, is carried out 3 times a year in Braunau.

Detected organisms on imported raw wood and timber from Siberia (Russia):

- Longhorn beetles (*Xylotrechus altaicus*, *Monochamus sutor* ssp. *pellio*, *Tetropium gracilicorne*),
- Bark beetles (*Ips duplicatus*)
- Detected organisms on imported plants for planting: *Phytophthora* sp. and fireblight.

Keywords: introduced pests, *Anoplophora glabripennis*, *Phytophthora, Xylotrechus, Monochamus, Tetropium*

Introduction

The large number of imported goods from overseas (especially from China and North America) which are packed in solid wood packaging material, the import of infested raw and sawn wood from Siberia, the transport of plants and fruits within the territory of EU, the increase of international transit (insects use wagons, containers, or cars as transport units by chance), and active immigration, are the main reasons for the introduction of foreign pests to Austria.

Wood packaging material

Wood packaging material is used for transport of goods such as granite stones, technical and electronic products, car components, iron products and small machines, because wood is cheap, almost available world-wide, and offers best protection for the transport of heavy goods. More than 70% of packaging material consists of wood, but less than 5% of it is made of processed wood (plywood, chip board or oriented strand board). Solid wood packaging material is a most serious phytosanitary problem because:

- ISPM 15 standard is not yet accepted and required by all countries (EU: next year)
- Bad quality of wood
- Wood comes from areas with heavy damages (windbreak, bark beetle attack, forest decline)
- Non-treated wood supplies provide good conditions for development of pests
- Border Inspections are very difficult and expensive.

Coleoptera (beetles)

- Bostrychidae (powder post beetles)
- Cerambycidae (long horned beetles)
- Buprestidae (buprestid beetle)
- Scolytidae (ambrosia bark beetles)
- Platypodidae

Vectors of nematodes and/or blue stain fungi

Lepidoptera

- Cossidae (wood borer)
- Sesiidae (clear wing moths)

Hymenoptera

- Siricidae (Wood wasps)

Table 1: Important harmful organisms detected in wood packaging material at phytosanitary inspections.

Asian longhorned beetle (*Anoplophora glabripennis)*

For Austria the most important introduced xylophagus species is the Asian longhorned beetle (ALB). It originates from Asia (China, Taiwan, Korea), was introduced in 1996 in New York, 1998 in Chicago and since July 2001 in Austria (Braunau). New detections were reported from France, Netherlands, Canada and Germany.

	2001	2002	2003	2004	Total
Infested trees with living stages of larvae or eggs (cut, chipped and burnt)	38	22	8	27	**95**
Infested trees with exit holes	?	0	3	4	**-**
Adult beetles collected in Braunau	89	0	25	4	**118**
Adult beetles emerged from infested logs from Braunau or out of artificial diet **in quarantine lab**		5	14	10	**29**

Table 2: Result of intensive monitoring of ALB in Braunau.

Fig. 1: Male of *Anoplphora glabripennis* (left).
Fig. 2: Larvae of *Anoplophora glabripennis* (right).

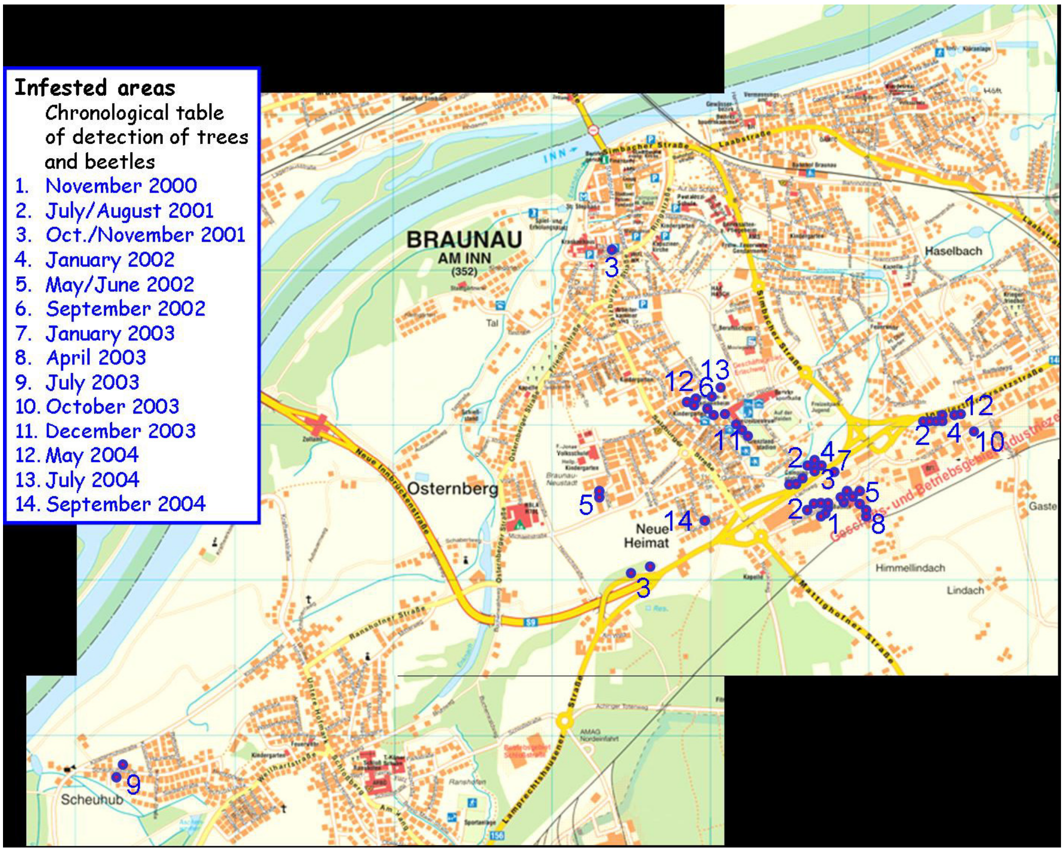

Fig. 3: Map of development of ALB infestation in Braunau.

Table 2 and Fig. 3 demonstrate the development of ALB infestation in Braunau. The affected tree species in Braunau were:

- Maple: *Acer saccharinum*, *A. platanoides*, and. *A. pseudoplatanus*
- Plane tree: Platanus sp.

- Beech: *Fagus sylvatica* „Atropunicea"and *Fagus sylvatica* „Asplenifolia"Birch: *Betula* sp.,
- Horse Chestnut tree: *Aesculus hippocastaneum*

Until September 2004 no ALB attacks on living trees outside Braunau were detected in Austria. According to the number of exit holes found on the analysed infected trees and the number of collected adult beetles, about 17 beetles escaped in 2003 and 15 in 2004. A complete development in Horse Chestnut and Maple trees can last only one year, if the weather conditions are optimal.

First results of PCR-Analysis show, that there might exist a second variation of *Anoplophora glabripennis*. The larvae show a characteristically 3-jagged prothorax.

The eradication and monitoring program carried out in Braunau shows that it is very difficult to find early symptoms such as egg laying sites (scars) or early larval feeding on the trees. Even heavily attacked trees do not always show symptoms of weakness in the crown. Therefore it is sometimes necessary to use fire engine turntable ladders for monitoring work.

Fig. 4: Larvae of *Anoplophora* with 3-jagged prothorax (left side) and "normal" larvae of *A. glabripennis* (right).

Fig. 5: ALB monitoring with help of fire engine.

Fig. 6: Destruction of infested trees.

Import of raw wood and timber from Siberia (Russia)

Most of the imported wood is coniferous wood, especially *Larix sibirica*, but also Spruce and Pine. Although there are strong EU-requirements (Phyto certificate, and wood has to be debarked and free of grub holes larger than 3mm or kiln-dried) living cerambycid larvae were often found even in sawn wood at the phyto-inspections on the border.

Detected organisms:

Long horned beetles:

Xylotrechus altaicus:
- Larvae lives 2 years in the wood
- Larvae 2-3cm long, without legs
- Galleries are filled with wood shavings, and go deep into the wood

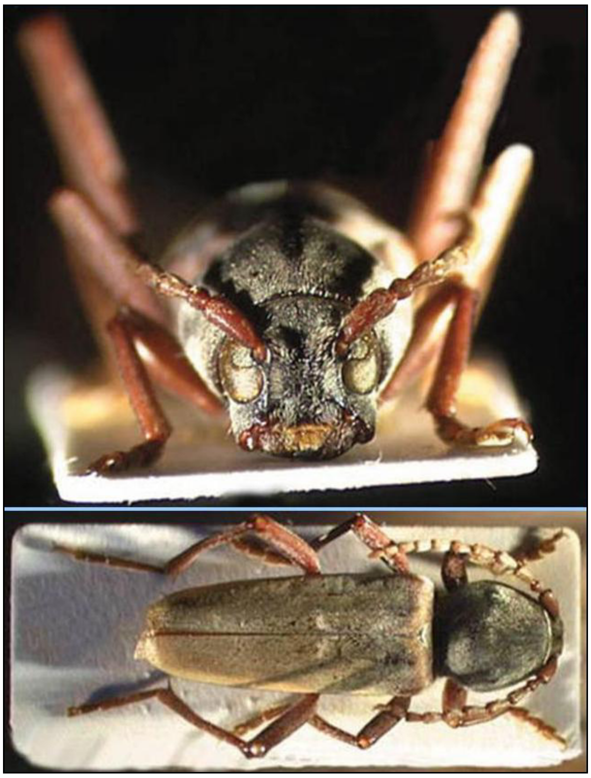

Fig. 7: *Xylotrechus altaicus.*

Monochamus sutor ssp. *pellio* Germer (Fig. 8):
- Beetle is not so brightly spotted and therefore darker than our native *M. sutor sutor* (Linne)

Tetropium gracilicorne (Fig. 9-10)
- Looks like our native *T. gabrieli*
- larvae with 3 pairs of sternum legs and 2 sclerotic humps on the final segment
- Galleries are filled with shavings, and do not deeply into the wood
- Oval exit holes

In several Austrian Larch stands possible primary *Tetropium*-attack was detected. No other biotic reasons for the decline of this native larch species were found. PCR investigations were done in order to get more information about the involved *Tetropium* species *Tetropium gracilicorne* and *T. gabrieli* (left side)

Fig. 8: *Monochamus sutor* ssp. *pellio* Germer.

Fig. 9-10. *Tetropium. gabrieli* (left) and *T. gracilicorne* (right).

Bark beetles:

Ips duplicatus:
- Very often detected in the course of wood inspections, and in the surroundings of wood importers
- Now also active invasion from Czech Republic
- Small infested areas in Lower Austria together with *Ips typographus*

Fig. 11: *Ips duplicatus* (left side) and *I. typographus.*

Transport of plants for planting

Phytophthora

Different *Phytophthora*-species actually cause severe dieback of different broadleaves in Austria, especially on:

a) Alder (*Alnus glutinosa* and *incana*)
b) Beech (*Fagus sylvatica*)
c) Oak (different species)

A very possible way of the spreading of these dangerous fungi is the transport of infested plants from plant nurseries. The spores can also survive and by that way be transported in the soil. The final propagation will be done by water.

Fig. 12: *Phytophthora* on Alder.

Fig. 13: Typical symptoms of *Phytophthora* on Alder.

Fig. 14: Typical symptoms of *Phytophthora* on Beech.

Fireblight (Erwinia amylovora)

Since the beginning of the nineties, fireblight has occurred in Austrian orchards and parks. The import (transport) of infested plants (e.g. *Cotoneaster*) is one of the main reasons for the introduction of this organism to Austria. Local spreading by insects, water, and gardening tools is leading to an increasing number of infected trees. Once established, it is nearly impossible to control fire blight.

The bacterium is also a very great danger for *Sorbus* species, and wild apple or pear trees growing in forests near orchards.

Oral presentation

Armillaria and *Heterobasidion* root diseases in Slovakia

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Abstract

Dieback of Norway spruce in northern Slovakia has been recorded since the early 1990s. Yellowing of needles is usually one of the first symptoms. Further symptoms include shorter needles, shorter length increment and top dieback. The most important pest agent is *Armillaria ostoyae*. Less important are *Heterobasidion annosum* and bark beetles. In 2003, foliar fertilizers, fungicides, biopreparations and carbonic materials were applied to improve resistance of forest trees. It seems that these were not successful and further sylvicultural measurements have been approved in August 2004. Prognosis for infected trees and stands is not good and the best thing foresters can do is to change tree composition from coniferous trees to broad leaf trees.

Key words: *Armillaria*, *Heterobasidion annosum*, sanitation felling, drought, Aliette 80 WP

Introduction

There are several methods to evaluate forest health in Slovakia. In the early 1990s, 111 permanent research plots of the first level, and 8 permanent research plots of the second level, were established. Common international parameters are used to state forest health, such as defoliation, discoloration, wounds, fungi, insects, etc. The second method for estimating forest health is the volume of sanitation felling. This factor is recorded on the forest statistical form named "L116 Report on the occurrence of pest agents in the last year". This report is completed by the owner of the forest stands in January, who is obliged to send it to the Forest Protection Service in Banska Stiavnica by the end of February, each year. The report consists of 5 parts: parts 1 to 3 relate to the type of pest agent (biotic and abiotic), part 4 covers the volume of sanitation and planned felling, and the last part, the realized control measures, such as applied pesticides.

The paper shows the extent of Slovak forests infected by *Armillaria* spp. and *Heterobasidion annosum* evaluated from the report L116. Then there is a description of symptoms, signs of fungi, applied treatment in 2003, and recommended measurements for the further periods.

Statistical information on dieback of forest trees

In 2003, total felling in Slovakia reached nearly 6.2 million m^3. Out of this volume, nearly 42% were ascribed to sanitation felling (Fig. 1). Last year there was no severe wind-throw disaster, which usually increases the volume of sanitation felling, but even so, it increased from the previous year by 18%.

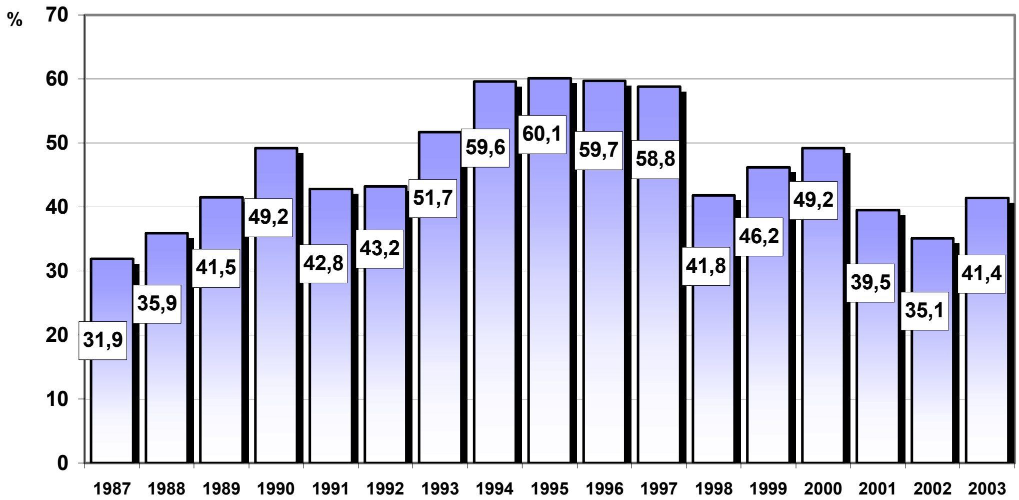

Fig. 1: The volume of sanitation felling caused by all pest agents within the last several years.

In 2003 the volume of wood infected by fungi reached nearly 185,000 m^3 (Fig. 2). That is only 8% of total sanitation felling, but in comparison to 2002 it rose by 81%. The main part of the fungal sanitation felling was ascribed to *Armillaria ostoyae* pest agent, which caused felling by 161% more than in 2002. This is important information, because in the present year (2004) the situation is even worse, and next year will most likely be at least as bad as this one.

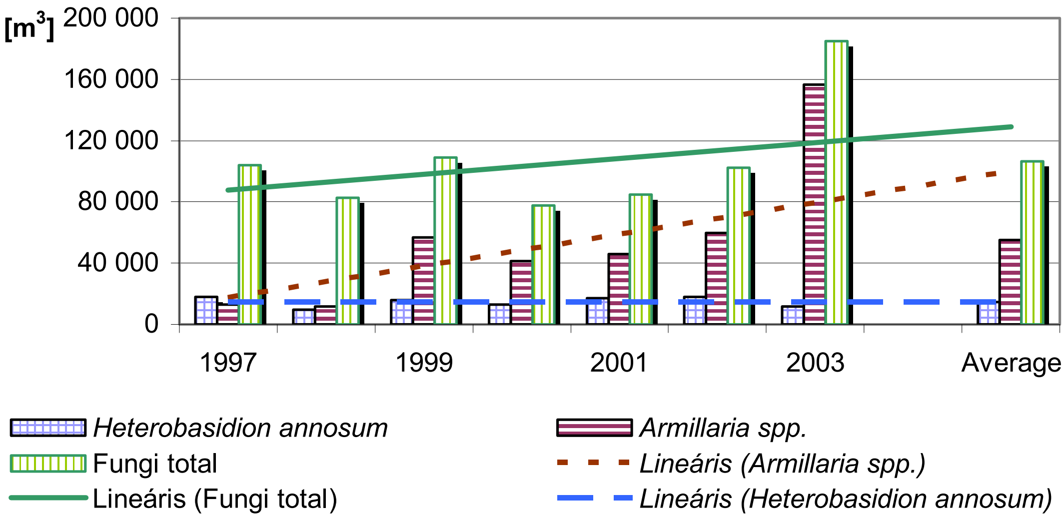

Fig. 2: The volume of sanitation felling caused by *Armillaria* spp., *Heterobasidion annosum* and total fungi within the last several years.

The most affected parts of Slovakia are the northern regions named Kysuce and Orava with 98,000 ha, Tatras 198,000 ha and Spiš 141,000 ha, altogether about 437,000 ha (Fig. 3; Table 1). Norway spruce is the most affected tree species, however, Silver fir *Abies alba* and European larch *Larix decidua* are susceptible as well. Tree dieback shows from early age of trees up to mature trees. *Armillaria ostoyae* is determined as the most important factor of Norway spruce dieback. The second fungal pest agent is *Heterobasidion annosum*, which is, however, far less important.

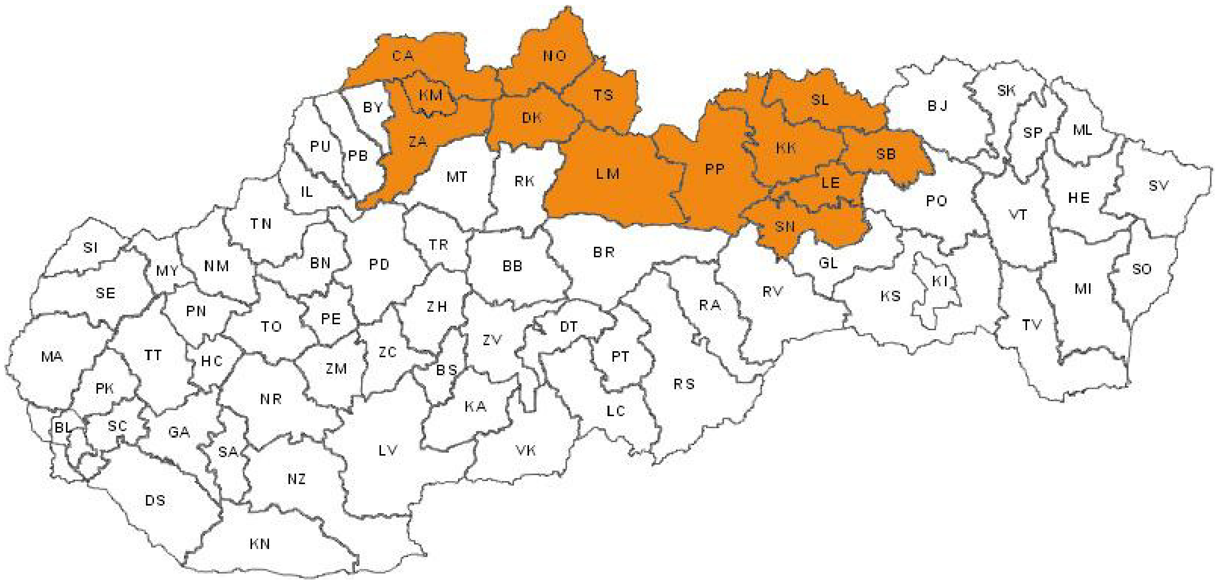

Fig. 3. Regions severely affected by *Armillaria ostoyae* dieback.

Year	Region	Felling of **coniferous** trees [m^3]		**Sanitation felling [%]**
		Sanitation	Total	
2002	Slovakia	**1 689 587**	3 107 247	**54,4**
2003		**2 293 380**	3 319 882	**69,1**
2002	Kysuce - Orava (98 000 ha)	**205 988**	379 682	**54,2**
2003		**316 778**	407 616	**77,7**
2002	Tatry (198 000 ha)	**476 564**	625 207	**76,3**
2003		**808 393**	877 328	**92,1**
2002	Spiš (141 000 ha)	**397 106**	462 593	**85,8**
2003		**377 694**	437 038	**86,4**
2002	Total Norway spruce dieback (437 000 ha)	**1 079 658**	1 467 482	**73,6**
2003		**1 502 865**	1 721 982	**87,2**

Table 1: Coniferous sanitation felling in 2002 and 2003 in northern part of Slovakia (by statistical report L116).

Symptoms

As for epidemiology of the disease, there are two forms of Norway spruce dieback: chronic and acute.

Chronic dieback

There are three periods. First period starts with chlorosis of needles. It appears on the current year shoots and after several years on older ones too. The chlorosis may last up to 10 years without any other symptoms. Shorter length increment and needle length are symptoms of the second period. This usually appears together with chlorosis and lasts 1 to 3 years without other symptoms. This is the stage when foresters seriously worry about their forest stands. The third period consists of top dieback. It includes the dropping of short and yellow needles, first from the current year shoots on the top of trees, later also from the older shoots and middle and lower part of the tree crown. Some of the trees with the symptoms of the third period are already infested with bark beetle, such as *Ips typographus*, *Pityogenes chalcographus*, *Ips duplicatus* and *Ips amitinus*. It is very likely, that bark beetles search for the trees which are already infected by *Armillaria* spp. Thus fungal disaster can easily result in bark beetle disaster.

Acute dieback

It shows the same three periods of different symptoms as chronic dieback described above. All of them, however, last much shorter. Symptoms of the first period can evolve to the third ones within 1 to 6 months, as it happened in 2003 or 2004.

Signs of fungi

It is not easy to properly determine the involved pest agents. The most common signs of fungi are white mycelial fans (known as syrrocium) under the bark of roots, butt roots, collar of the stem or stem. When the third period shows its symptoms, mycelial fans should be easily found at least on the butt roots. Earlier stages do not necessarily show mycelial fans on butt roots or higher on the trunk. But if one looks for the mycelial fans when trees show symptoms of the first period, they can be found on the roots as far as 3 m from the trunk. Therefore inspection for the mycelial fans on trees should be careful and on several butt roots, or even on roots which are under the ground.

Rhizomorphs are less common than mycelial fans. The can be found under the bark of trees or stumps which died several months or years before. Firstly, they are dark-red to brown, shiny, and with whitish growing tips. They can grow together with the mycelial fans as well as without them.

Fruiting bodies are formed in autumn and they are useful for determination of the taxon into species.

Armillaria causes white rot of sap wood. After 2 – 3 years the rotting sapwood can spread 2 to 10 cm from the edge into the center of the stump. There is a visible line between rotten (whitish color) and healthy wood (darker color).

Heterobasidion annosum can be determined by fruiting bodies which form on the stumps about 10 years after felling. It is not easy to find fruiting bodies because they are often hidden by moss, grass, leaves and other material. When trees are cut, the brown to red color of the rotting heart wood is visible.

Reasons of decline

There are several reasons why *Armillaria* dieback occurs in Norway spruce forest of northern Slovakia. First, Norway spruce has been cultivated as monoculture. The stands are, however, not suitable for pure culture of Norway spruce. In any case, there should be mixed forests of European beech and Silver fir, in elevation above 800m, in addition to Norway spruce. Second, it is not known what the origin of Norway spruce seeds was. In the time of Austria-Hungary (19^{th} century) and later in Czechoslovakia ($20t^{h}$ century), seed import from Šumava forests or from Austrian Alps was pretty common. Thus, Norway spruce in northern Slovakia could have most likely come from parts of other European forests. Third, these regions have been, for many years, strongly influenced by air pollutants coming from the Ostrava-Karviná and Katowice regions. Deposition of these pollutants has been cumulated in the soil which results in problems with available nutrients for root systems. Fourth, climate extremes in mountain areas cause terrible problems for the trees. In 2000 and 2003 there were drought conditions, with a hot spring, as well as summer. These facts weakened trees so much that they were not able to resist the spreading *Armillaria* and *Heterobasidion* mycelia in the stumps, soil and finally healthy trees were infected through fine roots. Once roots are infected, healing such trees is nearly impossible. All that foresters can do is to improve resistance of forest trees by mainly sylvicultural methods.

Control measurements

The symptom of yellow trees has been detected on Norway spruce trees in the regions of northern Slovakia since the early 1990s. During the last decade, several research projects to find the reasons for needle-yellowing, were carried out. After the drought in 2000, trees started to die in larger quantities, and we were talking about *Armillaria* calamity. In 2003 the situation was even worse and the government decided to spend some money in order to stop spreading of *Armillaria* and to improve health of trees. The Forest Research Institute in Banská Štiavnica worked out "the realization project" which had to be followed in Kysuce region. The project stated 5 application versions:

A) Aerial liming

They applied CaO+MgO with 48% in carbonic form, the amount of 0,5 mm MgO grains was 7 – 10% with mostly powder fraction. Application dose was 3 t/ha. They spread it at the end of August 2003 on 98,1 ha. The age of forest stand was above 50 years.

B) LAMAG B and Aliette 80 WP

Foliar fertilizing with LAMAG B and foliar application of systemic fungicide Aliette 80 WP was applied on the area of 85,67 ha.. Concentration of LAMAG B was 5 liters on 1 ha (max. concentration 4%). Concentration of Aliette 80 WP was 750-1000g/100 liters of H_2O/ha. Solution dosage was 100 l/ha.

C) Aliette 80 WP

Foliar application of systemic fungicide Aliette 80 WP in concentration 750-1000g/100 liters of H_2O/ha was applied on the area of 19.1 ha.

D) Trichodex

Foliar application of *Trichoderma harzianum* spores in 0,3% of water suspension. Application dosage was 100 l/ha. This was applied on area of 2,783 ha 4 weeks after version "B".

E) Boric acid

Boric acid in dosage of 5 kg/ha (max. 0,5%) was applied on the area of 2,23 ha.

Actual measurements

It seems that applied control measures will not solve the problem with *Armillaria* dieback of Norway spruce. Because of that, at the end of August 2004, the persons in charge decided to recommend further control measures, which are mostly sylvicultural. The aim of that suggestion is to change tree composition from coniferous trees to broad leaf trees.

a) Clear-cut

If tree density at the forest stand is less than 0,4 and there are more than 50% of standing trees infected by *Armillaria*, then all trees should be cut. Artificial regeneration with broad leaf trees is necessary at the stand because Norway spruce is so aggressive that it will get to grow on the stand naturally anyway.

b) Cutting in strips

If tree density at the forest stand is higher than 0,4 and less than 50% trees are infected by *Armillaria*, then trees should by cut in narrow strips. Regeneration can be artificial with broad leaf trees in combination with natural regeneration by which conifers can get on the stand too.

c) Single tree sanitary cuttings

If stand conditions are better than previous category, then just single trees with dieback symptoms should be cut without artificial regeneration.

Conclusions

Armillaria dieback of Norway spruce forest stands in northern part of Slovakia is going to be more and more serious. It may happen that dieback will slow down and stop naturally. On the contrary, not only Norway spruce can be seriously infected by *Armillaria,* but also *Fagus sylvatica*, *Abies alba*, *Larix decidua, Acer* spp. and other common forest tree species. When both natural and artificial regeneration with any forest tree species will be without success then even more serious problems may come to this region of northern Slovakia.

Oral presentation

Xylophagous and phloeophagous insects in the Hungarian coniferous forest - conflicts of forest protection and conservation

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Abstract

The xylo- and phloeophagous insect fauna of the Hungarian coniferous forests was analyzed during a long term monitoring program. Besides the faunal characteristics, the possible conflict sources between forest protection and nature conservation practices were analyzed. Significant differences were found at the insect fauna of the same location in different years. Each of the areas has another dominant species and the composition of the xylo- and phloeophagous insect fauna varies strongly from region to region. At species level we compared one international (IUCN: The World Conservation Union), one European (Natura 2000), and two national (Strictly protected and Protected species lists of the Ministry of Environment Protection) protected and/or endangered species lists for the xylo- and phloeophagous species. After four years of investigation, only one of the protected, coniferous-feeding insect species, namely *Acanthocinus aedilis* can be considered as a potential conflict source. All other xylo- and phloeophagous species have either economic or ecologic importance. In forest reserves (altogether 71 assigned areas in Hungary), the risk of outbreaks of different xylo- and phloeophagous insects is low, with the exception of localities with high coniferous proportion (altogether, 4 stands).

Keywords: xylophagous insects, ploeophagous insects, conifers, conservation, *Acanthocinus aedilis*

Introduction

The proportion of forested land in Hungary is low, approx. 21% (ÁESZ 2003) in comparison to the European Union average. Beyond that, the ratio of coniferous tree species is also low 14.8% (Fig. 1.). Despite this, bark and wood-boring insects have high significance in these stands. Although bark beetle outbreaks are known from the last century (e.g. 1945-48 and 1991-96), we do not have detailed data, such as what kind of other insects (e.g. Scolytidae, Curculionidae, Cerambycidae, etc.) have a significant effect on our coniferous forest ecosystems. Forest protection practices are now restricted to removing the attacked trees and trapping the bark beetle species if their aggregation pheromone are commercially available. Very often, we do not have aggregation pheromone for phloeophagous insects which cause damage of economic importance. Therefore no mass- or monitor trapping is possible (e.g. *Pissodes* spp.). The traditional monitoring method for xylo- and phloeophagous insects is the use of trap trees, where all kinds of insect species – living in the bark and wood – can be determined. These trees offer suitable breeding material for insect species that have no economic importance, but have high ecological importance. This is especially valid for the protected and/or endangered xylo- and phloeophagous species.

The aim of our investigations was to determine, whether the traditional use of trap trees can be recommended or whether there are any conflicts between forest protection and nature conservation practices.

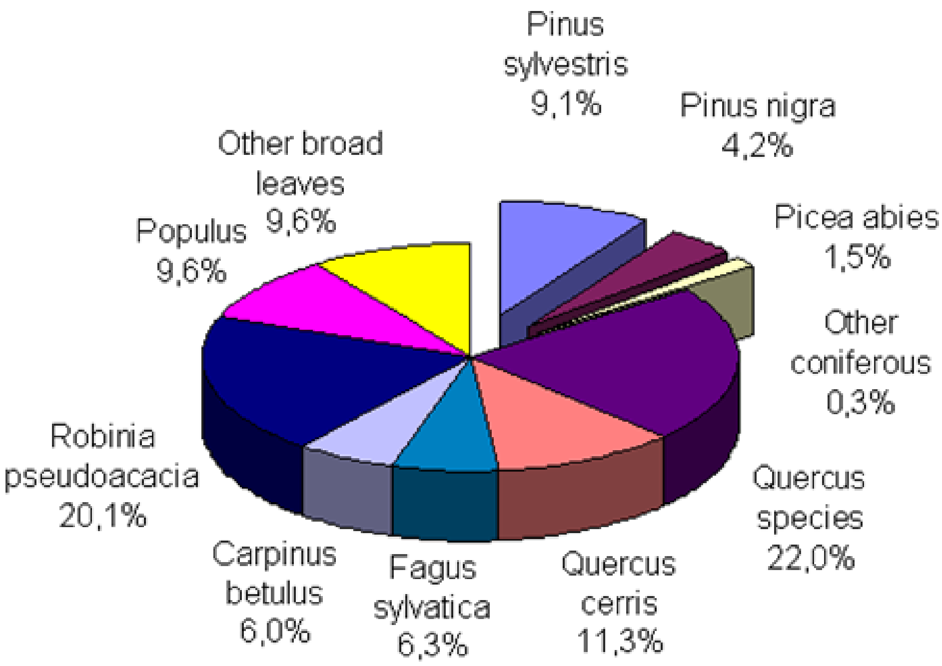

Figure 1:. Tree species composition of Hungary.

Materials and methods

During our long term monitoring program we analyzed the xylo- and phloeophagous insects of the Hungarian coniferous forests. 24 study plots were chosen, which were typical to the particular conifer tree species (Fig. 2). Scots pine (*Pinus sylvestris* Linné): 14 plots, Austrian pine (*Pinus nigra* Arnold): 4 plots and Norway spruce (*Picea abies* Karsten): 6 plots.

Trap trees were felled at each plot at the end of February. Data presented here are from the years 1998-99 and 2001-2002, respectively. 5 samples were taken from every tree, one by one from the base part, the trunk, the crown base, the top part of the crown and from small branches before the emergence of the first beetles (usually at the end of May). The collected samples were put into light eclectors. The species abundance and also the number of hatched insects were determined.

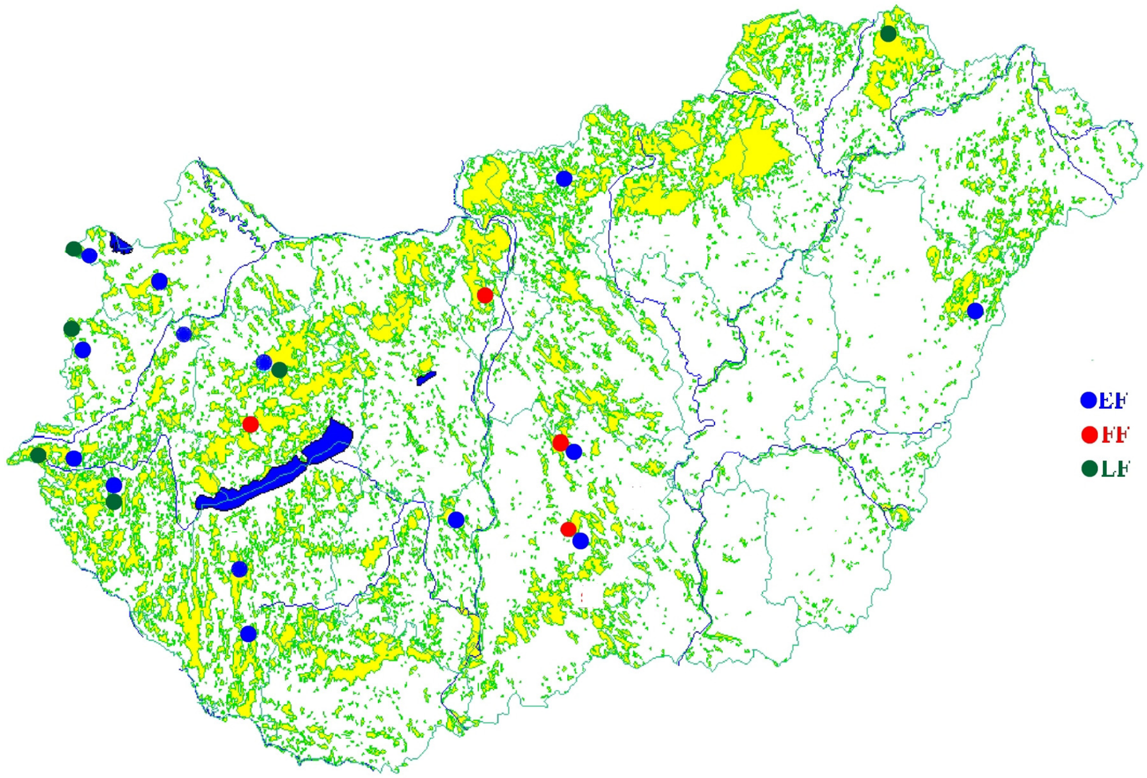

Figure 2. Forested land of Hungary and the study plots (EF: *Pinus sylvestris*, FF: *Pinus nigra*, LF: *Picea abies*).

Results and discussion

Scots pine (P. sylvestris):

Approximately 20,000 specimens of 39 species emerged and were determined (Table 1). Bark beetles (Scolytidae) were dominant, followed by long horned beetles (Cerambycidae), weevils (Curculionidae) and deathwatch beetles (Anobiidae). For the further evaluation, the composition of the long horned beetle species will have definite significance.

Austrian pine (P. nigra):

10,000 specimens of 30 insect species were determined. With the Austrian pine, the species of the family Scolytidae were also the most abundant (Table 2), while long horned beetles were also remarkable.

Norway spruce (P. abies):

18,000 specimens of 23 species were evaluated (Table 3). The vast majority of the emerged beetles – both species and individual abundance – belonged to the family of bark beetles. Other beetle families (e.g. long horned beetles and weevils) have minor importance.

Basic evaluation of species composition and abundance:

Significant differences were found in the insect fauna of the same area in different years (Tables 1-3). Many species are missing in a particular year, while some – economically important ones (e.g. *Ips typographus* Linné) – are present every year.

High variances can be found among the examined regions. Each of the areas has another dominant species and the composition of the xylo- and phloeophagous insect fauna varies from region to region. As a remarkable example we can take the 4 *P. nigra* stands in the year 2002 (Fig. 3). In Kerekegyháza, *C. pusillus* – a secondary bark beetle species, which makes its galleries starting from the galleries of other bark beetles – is the dominant species. In the other three localities, *I. sexdentatus*, *C. cinereus,* together with *P. bistridentatus* and *P. bistridentatus,* are dominant. Until now, we couldn't find any exact explanation for this phenomenon. Especially in the two closest regions Kerekegyháza – Bugac, which are approximately 50km from each other, and have very similar climatic and soil conditions, but differ strongly in the dominant species.

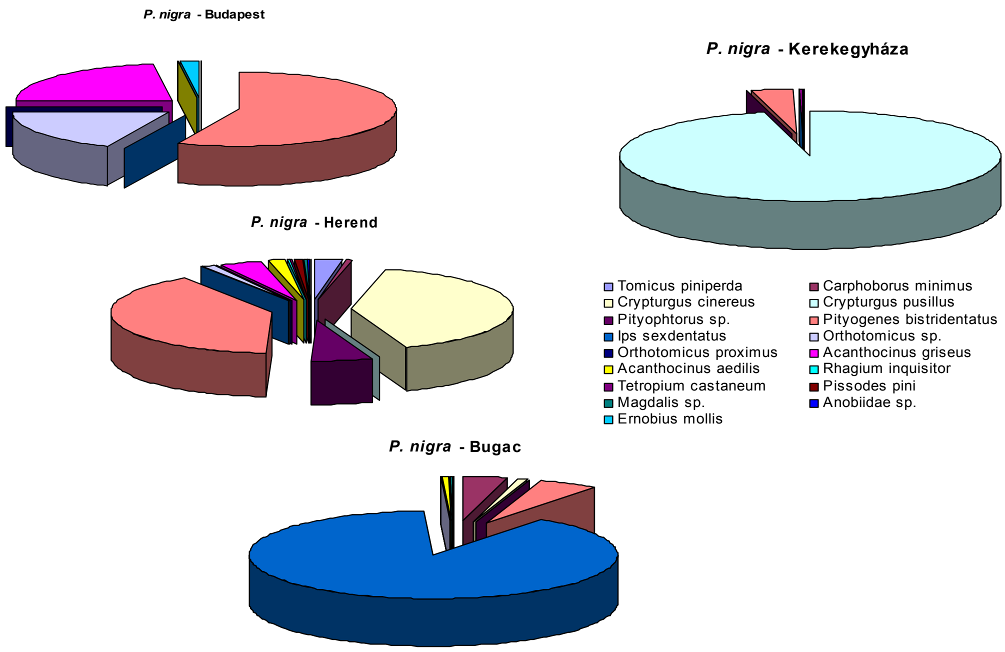

Fig. 3: Xylo- and phloeophagous species composition of four *P. nigra* stands in 2002.

Over moderate distances, remarkable differences were found, while over small distances, no significant deviation could be shown (Table 4), even if there were some species present on one plot, while missing on the other one.

The detailed analysis of the acquired dataset is still in progress; therefore additional relationships can be explained in the near future.

	1998	1999	2001	2002
Curculionidae				
Magdalis violacea			1	1
Pissodes pini			5	3
Pissodes piniphillus			1	2
Scolytidae				
Tomicus minor			6	2
Tomicus piniperda	8	8	5	5
Hylurgops glabratus			2	
Hylurgops ligniperda	1			
Hylurgops palliatus	3	2		
Hylastes ater	4	5		
Hylastes opacus	2	1		
Hylastes attentatus			2	
Hylastes angustatus			1	
Polygraphus poligraphus			1	
Crypturgus pusillus			4	
Crypturgus cinereus	1	6	3	
Crypturgus sp.			4	1
Cryphalus sp.			1	
Carphoborus minimus			1	
Pityophthorus pityographus	1		6	1
Pityophthorus pubescens			1	
Pityophthorus sp.			4	
Pityogenes chalcographus	3	1	5	1
Pityogenes bidentatus			5	
Pityogenes bistridentatus	1	3	4	5
Ips acuminatus		1	3	1
Ips sexdentatus	1	2	1	1
Orthotomicus laricis	4	3	1	
Orthotomicus proximus	2	1	2	
Orthotomicus sp.			1	4
Dryocoetes autographus		1	2	
Xyleborus monographus			2	
Trypodendron lineatum			1	
Cerambycidae				
Acanthocinus aedilis			5	7
Arhopalus rusticus				1
Monochamus galloprovincialis				2
Pogonochaerus fasciculatus			3	
Rhagium inquisitor			2	3
Anobiidae				
Ernobius mollis			1	
Anobium sp.				1
Number of plots (n)	14	14	13	10

Table 1: Number of plots, where the particular xylo- and phloeophagous species were found – *P. sylvestris.*

	1998	1999	2001	2002
Curculionidae				
Dorytomus sp.				1
Magdalis violacea			2	
Pissodes pini			2	1
Pissodes piniphillus			1	
Scolytidae				
Tomicus minor				1
Tomicus piniperda		1	1	2
Hylurgops ligniperda	1			
Hylurgops palliatus	1			
Hylastes ater		1		
Hylastes opacus	1	1		
Crypturgus pusillus			1	
Crypturgus cinereus	3	3	4	1
Crypturgus sp.			1	4
Carphoborus minimus			3	
Pityophthorus pityographus		1		1
Pityophthorus sp.	1		2	
Pityogenes chalcographus			1	
Pityogenes bistridentatus	3	1	4	3
Ips sexdentatus			2	2
Orthotomicus laricis	2	1		
Orthotomicus proximus			1	
Orthotomicus sp.	1		2	3
Cerambycidae				
Acanthocinus aedilis			2	2
Acanthocinus griseus			3	
Dorytomus sp.			1	
Monochamus galloprovincialis			2	
Rhagium inquisitor			1	2
Tetropium castaneum			2	
Anobiidae				
Ernobius mollis			2	
Anobium sp.			1	1
Number of plots (n)	4	4	4	4

Table 2: Number of plots, where the particular xylo- and phloeophagous species were found – *P. nigra*

	1998	1999	2001	2002
Curculionidae				
Pissodes harcyniae			1	
Scolytidae				
Tomicus piniperda	1			
Hylurgops glabratus			2	
Hylurgops palliatus	3	1	1	3
Hylastes ater	1	1		
Hylastes opacus	1			
Polygraphus poligraphus	2	2	2	2
Crypturgus pusillus			2	
Crypturgus cinereus	4	3	2	2
Crypturgus sp.			3	3
Pityophthorus pityographus	3		2	3
Pityophthorus micrographus			1	
Pityophthorus sp.			1	1
Pityogenes chalcographus	3	4	5	5
Ips amitinus		1	1	
Ips typographus	4	3	5	4
Orthotomicus sp.				1
Dryocoetes autographus	6	2	1	2
Xyleborus saxesenii	1			
Trypodendron lineatum	1			
Cerambycidae				
Acanthocinus griseus			1	2
Rhagium inquisitor			2	2
Tetropium castaneum			2	
Number of plots (n)	**6**	**6**	**5**	**5**

Table 3: Number of plots, where the particular xylo- and phloeophagous species were found – *Picea abies.*

2001	**Velf I-01**	**Velf II-01**	**Velf III-01**	**Velf IV-01**	**Velf V-01**
Curculionidae					
Pissodes harcyniae	0	0	0	0	4
Scolytidae					
Hylurgops glabratus	1	0	0	13	0
Hylurgops palliatus	-	-	-	-	-
Crypturgus pusillus	11	0	0	0	0
Pityophtorus sp.	9	0	0	0	0
Pithyophtorus pityographus	14	0	0	0	0
Pityogenes chalcographus	2,156	148	92	19	73
Ips typographus	286	644	770	132	431
Orthotomicus sp.	-	-	-	-	-
Cerambycidae					
Acanthocinus griseus	-	-	-	-	-
Rhagium inquisitor	0	0	0	3	0
Tetropium castaneum	0	0	0	0	3
2002	**Velf I-02**	**Velf II-02**	**Velf III-02**	**Velf IV-02**	**Velf V-02**
Curculionidae					
Pissodes harcyniae	-	-	-	-	-
Scolytidae					
Hylurgops glabratus	-	-	-	-	-
Hylurgops palliatus	0	0	1	2	2
Crypturgus pusillus	64	38	4	8	17
Pityophtorus sp.	3	0	0	0	0
Pityophorus pityographus	130	7	1	0	0
Pityogenes chalcographus	303	218	1,303	401	915
Ips typographus	265	114	864	466	1,045
Orthotomicus sp.	1	0	0	0	2
Cerambycidae					
Acanthocinus griseus	0	0	0	0	0
Rhagium inqusitor	0	2	0	0	2
Tetropium castaneum	-	-	-	-	-

Table 4: Differences over small geographic distances – number of emerged beetles in 2001 and 2002 – *Picea abies.*

Conflicts between forest protection and nature conservation

After the first results, the high number of long horned beetles in the sampled trees raised several questions. Is there any conflict between the traditional forest protection method (trap trees) and the conservation of protected and/or endangered species respectively? Potential conflicts were found at the species level (protected species) and at the management level (management in the protected area).

Conflicts at the species level

The expression: protected or endangered species have a different meaning, depending on the intention of the definition. In our four year investigation, we compared one international (IUCN: The

World Conservation Union), one European (Natura 2000) and two national (Strictly protected and Protected species lists of the Ministry of Environment Protection) protected and/or endangered species list to the xylo- and phloeophagous species.

The IUCN red list for Hungary comprises 126 animal species, including 37 insects, 4 of which are xylo- and phloeophagous species (Table 5). The EU directive Natura 2000 comprises 569 animals, including 24 (!) insects, with only one xylo- and phloeophagous species (Table 5). The list of strictly protected species for Hungary comprises 137 animals, including 31 insects, with only one xylo- and phloeophagous species (Table 5). The list of protected species for Hungary comprises 829 animals, including 391 insects, with 57 (!) xylo- and phloeophagous species (Table 5).

Family / species	**IUCN**	**EU Natura 2000**	**Strictly protected**	**Protected**
Buprestidae				9 species
Buprestis splendens	-	+	-	-
Lucanidae	-	-	-	3 species
Scarabeidae				1 species
Osmoderma eremita	+	-	+	-
Cerambycidae				32 species
Cerambyx cerdo	+	-	-	+
Morimus funereus	+	-	-	+
Rosalina alpina	+	-	-	+

Table 5: Xylo- and phloeophagous species developing in deciduous trees on different endangered and/or protected species lists and directives

Family / species	**IUCN**	**EU Natura 2000**	**Strictly protected**	**Protected**
Buprestidae				
Buprestis splendens	-	+	-	-
Chalcophora mariana	-	-	-	+
Lucanidae	-	-	-	-
Scarabeidae	-	-	-	-
Cerambycidae				
Ergates faber	-	-	-	+
Semanotus russicus	-	-	-	+
Acanthocinus aedilis	-	-	-	+

Table 6: Xylo- and phloeophagous species developing in conifers on different endangered and/or protected species lists and directives

All lists mentioned above, include the xylo- and phloeophagous species feeding on non coniferous tree species too. The number of species decreases heavily, if we only consider the ones, which occur on different coniferous species (Table 6). As you can see, there are four species altogether, which are considered as having ecological importance (or at least protected and/or endangered).

Comparing the species composition of our experimental plots (Tables 1-3) to the ecological important ones (Table 6), we can find only one species, the *A. aedilis* as a potential conflict source. All the other species have either economical (forest protection) or ecological (nature conservation) notability.

Conflicts at the management level

Hungary has 71 forest reserves, but only four of them have more than 10% coniferous tree species. As a typical conflict event, we can take the bark beetle outbreak in the forest reserve No. 46 (Soproni-hegység: Hidegvízvölgy erdőrezervátum). This forest reserve is one of the smallest in Hungary with a total are of 56.9 ha (core zone: 19.7 ha, buffer zone: 37.2 ha).

Bark beetle outbreaks have a long history there. Already in the early ’90-s a mass outbreak of *I. typographus* killed almost all Norway spruce trees in the core area (mixed spruce, beech oak and pine stand). During and after this attack nothing was done to reduce the damage or the number of beetles. In spring 2004 new infestations were observed, but now in the buffer zone, where there are also larger, unmixed spruce stands. Fortunately the attack was discovered early enough to enable discussion between forest managers and forest reserve representatives regarding possible solutions. The main objective was to keep the continuous forest cover as large and as long as possible. The final decision was to clear-cut the attacked trees, thereby protecting the remaining spruce trees and further, the continuous forest cover in the buffer zone. The situation showed several similarities to other protected areas in Europe, like the Bayerische Wald – Sumava, or the Tatra-mountains in Slovakia and Poland.

Conclusions

Besides the host tree species, the geographic location determines the composition of the xylo- and phloeophagous species in the Hungarian coniferous forests. The significant differences, which were found between the monitoring years and the examined regions, are essential for the evaluation on these insects. Accurate evaluation can only be given if the area is well known, while smaller distances do not have any influence on the species composition and abundance.

Potential conflicts between forest protection and nature conservation were found at the species level (protected species) and at the management level (management in the protected area). Only one of the protected, coniferous feeding insect species, namely the *A. aedilis* can be considered as a potential conflict source. All other xylo- and phloeophagous species have either economic or ecological importance. In forest reserves (altogether 71 in Hungary) the risk of outbreak of different xylo- and phloeophagous insects is low, with the exception of localities with high coniferous proportion (altogether, 4 stands).

Acknowledgement

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Oral presentation

Biological control of grubs of European cockchafer – *Melolontha melolontha* (L.): preliminary results

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Abstract

The most harmful insect pest in the Hungarian fruit production is the *Melolontha melolontha*. The grubs of *Melolontha melolontha* damage the root system of the trees and may cause destruction of the newly planted young trees. This problem concern mainly the orchards in light sandy soils, and about 60% of the Hungarian orchards were established in this type of soils. In Integrated Fruit Production (IFP) there is not possibility to use pesticides in the soil, consequently there is not chemical control of grubs. The only solution is the biological control and entomopathogenic nematodes (EPNs) are the most important candidates as effective control agents. There is an ongoing project to elaborate an effective product against grubs of *Melolontha melolontha* based on the new Hungarian nematode collection. The main steps of this new project are:

1. Isolation of new nematode strains from natural habitats of *Melolontha* in Hungary.
2. Screening the nematode collection for effective EPN strains against white grub.
3. Establishing a pilot scale bioreactor and elaborating the technology of industrial scale fermentation of selected EPN strains.
4. Developing application techniques of EPN in the horticultural practice.

Key words: biological control, entomopathogenic nematodes, european cockchafer, *Melolontha melolontha*

Introduction

The European or common cockchafer - *Meleolontha melolontha* (L.) is the most serious insect pest in Hungary, and locally or temporally in other Central European countries. The adults feed on blossoms and young leaves of fruit trees and other deciduous forest and ornamental trees, while the larvae (grubs) cause extensive and lethal damage on the roots of especially young trees. Chemical control of soil-dwelling larvae of cockchafer is not allowed in integrated fruit production (IFP – the most widespread environmentally sound production system in Hungary) and mechanical control is not possible in perennial crops. The growers have therefore no other option to control scarabeid larvae just biological control. The only available product effective against grubs of *Melolontha* is based on the entomopathogenic fungi, *Beauveria brongniartii* and it is registered in some countries (Austria, Italy, Switzerland but not in Hungary) in different product names. Application possibilities of *Beauveria* products are restricted under the Hungarian conditions, because the soil temperature is frequently higher (especially in young orchards) during summer than 27°C, the upper threshold of growth of *Beauveria*. High temperature is lethal to spores, so hyphal network, necessary to effective control, can not develop (Kessler et al., 2003). Other potential biological control agents are entomopathogenic nematodes (EPNs), an efficient pathogens over 200 insect hosts (Shapiro-Ilan *et al* 2002). Great advantage of EPNs is the fast infection process: infective juveniles (IJs) of EPNs generally enter insect host within one or two days after inoculation and kill the insect larva in 24-36 hours, so only some days with favourable weather conditions could be enough to effective control of pests.

There are five EPN manufacturers in Europe (Kaya et al., 2005), and four of them produce EPNs (different strains of *Heterorhabditis bacteriophora* or *H. megidis*) effective against some important scarab larvae (e.g. *Phyllopertha horticola*), but there is not any suitable for controlling grubs of *Melolontha melolontha* and *M. hippocastani*.

The aim of this project is to elaborate an effective EPN biocontrol product against grubs of *Melolontha melolontha*. Preliminary results of this ongoing project are shown in this present paper.

Material and methods

EPN strains

The EPN strains used to these studies originated from the EPN collection of our institute (Tóth, in press). All the strains isolated in 2003 were used in this work, tests with further EPNs are in progress.

Pathogenecity tests

Pathogenecity of EPN strains to grubs of cockchafer were tested by two different methods. Screening all the strains to select virulent EPNs was carried out in petri dishes. Field collected third instar larvae were washed by tap water, than were placed on a filter paper disks in petri dishes separately. Filter papers were wetted with 1 ml of sterile tap water containing 1000 IJs. Five grubs per combination were used to all the EPN strains. Mortality was recorded after 7 and 14 days. Strains, could kill 4 or 5 grubs, were used to further tests. Washed larvae were put separately into plastic vials containing 8 grams of sterile sandy soil wetted to 50% of field water holding capacity, and infected with 1000 IJs/gram soils of selected strains. Vials were kept at 25°C, 10 grubs per combination were used to each strains. The test with the most effective strain was carried out at different temperatures, and with different doses, as well.

Results

After screening of isolates 5 EPN strains were chosen for further experiments, but only one strain could reach considerable mortality in sterile soil (data not shown). This was the *Heterorhabditis downesi* strain '267'. Dose effect of this strain is shown on Fig. 1. At high dose 90% mortality could be reached, and 100 IJs/gram of soil killed half of the grubs. 20°C proved to be the optimal temperature for infection (Fig. 2), but relatively high mortality was recorded at 15°C (at 10°C IJs are inactive).

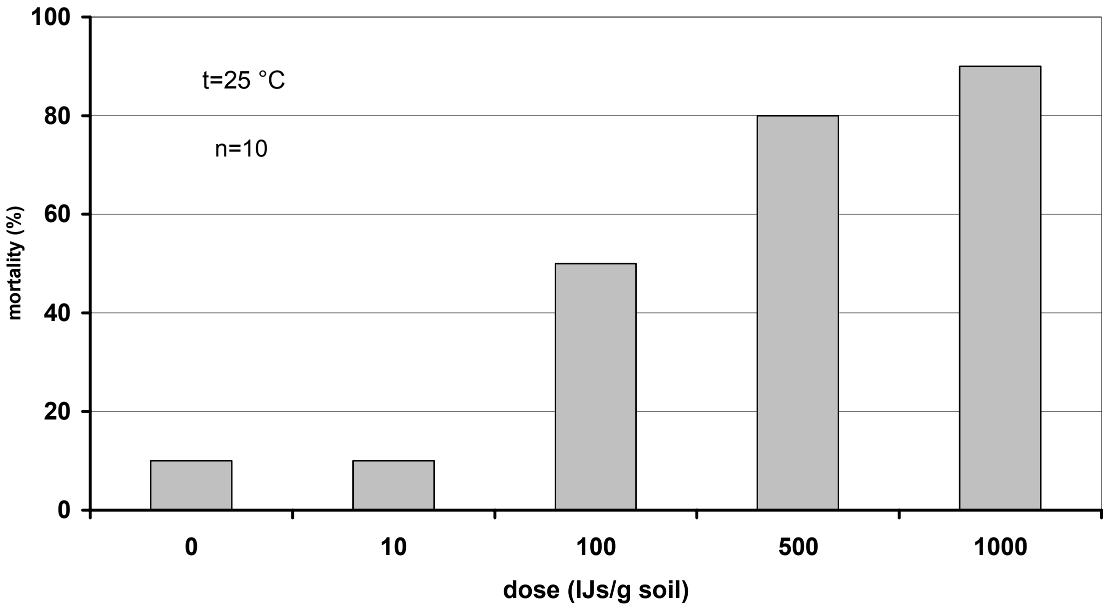

Fig. 1: Effectivity of *Heterorhabditis downesi* '267' in different doses against grubs of *Melolontha melolontha.*

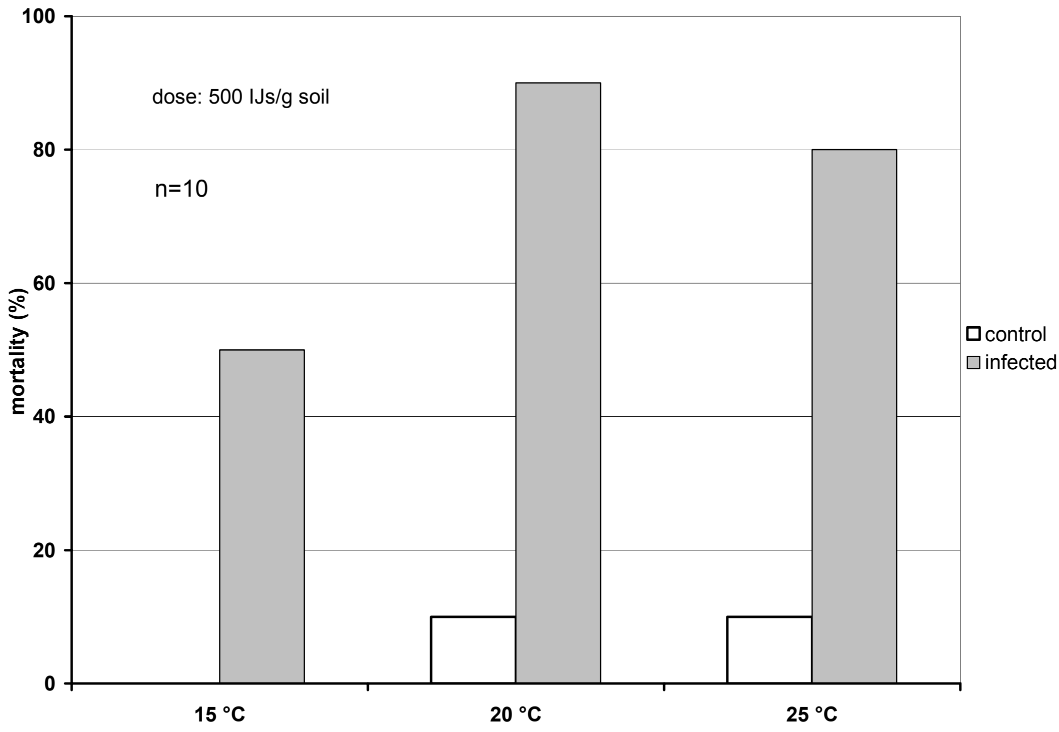

Fig. 2: Effectivity of *Heterorhabditis downesi* '267' against grubs of *Melolontha melolontha* at different temperature.

Discussion

EPNs are applied as effective biological control agents of some scarab larvae, for example *Popillia japonica* and *Phyllopertha horticola* (Kaya *et al* 2005). However, commercially available nematodes failed to control the important insect pest, *Melolontha melolontha* (Peters and Galarza, 2002). In laboratory studies, the most promising nematode against cockchafer was *Steinernema glaseri* (Peters, 2000), however since this species originates from the USA its use in Europe is restricted. Different strains of two European *Heterorhabditis* species (*H. bacteriophora* and *H. megidis*) were equally unefficient against second and third instar larvae of cockchafer (Berner and Schnetter 2001). After screening of the strains collected in 2003 the *Heterorhabditis downesi* strain '267' proved to be effective against European cockchafer, so our survey of Hungarian EPN fauna resulted at least one potential biocontrol agent. The temperature optimum of this strain is relatively low, and this phenomenon makes the application in spring or in autumn possible, but can be disadvantageous in warm summer. Fortunately, the infection process is fast, majority of the infected grubs were killed within 4-6 days, so short period with favourable weather conditions could be enough to apply the nematodes.

Great amount of nematodes is needed to confirm our laboratory data in the field. We started to elaborate the in vitro liquid mass production technique of the selected strain. Field tests are intended to make next year.

Acknowledgement

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Oral presentation

Protection of Norway spruce stand edges against bark beetle attack in windfall areas

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Abstract

After the windfalls that affected the forests from Suceava district in March 2002, long forest edges appeared vulnerable to the attack of spruce bark beetle populations, especially *Ips typographus* L.. The previous studies began with the idea that the vegetation state plays an important role in establishing the resistance of the trees to bark beetle attacks, so this study attempted to identify the differences that exist from this point of view between the infested and not infested trees. In order to determine the individual tree status, the annual radial increment analysis has been used. Thus the increment cores have been sampled from the two categories of trees mentioned before, from two experimental plots situated in similar site conditions. The annual radial increments of infested trees have been significantly lower during the last 20 years in both experimental plots. This aspect could have important implications in the determination of the bark beetle attack mechanisms on the gap edges and, in consequence, contributes to establish the optimal reports between the trapping efforts and the historical past of the stand.

Keywords: Norway spruce, *Ips typographus*, bark beetle, stand edge

Introduction

The windfalls: are they accidental, or cyclical phenomena that interfere with forest life?

In Suceava district, North Eastern Romanian region with wide spruce forests, the storms are annually producing damage that exceeds 300 thousand cubic meters of timber on average (Simionescu 2001), the equivalent of a quarter of the allowable annual cut. Sometimes this phenomenon reaches catastrophic proportions, damaging important amounts of wood material over wide areas.

In March 2002, such a storm felled over 4.5 million cubic meters of timber from a total area of 250 thousand hectares in Suceava district. This amount of wood material is almost four times the allowable annual cut.

Due to the great amount of wind-thrown trees and to the unfavourable technical conditions, at the end of 2002 almost 3 million cubic meters of timber remained to be harvested, and at the end of 2003, over 400 thousand cubic meters.

During the first vegetation season after the storm, the trees damaged by the wind were colonized by bark beetle species, most frequently by *Ips typographus.* The broken trees were especially prone to infestation during this period. Wind-thrown trees that kept contact with soil by their roots, as well as a part of the broken ones, situated on shady and humid slopes, remained attractive for bark beetles and were infested for the next two years.

With such favourable breeding material and weather conditions, the bark beetle populations realize outbreaks and standing trees will also be colonized (Christiansen and Bakke 1988). Standing trees from the new storm gap edges were attacked so that in 2003 there were over 220 thousand cubic meters affected. How do bark beetles choose their future hosts? How much does it matter about individual tree-state in the colonization mechanisms?

The aim of this paper is to study the characteristics and vegetation status of the trees from new gap edges, attacked by bark beetles, considering the radial increment as an indicator of trees resistance (knowing that biomass accumulation is lower on weakened trees than resistant ones).

Materials and methods

The experimental plots placement

The study developed in two experimental plots situated in spruce stands damaged by wind and bark beetle attacks. This was in accordance with the basic principle of dendrochronology for choosing the samples providing that the selection criteria are determined especially by the goals of the research and aim to maximize the single investigated, and to minimize the others (Popa 2004). The experimental plots were established on the new, unstable stand edges, and in both plots two samples were set: the first that contained standing trees infested by bark beetles, and the second that contained non-infested trees from the close stand nearby (Fig. 1).

Fig. 1: General view of experimental plot Moldovița.

Increment cores were sampled from each tree, avoiding extracting the cores from the same direction, the reaction and the compression wood, and structural or shape defects. The cores were collected from the stems at breast height. It has been checked that for each tree from the first sample to correspond a tree in the second sample with the similar biometric characteristics.

For each sample, and tree from the sample, the dates regarding the general and particular vegetation condition have been registered. The information includes spatial and temporal localization of the sample (name of the sample, collecting time), site conditions (altitude, exposition, topography, slope, soil), dates about the collected cores (the source: dead or alive tree), biometric parameters of the sampled tree (height, diameter, defoliation class, defects).

The sampling, processing and measurement of increment cores

The collecting of the increment cores for measurement of tree ring width was done by a non-destructive method by using a Pressler borer. The cores were transported and preserved in paper tubes for a slow drying. After this, the cores were set on a wooden support by attaching with an adhesive. This mounting allows an efficient mechanical processing and safe storage. The increment cores were polished with abrasive discs, which emphasises the structure of tree rings.

The measurement of the tree ring width was realized by a semi-automatic method based on image scanning and analysis.

Statistical processing

For testing the significance of differences between the average radial increment of each two samples from each experimental plot, Student t-test was applied for the averages of each 10 years interval.

Results and discussion

New stand-edge protection is very difficult because wind-felled trees were not extracted from the gaps before the beetles emerged (Fig. 2). The application of protection measures must be synchronised with the time that the entire damaged timber is harvested and extracted from the forest (Ravn 1984) so we can establish an optimal relationship between the trapping efforts and the past of the stand (Grégoire *et al* 1997).

It is generally known that the majority of the standing trees infested by *Ips typographus* are situated on the storm gap edges where there are a lot of wind felled trees colonized by bark beetles (Butovitsch 1941, Lekander 1972, quoted by Lindelöw and Schroeder 2001). In this case, the occurrence of attacked trees in stand edges can be explained by beetles switching from newly colonized lying trees to standing trees, or high densities of beetles emerging from the wind felled trees in the gaps. It seems that *Ips typographus,* preferring sun-exposed breeding material, occurs in high densities at stand edges during the flight and host-finding period. In this way, the risk of attack on standing trees at gap edges is higher than on trees inside stands (Lindelöw and Schroeder 2001).

The growth–dependent mortality studies assume that the trees become vulnerable to higher mortality rates only after three or more consecutive years of below–threshold diameter growth, and growth rates below a specified threshold will predispose trees to insect attacks (Keane *et al* 2001).

Under epidemic conditions, *Ips typographus* is able to overcome the resistance of apparently healthy trees. A study developed by Bakke (1983) to describe the interaction between host tree and bark beetles under epidemic conditions didn't identify an indicator of tree vitality so this could be used in establishing the differences between the infested trees and the ones that survived the attack. The study developed in an area with a high beetle population and extensive attacks on standing trees caused by the severe drought. It was concluded that the beetle population in the area was so high in relation to the tree resistance, that the defences of practically every tree could be overcome.

Fig. 2: General view of a forest edge severely affected by bark beetles.

In this study the experimental plots were localized in spruce stands from which the wind-felled trees were extracted until the beginning of 2003. In both situations, trees from the edges were protected with chains of pheromone traps baited for *Ips typographus*, in 2003 and also in 2004. To avoid trap-induced infestations of nearby standing trees, the traps maintained the safe distance from the next spruce of 12–15 meters, and from trap to trap of about 25–30 meters. In spite of all these precautions, low attacks on standing trees have occurred in the last two years. Speaking of similar conditions, Niemeyer (1997) emphasised that no bark beetle trapping system is able to reduce the population density of *Ips typographus* over a large area, or for a long time. However, it does lure a sufficient number of the beetles, that are searching for breeding material, away from endangered nearby trees, and collects them in the traps, so that the remaining population of the beetles at the spot is not numerous enough to overcome the resistance of the normal vigorous spruce by mass attack.

Increment core analysis and radial increment dynamic study over a long period of time could indicate if tree status represents a favourable condition for bark beetle attack on edges (Tatry Final Report 2001).

The sampling of increment cores took place in 2004, but this year was excluded from the radial increment analysis because the vegetation season was not finished at that time.

In Moldovița experimental plot, the radial increment dynamic of the infested trees presents an almost continuous decrease. Although these trees had had significant larger increments in the first four decades of the studied interval than the non-infested ones, in the early eighties they began to register lower increments, a tendency that has remained the same until now (Fig. 3). The two categories of studied trees presented similar variations of the radial increment curves in the auxological regress periods due to the climatic conditions: 1946–1949, 1960–1968, the 1980's and the mean yearly values are significantly correlated ($0.852<r<0.917$).

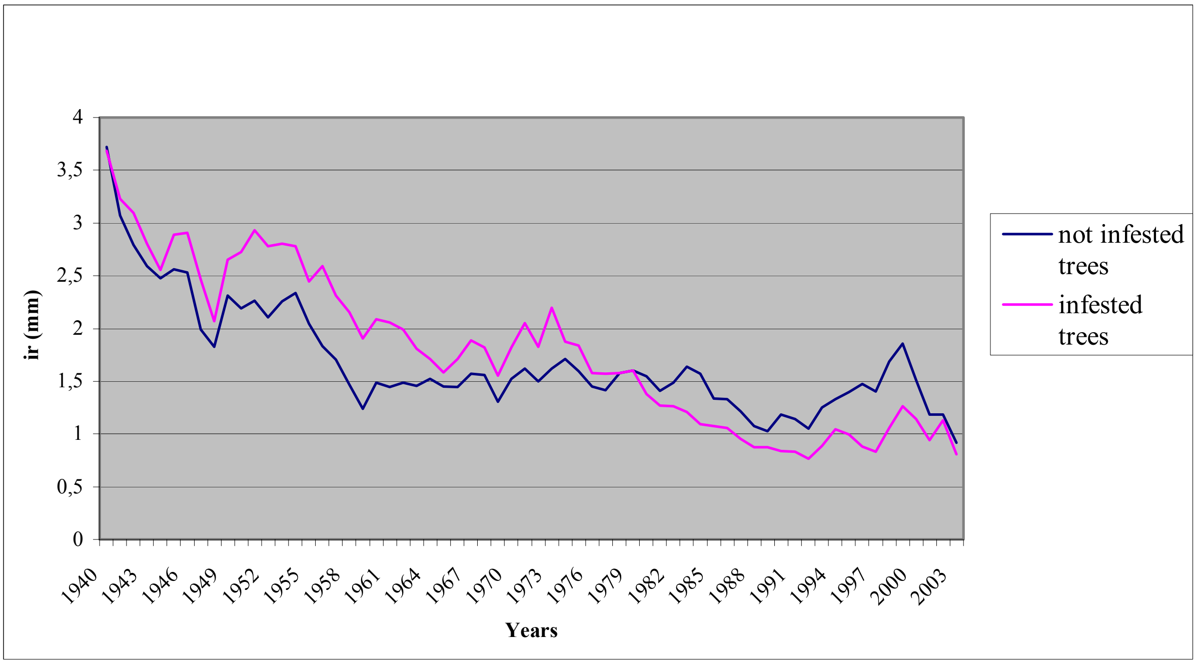

Fig. 3: Mean radial increment dynamic in Moldovita plot.

The differences between the increment of attacked and non-attacked trees are significant, and reflect the decreasing tendency of attacked tree growth in the last two decades (when the attacked trees had an increment almost 25% lower than the non-attacked ones). One exception is 1974–1983 period, when the difference is not significant and when a severe auxological decline of infested trees also starts (Table 1).

Trees:	Mean radial increment in the period:					
	1994–2003	1984–1993	1974–1983	1964–1973	1954–1963	1940–1953
Attacked	1.008	0.924	1.516	1.816	2.213	2.828
Not attacked	1.394	1.217	1.544	1.511	1.649	2.478
Differences between means	0.385^{***}	0.292^{***}	0.028	0.304^{***}	0.564^{***}	0.35^{***}
Significance of differences	Significant	Significant	Not significant	Significant	Significant	Significant

Table 1: Tree ring increment analysis of attacked and non-attacked trees in Moldovița plot.

In Pojorâta experimental plot, the increment variations in the two samples are similar, especially for the last two studied intervals (1974–1983 and 1960–1973), when the averages are strongly correlated (0.725<r<0.869) (Fig. 4).

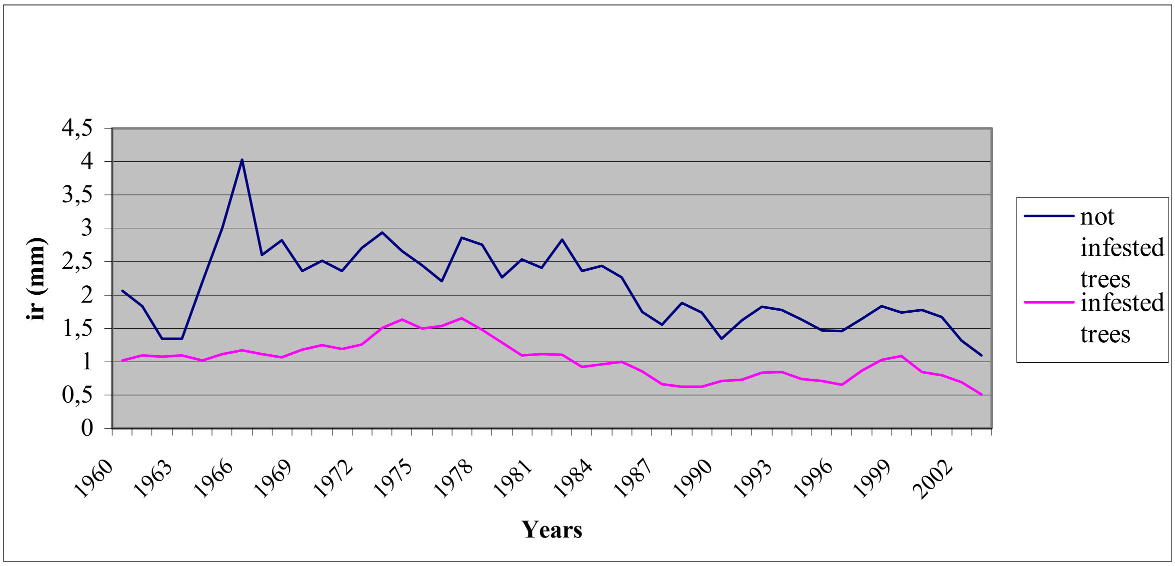

Fig. 4: Mean radial increment dynamic in Pojorata plot.

The differences between the radial increment means of the two samples are significant, the non-attacked trees registering larger increments with almost 50%, during the entire studied period, than the attacked ones (Table 2).

Trees:	Mean radial increment in the period:			
	1994 - 2003	1984 - 1993	1974 - 1983	1960 – 1973
Attacked	0.791	0.783	1.331	1.152
Non-attacked	1.561	1.819	2.532	2.435
Differences between means	0.77***	1.035***	1.2***	1.283***
Significance of differences	Significant	Significant	Significant	Significant

Table 2: Tree ring increment analysis of attacked and not attacked trees in Pojorâta plot.

In this plot, a high incidence of root red rot produced by *Heterobasidion annosum* Fr. (Bref.) fungi was recorded, 70% of trees having different degrees of infection. In these conditions, the studied interval was reduced to period 1960-2003. No correlation could be found between bark beetle infested trees and occurrence of red rot, which supports the theory that *Ips typographus* does not increase to epidemic levels on trees which are weakened by red rot (Bakke 1983).

In spite of the fact that the trees accelerate their radial increment after a sudden sun exposure, during the first 2 – 3 years after the windfalls, those localized on storm gap edges recorded significant decay of growth, caused probably by the physiological stress.

The significant differences recorded between the mean radial increments of the attacked and non-attacked trees are important in order to estimate the defence capacity of trees against the bark beetle infestations. Therefore it is necessary to extend the study in order to check the possibility of the results extrapolation.

Nevertheless, it is important to establish to what extent the diameter class distribution and the crown status may influence the significance of the differences recorded between radial increments, knowing that the tree resistance at bark beetle attacks is influenced by these parameters (Mihalciuc 1997).

The special importance of the weather conditions on bark beetle population development during the first years after the wind felling must also be considered, knowing that the warm and droughty summers create favourable conditions for concentrating in masses and establishing successful sister broods (Bakke 1983). Nevertheless, the rainy summer of 2004 had a negative influence on *Ips typographus* populations and could contribute to an improvement of trees resistance to biotic damage.

Conclusions

- The storm gap edges protection raises important issues due to the trees vulnerability to bark beetle attacks.
- The trees infested by *Ips typographus* populations from both studied stand edges have recorded significantly lower radial increments (with 25–50%) than the non -infested ones during the last 20 years.
- Significant differences between the two categories could indicate the variable defence capacity of trees against the bark beetle attacks.
- It is important to establish to what extent other parameters like diameter class distribution and crown status may influence the significance of the differences recorded between radial increments and therefore it might be relevant to verify the possibility of the results extrapolation.

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Oral presentation

Impact of invasive species in North American Forests

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Abstract

Nonnative invasive species have periodically devastated forested ecosystems in the United States, and the magnitude of this threat is growing in relation to increased global trade and transportation. Examples of past and recent introductions and their subsequent impacts are provided along with remedial actions that have been taken to date.

Keywords: invasive pests, North American forests

Introduction

Thousands of invasive plants, insects, fish, mollusks, crustaceans, pathogens, mammals, birds, reptiles, and amphibians have infested millions of hectares of land and water across the United States, causing massive disruption to ecosystems, reducing biodiversity, and degrading the health of forests, prairies, wetlands, rivers, and oceans. These nonnative invasive species (NIS), also called exotic, alien, or nonindigenous species, have been characterized as a catastrophic wildfire in slow motion-they have no boundaries and they span landscapes, land ownerships, and jurisdictions.

Global trade and transportation have provided new pathways for NIS; new and modified international trade agreements can compromise the rapid adaption of more effective safeguards that are needed to reduce or prevent new introductions. Unfortunately, regulatory agencies have not had the resources with which to cope with the burgeoning volume of imported goods; consequently, it is estimated that less than 2 percent of goods are inspected properly (Campbell and Schlarbaum 2002). Although some generalizations can be made, we seldom can predict how an NIS will react in a new environment nor its potential impact on affected ecosystems. Once established in new habitats (often without the natural controlling processes extant in their native ecosystems), invasive species can flourish aggressively and if unimpeded can readily out-compete native species.

In the past century, most of the native tree species in eastern U.S. forests have been attacked by an exotic insect, pathogen, or combination of both; some species have been virtually eliminated or reduced to relict species. NIS cause unsustainable social, economic, and ecological impacts:

➢ NIS can be exceptionally damaging in urban environments where ecological systems already are under stress and where they can adversely affect the quality of life. Examples include the disappearance of American elm (*Ulmus americana* L.) caused by Dutch elm disease and the threat to many species of urban trees caused by recent introduction of the emerald ash borer, *Agrilus planipennis* Fairmaire, and Asian longhorned beetle, *Anoplophora glabripennis* Motschulsky.

➢ Estimated economic losses and associated control costs attributed to all invasive species total $138 billion annually. Estimated annual losses caused by invasive weeds alone amount to $13 billion annually (Pimentel *et al* 2000).

➢ Scientists estimate that NIS are the single greatest cause of loss of biodiversity in the United States, and that they contribute to the decline of nearly half of all endangered species. NIS alter communities, nutrient cycling, hydrology, and natural fire regimes.

An example of the broad impact of NIS on ecosystem health concerns the Great Lakes ecosystem. Since the mid 1800's, about 140 plant and animal invaders have become established in the Great Lakes (Detmer 1998), which provide easy manmade access for invaders through canal systems that link the Lakes with both the Atlantic and Mississippi drainages and facilitate worldwide shipping traffic throughout the region. Consequently, several aquatic NIS such as the zebra mussel (*Dreissena* polymorpha), round gobey (*Neogobius* melanostomus), sea lamprey (*Petromyzon marinas*), and rusty crayfish (*Orconectes rusticus*) have been introduced via ballast water from foreign vessels. These invaders have displaced native species, permanently changed habitats, destroyed fisheries, and caused severe economic losses (Detmer 1998).

It has been suggested that NIS have become so widespread that they constitute a significant component of global environmental change in part by causing the extinction of genetically distinct populations or species (Vitousek *et al* 1996). In 1993, a report on harmful nonindigenous species by the U.S. Congress documented the magnitude of the threat and issued a call to action (Office of Technology Assessment 1993). The report proved prophetic: during the past 10 years, several significant exotic pests have been introduced that threaten the nation's forests and tree species. Examples include the Asian gypsy moth (*Lymantria dispar* L.) in Washington, British Columbia, and North Carolina, Asian long-horned beetle in New York, Illinois, New Jersey, and Ontario, sudden oak death (*Phytophthora ramorum* (Pr)) in California, and emerald ash borer in Michigan and Ohio.

In this paper I provide a brief overview of the impact and status of select past and recent introductions of NIS on U.S. forests and highlight remedial actions that have been implemented to date.

Historic examples

The European strain of the gypsy moth, *Lymantria dispar L.,* introduced accidentally into North America in 1869, is considered the most damaging forest defoliator in eastern deciduous forests. Although it is currently distributed in all or parts of 19 states, gypsy moth still is considered by many as "invasive" because it is established only in about one-third of the potentially susceptible forest land in the United States, and because it continues to spread to the south and west. The oaks are preferred *by L. dispar,* though it feeds on more than 200 species of trees. The estimated economic impact of gypsy moth is $30 to $150 million annually depending on the severity and extent of the infestation (Leuschner *et al* 1996). This includes both tangible (control costs, losses related to tourism, recreation property values) and intangible (ecosystem degradation, nuisance, and aesthetic) costs. The current management strategy is to minimize damage where the insect is established, eliminate isolated infestations found beyond the generally infested area, and slow the spread of gypsy moth into currently uninfested states.

White pine blister rust, a canker disease caused by *Cronartium ribicola* J.C. Fisch., was introduced on nursery stock from Asia in 1910. It is the most serious pest of five-needle pines such as western white (*Pinus monticola* Dougl.), limber (*P. flexilis* James), sugar (*P. lambertiana* Dougl.), and whitebark (*P. albicaulis* Engelm.). Stands of these species are important ecological components of many western national parks and forests. For example, whitebark pine seeds are an important food source for the American grizzly bear and other wildlife species, and limber pine grows on sites that are too harsh for other plants and for which there may be no surrogate.

Chestnut blight, caused by *Cryphonectria parasitica (Murrill)* M.E. Barr, apparently was introduced from China on nursery stock from between 1893 to1904. It has caused the demise of American chestnut *Castanea dentata* (Marsh.) Borkh., which accounted for about half of most eastern hardwood forests. *Castenea dentata* was a commercially valuable species that also produced edible nuts that were prized by both humans and many species of wildlife. Although the pathogen was recognized in China as a weak parasite, it spread up to 80 kilometers per year throughout the natural range of chestnut in the United States, and remained highly virulent within its new habitat.

The Dutch elm disease fungus, *Ophiostoma ulmi* Buisman Nannf., was identified on elm (*Ulmus* sp.) in the Netherlands in 1921 and was first detected in Ohio and several other states on the East Coast in the early 1930s. Between 1950 and 1970, the pathogen, which is transmitted by two species of *Scolytus* bark beetles, killed millions of American elms in the eastern United States. The disease kills branches and entire trees within several weeks to years depending on the time of the season in which infection occurs. Many cities and towns that had planted elms-- almost exclusively along streets and parkways-- ignored the preferred concept of diversifying species and lost most of their shade trees to this disease.

The balsam woolly adelgid, *Adelges piceae* Ratzeburg, was introduced into Maine in 1908 and was first detected in the Appalachian Mountains in the 1950s. The adelgid attacks balsam (*Abies balsamea* L.) and Fraser (*A. fraseri* (Pursh) Poir.)firs, and has killed vast stands of the *A. fraseri* at higher elevations of the Great Smoky Mountains National Park. Damage is minimal until trees reach the age of about 30 years. Decline is then rapid and death follows. The normal 150-year lifespan of true firs is 150 years.

The beech bark disease complex on American beech, *Fagus grandifolia* Ehrh., is precipitated by attacks of the exotic beech scale insect, *Cryptococcus fagisuga* Lind., followed by killing attacks by fungi of the genus *Nectria.* The principal fungus, *N. coccinea* var. *faginata* Lohm. and Watson, probably was introduced also, though the native pathogen, *N. galligena* Bres., also attacks and kills trees predisposed by *C. fagisuga* (Houston 1994). The beech scale was introduced into Nova Scotia around 1890 and now is found south through North Carolina and west into Michigan. *Nectria* infections and tree mortality occur 1 to 4 years after buildup of the scale insect on large trees; this is referred to as the “killing front.” In aftermath forests, the causal agents establish on smaller trees originating from root sprouts and cause severe cankering that results in stands of highly deformed trees.

Recent introductions

The hemlock woolly adelgid (HWA), *Adelges tsugae* Annand, apparently was introduced into the western United States from Japan or China in 1910. However, it was first observed in Virginia in the 1950s. Although western species of hemlock apparently are resistant to this pest, eastern species such as *Tsuga canadensis* and *T. caroliniana* are highly susceptible. In Virginia’s Shenandoah National Park, 80 percent of the hemlocks have been killed since the adelgid was first identified there in 1988. Eastern hemlocks are ecologically important as they are specific to riparian habitats where they provide critical habitat for birds and other wildlife species and also shade streams to maintain cool water temperatures required by trout and other aquatic organisms. HWA now is found from New Hampshire to Georgia and west to Tennessee, and occupies about half of the native range of hemlock in the eastern United States.

The Asian longhorned beetle (ALB), *A. glabripennis,* was first detected in New York City in 1996 and then in the Chicago metropolitan area in 1998. Both infestations were traced to infested solid wood packing material (SWPM) from China where it is considered to be a serious pest and is distributed widely. More recently, infestations have been found in Jersey City, NJ (October 2002), Toronto, Canada (September 2003), and in three counties in northern New Jersey (August 2004). ALB is considered a significant threat to the health of North American forests and urban trees because it is known to attack tree species within 19 genera, though species of *Acer*, *Ulmus*, *Salix*, and *Populus* are preferred. Although efforts are underway to eradicate known infestations, it is estimated that eradication could cost about $365 million and take until 2009 to complete. The value of urban trees that are at risk has been estimated at $669 billion. In addition to the thousands of trees that already have been cut and destroyed, state and federal regulatory agencies are treating 160,000 trees with the systemic pesticide Imidacloprid® in 2004 as a preventive measure.

The emerald ash borer (EAB), *A. planipennis*, is native to China, Japan, Korea, and Mongolia and attacks and kills healthy trees of all sizes (5 to 90 cm dbh). It was first identified in Michigan in July 2002 and since has infested species of ash (*Fraxinus*) in Ontario, Canada, and, more recently, in Ohio and Indiana. *Agrilus planipennis* is thought to have been introduced in SWPM and, based on its occurrence in dead trees, probably has been present in Michigan for at least 5 years. Severely attacked trees exhibit crown dieback in the first year and then might die by the end of the growing season in the following year. A pest risk assessment completed by the Canadian Food Inspection Agency has concluded that EAB is a serious pest of potential economic and environmental significance, and poses a risk to both urban and forested areas throughout much of eastern Canada and the United States. States have imposed quarantines on ash nursery stock, lumber and related products, and the movement of ash firewood.

All native species of ash are susceptible. An important component in the forests of the eastern United States and Canada, ash trees were planted extensively in urban areas as a replacement species for American elm, which ironically was decimated by Dutch elm disease, another exotic species. Ash is important for wildlife and its wood is used for flooring, furniture, and numerous other items such as tool handles.

The Asian strain of the gypsy moth (AGM), is considered a serious threat to the forests of North America, even more so than the European strain (EGM) because: (a) AGM females are capable of directed flight (thus enhancing dispersal), and (b) the host range of the AGM is even broader than the European biotype and it is considered a potential threat to the conifer forests of the Pacific Northwest. Also, AGM is thought to be more adaptive, may develop faster, often has a shorter egg diapause requirement, and survives much better on marginal hosts.

AGM was identified in 1991 near the Port of Vancouver, British Columbia, Seattle, WA, and Portland, OR. In each case, the source of introduction was egg masses that had been deposited on grain vessels originating from the Russian Far East. At that time, nine Soviet vessels were banned from Canadian waters until all egg masses and larvae had been removed and the vessels inspected. A multiyear and expensive eradication program was initiated in 1992 to eliminate all suspected infestations.

A second infestation occurred in June 1993 near Wilmington, NC. The source of this introduction was traced to military cargo shipped from bases south of Frankfurt, Germany. Female moths were observed actively flying from the vessel as it prepared to dock. A pheromone trap monitoring system later confirmed that several trapped male moths were of Asian origin. This population was declared as eradicated after 3 years at a cost of about $9 million. AGM has since been detected at Tacoma, WA (1997), Portland, OR (2000), and Long Beach, CA (2003). Consequently, extensive monitoring programs have been implemented both at forested sites adjacent to Russian Far East ports and at ports of entry in North America.

A disease called "sudden oak death," caused by a recently described plant pathogen, *Phytophthora ramorum* (Pr), produces deadly cankers on four native oak species in California forests. Data indicate that nearly all of the state's primary tree species in mixed-evergreen and redwood-tanoak forests, including the coniferous timber species coast redwood (*Sequoia sempervirens*) D. Don) Endl., and Douglas-fir (*Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco), may be hosts for *P. ramorum*. *Phytophthora ramorum* was first discovered in 1995 in central coastal California, where it has killed thousands of oaks. It also has been found in coastal Oregon.

Two types of disease have been distinguished across the range of known hosts: nonlethal foliar and twig infections and lethal branch or stem infections. The foliar infections, common in ornamental shrubs and plants, play an important role in the epidemiology of *P. ramorum* by serving as a source of inoculum (Garbelotto *et al* 2003). Comparison of morphological characters and DNA sequences confirmed that *P. ramorum* is identical to an undescribed species of *Phytophthora* that causes a leaf and stem blight on ornamental rhododendron and viburnum plants in Germany and the Netherlands. This species was described as *P. ramorum* by Werres et al. (2001). An additional 13 species from 10 plant families have been identified as acceptable hosts for *P. ramorum* in California.

The broad host range and clonal reproductive strategy of *P. ramorum* is similar to that of *P. cinnamomi*, which infects more than 2,000 plant species and causes significant ecological damage to forest ecosystems in Europe, Australia, and North America. Its characteristics--broad host range, variability of symptoms and airborne dispersal of propagules--suggest that *P. ramorum* can cause landscape-level changes in California forests. To slow the spread of the disease, emergency quarantines have been imposed by at least 15 states in the United States and several European countries. Despite these efforts, shipments of infected bonsai *Camellia* plants from a nursery in California resulted in the establishment of *P. ramorum* on plants in 108 nurseries in13 states and British Columbia. All of the infected plants have been destroyed.

Of greatest concern is the risk of *P. ramorum* to the massive oak resource in the eastern United States. Laboratory and greenhouse studies have shown that most if not all eastern species of *Quercus* might be as susceptible to *P. ramorum* as western oak species. Recently, *P. ramorum* infections were found in northern red oak (*Q. rubrum)* and southern red oak (*Q. falcata)* in the Netherlands and in the United Kingdom, and on a mature red oak on Long Island, NY. A risk/hazard map indicates that 13 states are at high risk for the disease, particularly areas in the Southern Appalachians where weather conditions (cool and wet) might be more conducive to infection and transmission of the disease. Species of mountain laurel (*Kalmia*), which are highly susceptible to foliar and twig infections by *P. ramorum*, are abundant native understory shrubs in most oak forests and may serve as a source of inoculum.

Invasive plants

While disturbance is a normal aspect of a functioning ecosystem, excessive disturbance caused by overuse and abuse can result in invasion by a range of nonnative pests, including invasive plants. In forests, invasive plants:

- create monocultures that reduce habitat for native and endangered species
- degrade riparian areas
- create fire hazards
- increase the effects of natural disturbances such as fire, flooding, and drought
- reduce yields in nurseries and young plantations
- inhibit/prevent natural regeneration

Mile-a-minute weed (*Polygonum perfoliatum L.*) is an invasive plant that outcompetes native flora and grows to a length of 7 m. It readily engulfs habitats and structures and can spread over shrubs and understory trees. It was first collected from ship ballast in the 1890s and was first detected in *Rhododendron* nurseries in Pennsylvania in 1946. Since that time it has spread rapidly through states to the north and south of Pennsylvania. This species is a serious threat in forest margins, nurseries, and clearcuts.

Kudzu (*Pueraria montana var lobata* (Willd.) Maesen & S. Almeida)) is a high-climbing perennial vine that was introduced from Japan in 1876 as an ornamental vine and to reduce erosion and improve the soil. It is sometimes called “the vine that ate the South” because it grows as much as 0.3 m per day and covers everything in its path. More than 3 million hectares are infested in the southern United States as impenetrable thickets of kudzu covering vast areas. This plant poses a serious threat to timberlands.

Purple Loosestrife (*Lythrum salicari* L.) is an upright perennial herb that grows to a height of 3 m. Introduced to the United States from Europe in the early 1800s in ship ballast, it was considered a medicinal herb and ornamental plant. The plant now grows wild in 42 of the 50 states and grows best in freshwater marshes and on the margins of streams. This highly competitive plant threatens endangered, sensitive, and declining plant species. Some wetlands may lose 50 to100 percent of native plant biomass; under these conditions, changes in habitat (food and cover) result in a reduction in vertebrate and invertebrate populations.

Melaleuca or paper bark (*Melaleuca quinquenervia* (Cav.) T. Blake, is a tree native to northern Australia and New Guinea that was introduced into south Florida in the early 1900s as a landscape ornamental and to dry up the Everglades. It grows to a height of more than 15 m, is a prolific seed producer, and tolerates fire and flooding. In freshwater wetlands, *Melaleuca* almost displaces native vegetation and degrades habitat for wildlife. It now infests more than 250,000 hectares and is spreading rapidly. It is considered a major threat to the entire Everglades ecosystem.

Remedial actions

In the early 1990s, concerns about the risks associated with wood imports prompted several risk assessments to determine the potential threat of pest introductions on imported logs: larch from Siberia, Monterey pine and Douglas-fir from New Zealand, Monterey pine from Chile, and *Pinus* and *Abies* logs from Mexico. Similar risk assessments have been prepared in cooperation with the European Plant Protection Organization and by other countries such as New Zealand and Australia. These assessments are important for identifying the potential risk of importing logs and lumber with associated indigenous pests and for recommending phytosanitary measures needed to prevent their introduction. These assessments are similar to the pest risk analysis required by the World Trade Agreement on Application of Sanitary and Phytosanitary Measures (MacLeod *et al* 2002).

In 1999, the National Invasive Species Council was established by President Clinton under Executive Order 13112 to formulate a national strategy on invasive species, coordinate activities among Federal Agencies, and develop an Invasive Species Management Plan. Several other significant activities have been initiated in recent years to address the burgeoning threat posed by NIS.

Inspection and Certification. Regulations were passed in December 1998 to amend the importation of logs, lumber, and other unmanufactured wood articles by adding treatment and documentation requirements for SWPM imported from China. This action was needed because 85 to 97 percent of forest insects and disease pathogens that have been introduced into the United States since the 1970s have been transported via SWPM. Although the United States is the largest importer of forest products, it is recognized that less than 3 percent of imported goods are being inspected properly (Campbell and Schlarbaum 2002).

Monitoring Networks. In 1993, International Forest Pest Exclusion Program was initiated by agencies in the United States and Russian Far East to reduce the risk of exporting three serious forest Lymantriid defoliators from that region to other countries where they are not established. The target pests are the Asian gypsy moth, nun moth (*L. monacha* L.), and rosy or pink gypsy moth (*L. mathura* L.). This program was initiated in response to repeated interceptions of *L. dispar* in the western United States and Canada on Russian vessels and the apparent establishment of AGM populations in Vancouver, Portland, and Seattle in 1991.

A monitoring program has been established in forested areas contiguous with eight Russian Far East ports, including the three major ports of Vladivostok, Nahodka, and Vostochny. A variety of techniques is used to track populations of the three forest pests. Pheromone traps, burlap bands, and light traps are deployed to monitor insect densities and development and to document flight periodicity. The goals of the project are to:

(a) better understand the biology and behavior of the three species in the Russian Far East;
(b) produce an annual database that identifies periods of risk for ship traffic within monitored ports;
(c) maintain a database of all ships in ports during high-risk periods (this database is shared with all cooperating countries); and
(d) develop monitoring procedures that reduce costs and improve effectiveness

In 2001, an Exotic Pest Rapid Detection Team was established to develop effective strategies for rapidly detecting and responding to introductions of non native Scolytid bark beetles. The team consisted of specialists from three USDA agencies (FS, ARS, APHIS-PPQ), state departments of agriculture, and universities. Ten species of bark and ambrosia beetles were targeted in the initial year because they had been detected in previous years by APHIS-PPQ at ports of entry in the United States, and exhibited the potential to cause economic impacts and alter coniferous ecosystems. These targeted Scolytids include *Orthotomicus erosus*, *Pityogenes chalcographus*, *Ips sexdentatus*, *Tomicus minor*, *Ips typographus*, *Tomicus piniperda*, *Hylurgops palliatus*, *Trypodendron domesticum*, *Hylurugus ligniperda*, and *Xyleborus spp.*

Funnel traps baited with several standard lures were placed in high-risk sites, including forested areas around port and wood-processing facilities as well as urban forests adjacent to three ports in the northeastern, southern, and western United States. Several of the targeted and nontargeted species of Scolytids were identified from collections at multiple sites. It was concluded that several exotic species are established locally and may have a wider geographic distribution than previously suspected. The pilot project demonstrated the feasibility of implementing a regionally coordinated national survey for the early detection of targeted invasive Scolytids. The program was continued in 2002 and 2003 by expanding the detection survey to other high-risk ports and by initiating more intensive delimitation surveys for select species such as *Xylosandrus multilatus*.

An Exotic Forest Pest Information System for North America was established as a joint project by regulatory agencies and operations and research agencies of Canada, Mexico, and the United States. The goal of this project is to establish a database for forest insects and diseases that are non-indigenous to North America that includes risk assessments and information on the identification and biology of pest species and their management. Detailed information can be obtained at http://www.spfic.fs.fed.us/exfor/

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Oral presentation

Two invading black locust leaf miners, *Parectopa robiniella* and *Phyllonorycter robiniella* and their native parasitoid assemblages in Hungary

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Abstracts

Parasitoid communities of two invasive leaf-miners, *Phyllonorycter robiniella* and *Parectopa robiniella* (Lepidoptera: Gracillariidae) were under investigation during 2001-2003 in Hungary. Nineteen species of parasitoids were recorded from *Phyllonorycter robiniella* and twelve species – from *Parectopa robiniella*. Parasitoid species diversity in *Phyllonorycter* and *Parectopa*, the rate of parasitism and species composition prolong the season, leaf-miner life cycles and the mine structure versus parasitoid diversity, the parasitism rate and the population density of leaf-miners are discussed.

Keywords: *Parectopa robiniella*, *Phyllonorycter robiniella*, leaf miners, parasitoids, black locust

Introduction

Biological invasions are global phenomena that threaten biodiversity and the rate of invasions resulting from anthropogenic activities is permanently increasing (Prenter *et al.* 2004). Recently a number of new insect pests were introduced to Europe and during 2-3 decades they became widespread throughout the continent and particularly in Hungary. Between them two leaf-miners, *Parectopa robiniella* Clemens, 1859 and *Phyllonorycter robiniella* Clemens, 1859 (Lepidoptera: Gracillariidae), natives of North America, were established on the continent on the black locust (*Robinia pseudoacacia* L.)

Parectopa robiniella was recorded for the first time in Italy, near Milano in 1970 (Vidano 1970) and in 1983 was found in south-western Hungary (Bakó and Seprős 1987, Seprős 1988).

Currently distributed in Italy, Slovenia, Croatia, Austria, Slovakia, Hungary and Romania (Tóth 2002). It is a bivoltine species, with only one larva per mine, pupation in the litter. Developing and growing of mines starting at least 2-3 weeks later than in *Phyllonorycter robiniella*.

Phyllonorycter robiniella was recorded for the first time in Switzerland, near Basel in 1983 (Whitebread 1990) and in 1996 was found in west and south-west Hungary (Szabóky and Csóka 1997, Szabóky and Leskó 1997a, 1997b, 1999, Tóth 1997). Currently distributed in Swiss, Italy, Austria, Slovakia, Hungary, Slovenia and Croatia (Whitebread 1990, Tóth 2002, Sefrova 2002). Three generations per year, one to 5-8 larvae per mine; pupation in the mine.

The black locust (*Robinia pseudoacacia* L.) is a very important industrial tree species in Hungary which was introduced to Hungary in the XVIII century. Currently about 400,000 ha of black locust forests can be find in Hungary what is more than 22% of the total forested area. In 2002 in Hungary 6,200 ha of *Robinia* plantations were damaged by *Parectopa robiniella* and 11,000 – by *Phylonorycter robiniella* (Tóth 2002).

Parasitoids have a larger impact on community interactions during animal invasions than was previously acknowledged (e.g. Mouritsen and Poulin 2002, Prenter *et al* 2004). Invaders lose their parasitoids in the process of invasion. It is leading to higher demographic success of invaders, which might give them a competitive advantage over natives (Aliabadi and Juliano 2002). However, parasitoids of native counterparts are influence the population dynamic and success of the invaders, new host-parasitoid associations can be easily established. Therefore, investigation of the likelihood of such transmission between natives and invaders is crucial to our understanding of the invasion success. Such invasions provide natural experiments that can be used to test hypotheses about how parasitoid communities are structures (Godfray *et a*l 1995). The colonization of novel herbivores by native parasitoids is of applied interest also, because they can play an important role in the population density regulation of newly introduced pest. An invading phytophagous insect is likely to have less parasitoid species because it will generally lack native specialist parasitoids and more generalist species may not search the new ecological niche occupied by the invader (Cornell and Hawkins 1993, Strong, Lawton and Southwood 1984). Studies on parasitoid communities of two invaders, *Parectopa robiniella* and *Phyllonorycter robiniella* in Europe were undertaken by some researchers (Vidano 1983, Gibogini *et al* 1994, 1996), however, they were mainly limited to checking what species of parasitoids attacking the invaders and how effective they are in the population density regulation. So, our knowledge of these communities is still very superficial.

We described here the parasitoid community attacking the two invader leaf-miner species in Hungary from data collected in 2001-2003, less than 10 years after the introduction of *Phyllonorycter robiniella* and 20 years since *Parectopa robiniella* was found for the first time in Hungary. These two invaders provide an excellent opportunity to study the insertion of new species into an existing host-parasitoid community, because leaf miners support rich parasitoid communities (Hawkins and Lawton 1987) and parasitoids of *Phyllonorycter* species, especially on woody plants have been intensively studied (Askew and Shaw 1974, 1979a, 1979b, Askew 1980, Shaw and Askew 1976). We tested the following hypothesis: (1) parasitoids attacking the invaders have a wide rather than a narrow host range; (2) the invading leaf-miner species on black locust are attacked by fewer species of parasitoids than endemic species; (3) the parasitoid communities attacking invading species are most similar to those attacking endemic leaf-miners with similar ecology; (4) how the parasitoid communities affect the population dynamic of invaders; (5) what is the difference between the *Phyllonorycter robiniella* and *Parectopa robiniella* parasitoid communities.

Materials and Methods

In 2003 three sampling sites with pure *Robinia* stands were chosen in the western part of Hungary (Győr-Moson-Sopron County): Koroncó - both leaf-miner species were present (sampling - VI.18-IX.25); Csorna – *Parectopa robiniella* was the dominant species, *Phyllonorycter robiniella* was rare (VI.26-IX.25); Lövő – *Phyllonorycter robiniella* dominant, *Parectopa robiniella* -- very rare (VI.26-IX.25).

In 2001-2002 two sampling sites were in Pest County: Gödöllő and Visonta. In both sampling sites *Phyllonorycter robiniella* and *Parectopa robiniella* were present.

All sampling sites were located in the neighbourhood of oak forest where from parasitoids' transmission from native leaf-miner hosts were expected. Samples were taken ones per 2 weeks.

Leafminers' density estimation. From each sampling site twenty 60cm long braches were randomly cutted and the first top 15 leaflets were checked on each branch: number of leaflet per leaves and number of mines per each leaflet were counted. For *Phyllonorycter robiniella* the number of larvae per mine was also taken into account.

*Parasitoid species richness and abundancy***.** 300 mines of each leaf-miner species were chosen randomly from 10 trees in different canopy levels and were carried to the laboratory for further individual rearing. In the laboratory, under controlled 18-20°C, and 70-80% relative humidity, each collected leaf with mine(s) was put into a separate vial. Checking of parasitoid and moth emerging was done ones per week. Collected mines were kept in laboratory for four weeks, afterwards they were dissected and the mortality factors and the parasitization level were checked.

Statistic analysis was carried out in R using the standard, mva and vegan packages.

Results and discussion

Phyllonorycter robiniella parasitoids

From all sampling sites 19 parasitoid species were reared: *Pholetesor nanus* (Braconidae), *Holcothorax testaceipes* (Encyrtidae), *Necremnus hungaricus* Erdös, *Pnigalio pectinicornis* L., *P. soemius* Walker, *Sympiesis acalle* Walker, *S. gordius* Walker, *S. sericeicornis* Nees, *Cirrospilus lyncus* Walker, *C. talitzkii* Boucek, *C. viticola* Rondani, *Pediobius saulius* Walker, *Closterocerus trifasciatus* Westwood, *Chrysocharis pentheus* Walker, *Neochrysocharis formosa* Westwood, *Achysocharoides cilla* Walker, *Minotetrastichus frontalis* (Nees), *Baryscapus nigroviolaceus* (Nees) (Eulophidae), *Eupelmus urozonus* Dalman (Eupelmidae). In Koroncó from 2,979 collected larvae/pupae 867 were parasitized. The rate of parasitization was lower in the 1st half of June - 38% and than prolong the vegetative season increased to 85% till mid August. In Lövő from 2260 collected larvae/pupae 715 were parasitized, respectively 42% in June and up to 84% in August. Later on, in autumn, the parasitization rate slightly decreased (Figs 1-2).

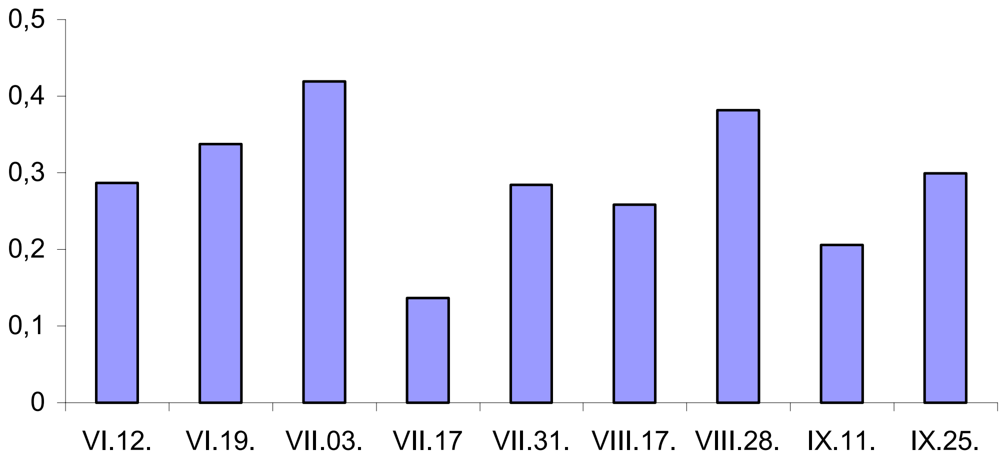

Fig. 1: *Phyllonorycter robiniella* parasitization rate prolong the season Koroncó(2003).

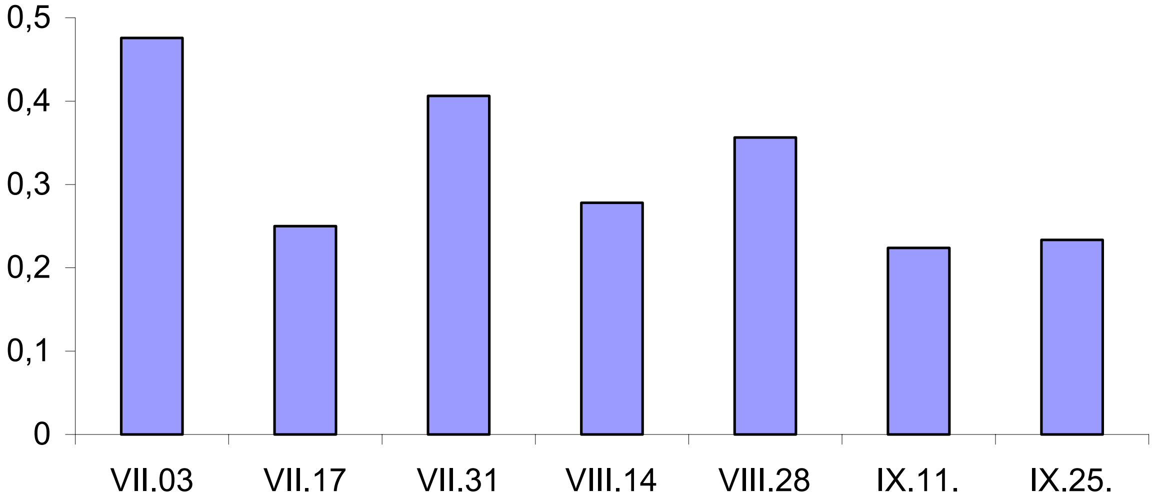

Fig. 2: *Phyllonorycter robiniella* parasitization rate prolong the season Lövő (2003).

Prolong the season on both sampling sites *Ahrysocharoides cilla* was the dominant parasitoid species, in smaller number *Holcothorax testaceipes* and *Minotetrastichus frontalis* were present, while *Pholetesor nanus*, *Cirrospilus lyncus*, *Baryscapus nigroviolaceus* and some others were relatively rare (Fig 3-4). *Pediobius saulius* was observed mainly as a secondary parasitoid in *P. nanus* and *A. cilla*.

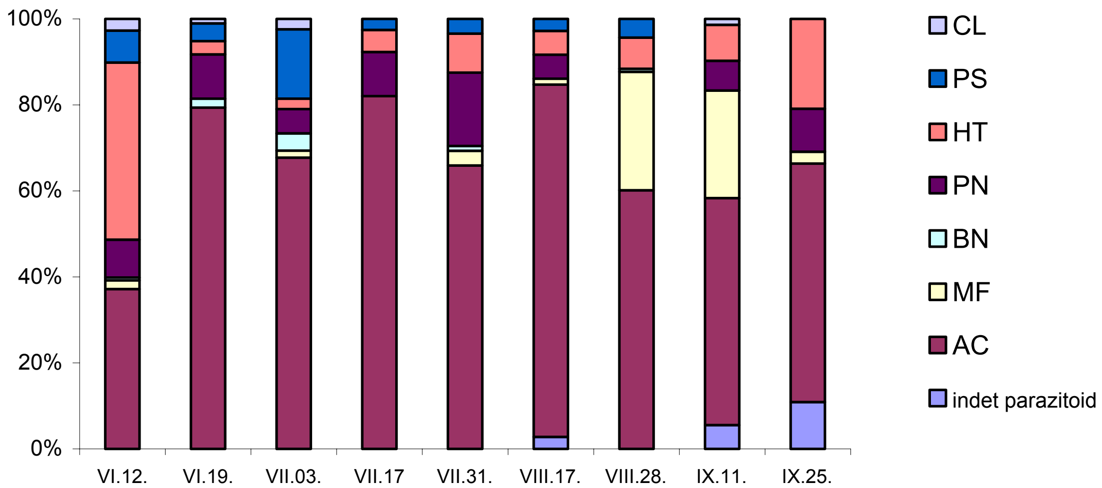

Fig. 3: Parasitoid species diversity of *Phyllonorycter robiniella* (%) (Koroncó, 2003).
(AC=*Achrysocharoides cilla*, BN=*Baryscapus nigroviolaceus*, PS=*Pediobius saulius*, HT=*Holcothorax testaceipes*, PN=*Pholetesor nanus*, MF=*Minotetrastichus frontalis*, CL=*Cirrospilus lyncus*)

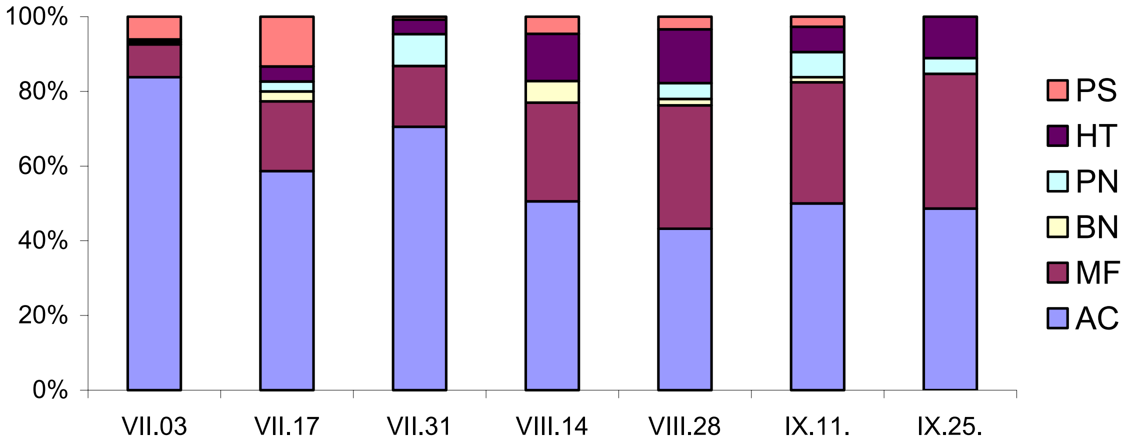

Fig. 4: Parasitoid species diversity of *Phyllonorycter robiniella* (%) (Lövő, 2003).
(AC=*Achrysocharoides cilla*, BN=*Baryscapus nigroviolaceus*, PS=*Pediobius saulius*, HT=*Holcothorax testaceipes*, PN=*Pholetesor nanus*, MF=*Minotetrastichus frontalis*)

In both sampling sites, Koroncó and Lövő, in the parasitoid complexes of *Ph. robiniella* a few main parasitoid species were more abundant than all other species (Fig. 5). In sampling sites, where *Phyllonorycter robiniella* was present in large numbers, species diversity had been found very similar (Fig. 6).

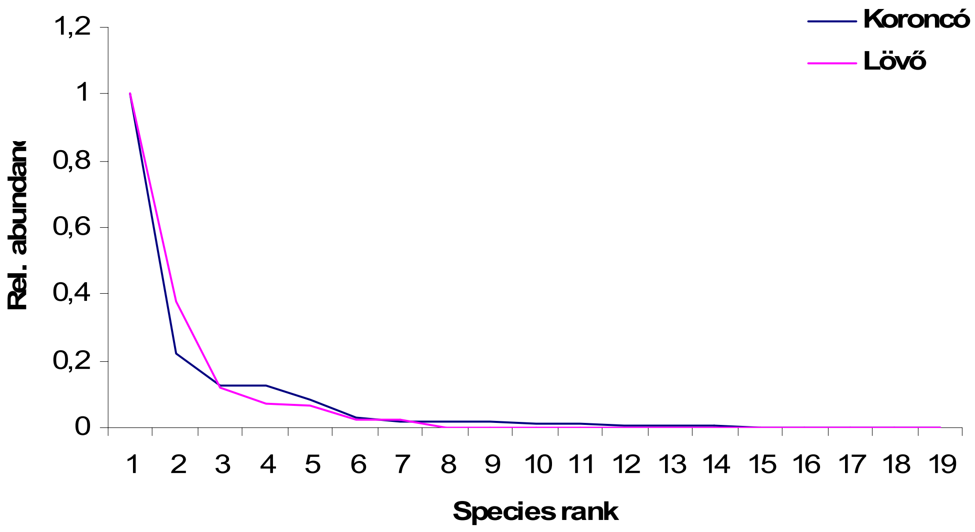

Fig. 5: Dominance-diversity curves of the *Phyllonorycter robiniella* parasitoids.

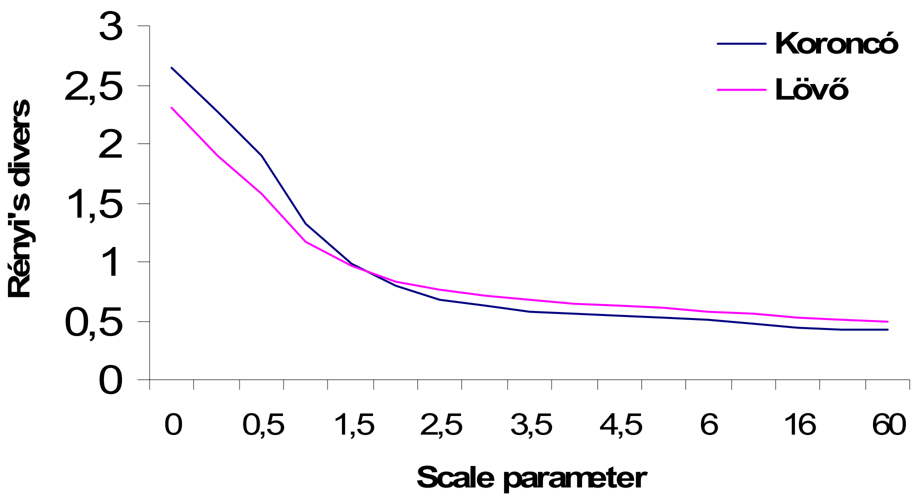

Fig. 6: Comparison of the *Phyllonorycter robiniella* parasitoid diversity between places (Rényi's diversity ordering).

Also the hierarchical cluster analysis based on the parasitoid species composition showed no clear tendencies in the subsequent sampling date and sites (Koroncó and Lövő), irrespectively of whether parasitoid presence-absence (Fig. 7.) or relative abundance (Fig. 8.) were considered.

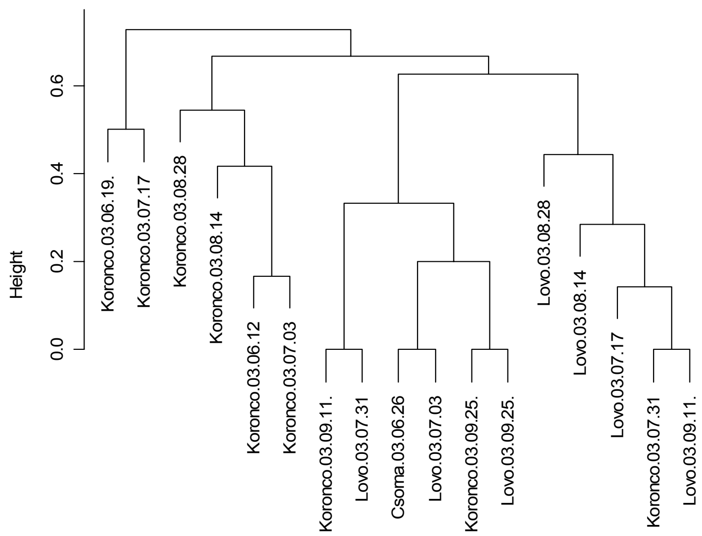

Fig. 7: Classification of the sampling sites and dates by parasitoid presence (Koroncó, Lövő and Csorna 2003; binary distance measure is used).

In two other sampling sites, Gödöllő and Visonta (Pest County, 2001-2002) the main dominant parasitoid species were *Pholetosor nanus, Pediobius saulius* and *Sympiesis sericeicornis* (Table 1). The role of *Pholetosor nanus* in the parasitoid communities in both sites was much higher than that of all other parasitoid species all together (8.9 and 12.6% respectively in Gödöllő and Visonta). Prolong the season the parasitization rate of *Ph. robiniella* in both sites also changed – it was much higher in the 1st generation and than essentially decreased till the 3rd generation. Such decreasing in the parasitization rate was absent or very small in Koroncó and Lövő during 2003.

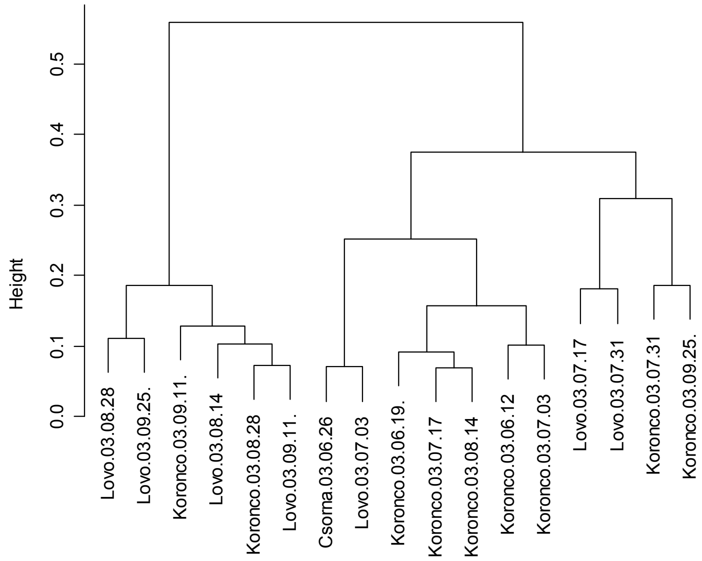

Fig. 8**:** Classification of the sampling sites and dates by parasitoid proportions (Koroncó, Lövő and Csorna 2003). Euclidean distance is used (proportion of parasitism by different parasitoid in a given sampling unit).

Year/Generation	**Gödöllő**						**Visonta**					
	2001			**2002**			**2001**			**2002**		
Parasitoid	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Pholetesor nanus	8,9	7,5	0,4	7,5	4,5	0,4	12,6	8,5	0,4	12,6	21,4	0,2
Pediobius saulius	2,0	2,2	0,4	7,3	0,1	0,8	0,7	2,2	0,2	11,5	4,1	0
Sympiesis sericeicornis	0,2	1,1	0	2,5	0	0,1	1,2	1,7	0	3,6	0,5	0
Other species	2,9	3,1	0,1	3,3	0,1	0,4	2,0	2,1	0,1	6,6	2,3	0,5
Total	**14,0**	**13,9**	**0,9**	**20,6**	**4,7**	**1,7**	**16,5**	**14,5**	**0,7**	**34,3**	**28,3**	**0,7**

Table 1: Parasitization rate of *Phyllonorycter robiniella* (Gödöllő and Visonta, 2001-2002)

It is also interesting, that on these sampling sites, *Pediobius saulius* appeared mainly as a primary parasitoid in larvae and pupae of *Ph. robiniella* and not as a secondary parasitoid like in the three previous sampling sites in Győr-Moson-Sopron County, in western Hungary.

Parectopa robiniella parasitoids

From all three sampling sites in western Hungary (Koroncó, Csorna & Lövő, 2003) 12 parasitoid species were reared: *Pholetesor nanus, Holcothorax testaceipes*, *Pnigalio soemius,* *Sympiesis acalle*, *S. sericeicornis*, *Cirrospilus viticola*, *Pediobius saulius*, *Closterocerus trifasciatus*, *Neochrysocharis formosa, Achysocharoides cilla, Minotetrastichus frontalis*, *Eupelmus urozonus.* In Koroncó from 2181 collected larvae/pupae 88 were parasitized. The rate of parasitization is much lower than in *Phyllonorycter robiniella* – maximum 4.03%. In Csorna from 2,677 collected larvae/pupae 159 were parasitized, maximum rate of parasitism was 5.9% The parasitization rate of *Parectopa robiniella* appeared to be increased prolong the season and the parasitization of the second generation of the leaf-miner was higher than in the 1st generation (Fig. 9-10).

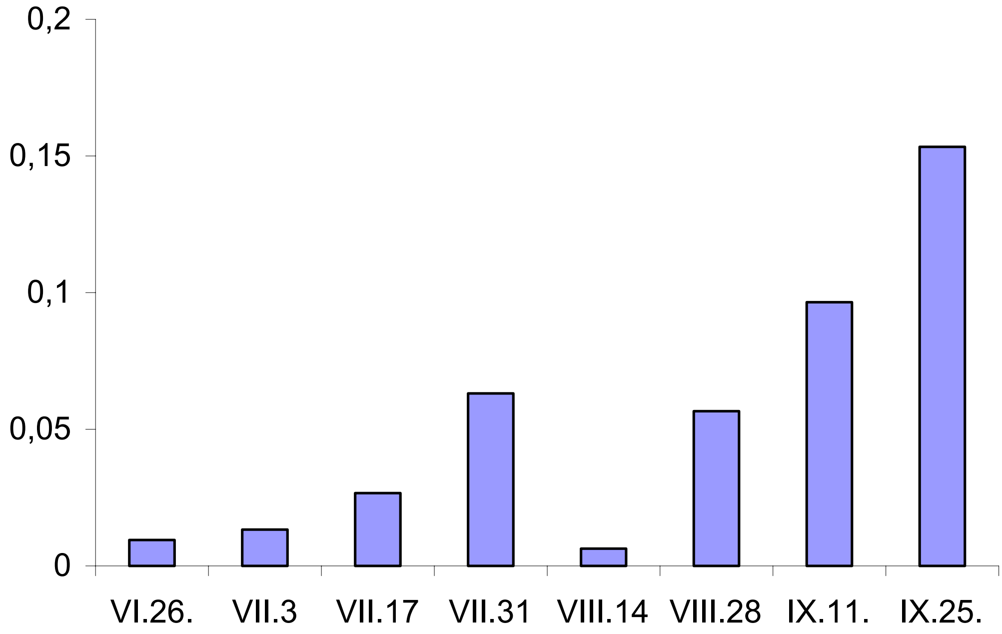

Fig. 9: *Parectopa robiniella* parasitization rate prolong the season (Csorna, 2003).

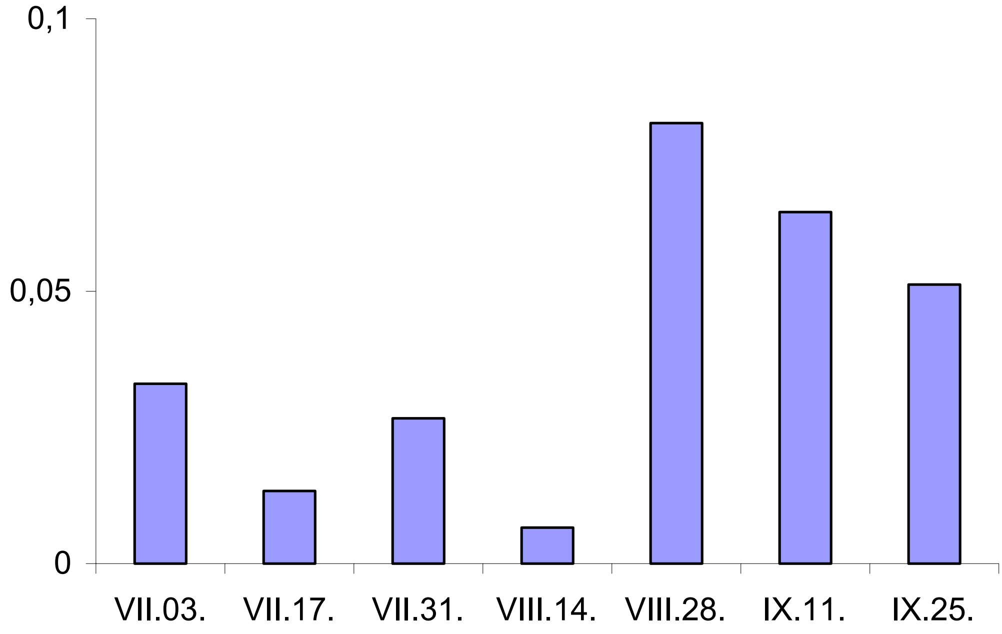

Fig. 10: *Parectopa robiniella* parasitization rate prolong the season (Koroncó, 2003).

Prolong the season on both sampling sites *Ahrysocharoides cilla* was the dominant parasitoid species, in smaller number *Minotetrastichus frontalis, Pnigalio soemius, Sympiesis acalle*, *S: sericeicornis, Cirrospilus viticola, Closterocerus trifasciatus* and *Neochrysocharis formosa* were present (Fig. 11-12). *Pediobius saulius* appeared to be mainly secondary parasitoid in *Ahrysocharoides cilla* and other primary parasitoids. After dissection of mines we found many parasitoid larvae which we were unable to identify.

In Gödöllő and Visonta (Pest County) *Parectopa robiniella* was also presented in a large number and samples for laboratory rearings were taken. However, the level of parasitization was very low, below 1.0% and, thus we omitted this data here. However, this low parasitization rate, probably is not adequate to the real situation. The laboratory rearing of *Parectopa robiniella* was carried out in a wrong way, under insufficient relative humidity and as the result, the majority of *Parectopa* larvae dried out before the parasitoids were able to develop and emerge. Dissections approved it.

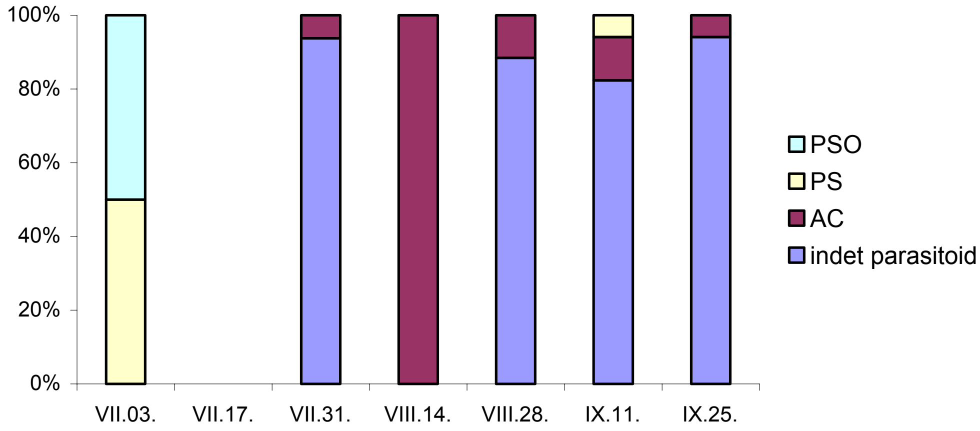

Fig. 11: Parasitoid species diversity of *Parectopa robiniella* (%) (Koroncó, 2003).
(PS=*Pediobius saulius*, PSO=*Pnigalio soemius*, AC=*Achrysocharoides cilla*)

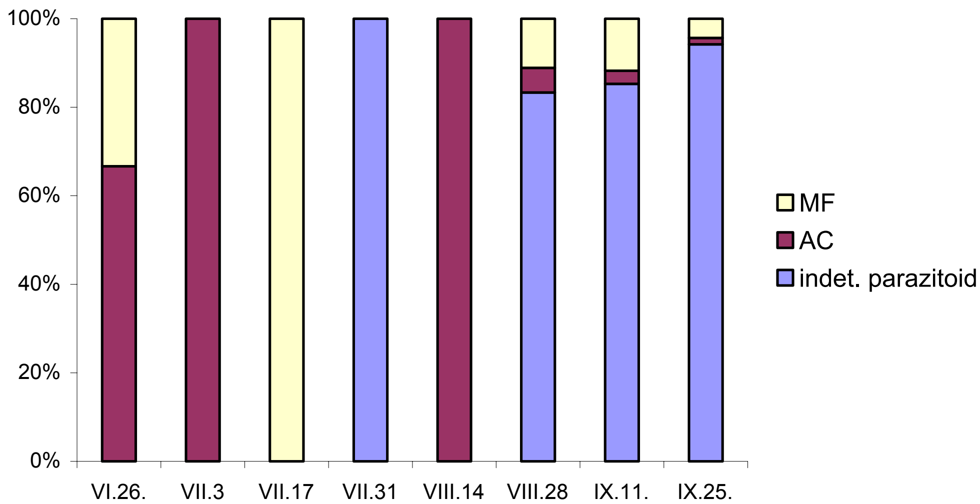

Fig. 12: Parasitoid species diversity of *Parectopa robiniella* (%) (Csorna, 2003).
(MF=*Minotetrastichus frontalis*, AC=*Achrysocharoides cilla*)

Discussion

Our preliminary data showed that polyphagous parasitoid species can easily shift onto newly introduced invader hosts, in our case - *Phyllonorycter robiniella* and *Parectopa robiniella*. All the parasitoid species we reared from these two leaf-miners are generalists - common and abundant species on different lepidopteran leaf-miners associated with oaks and other woody plants (Askew and Shaw 1979a, b). All sampling sites were located in the neighbourhood of oak stands, where *Phyllonorycter* and *Tischeria* leaf-miner species (about 12 species) were very common and abundant during the sampling periods. Parasitoid species composition of two black locust leaf-miners is identical with those we reared simultaneously from oak leaf-mines. The only difference is that the species richness of parasitoids on oak leaf-miners appeared to be slightly higher than that we got for the two black locust leaf-miners. Probably some parasitoids are much higher specialized onto oak leaf-miners and thus a host-shift on new host does not occurred yet.

Parasitoid species diversity in Phyllonorycter and Parectopa.

In both, *Phyllonorycter robiniella* and *Parectopa robiniella* the same dominant species of parasitoids were reared. In *Ph. robiniella* the parasitoid species richness was slightly higher than in *Parectopa robiniella* (19 and 12 species respectively) although differences might be overestimated owing the different sample sizes. It is too early to make any conclusions about it, however, some possible interpretation we shall give below.

The dominance of a parasitoid species seems to be more pronounced in *Phyllonorycter* (Fig. 13), however, the species richness and species composition is very similar. The diversity of the two communities is non-comparable (Fig. 14). Nevertheless, it suggests the same tendencies. *Parectopa* has higher parasitoid diversity in case of the rare species.

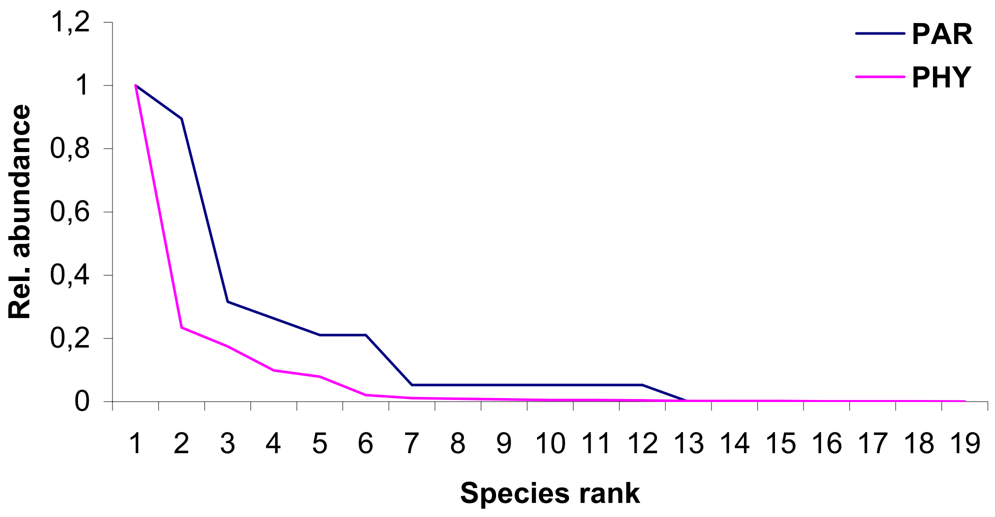

Fig. 13: Dominance-diversity curves in different hosts

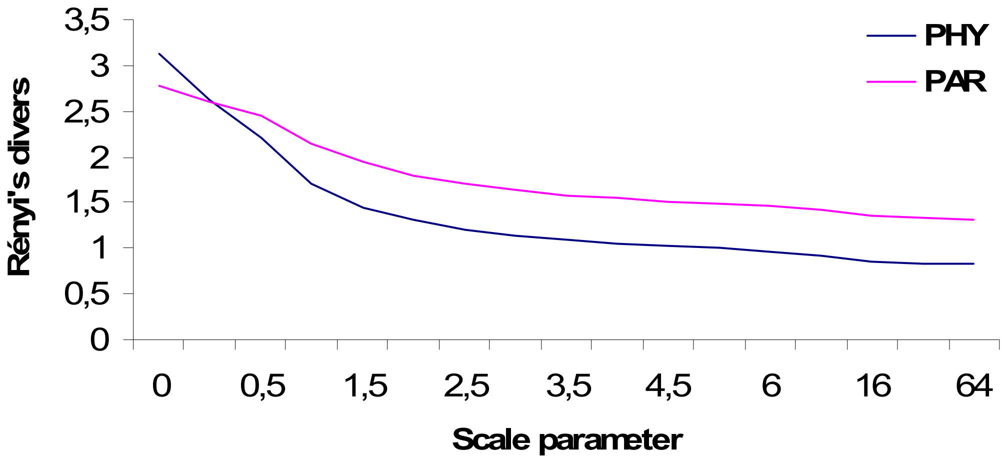

Fig. 14: Rényi's diversity ordering (right diagram) in different hosts

Life cycle and the mine structure versus parasitoid diversity

Phyllonorycter robiniella has 3 generations per year and the larva pupate in the mine, while *Parectopa robiniella* has only 2 generations and the larva when finished the feeding, leaves the mine and pupates in the litter. Furthermore, *Parectopa* starting to develop 2-3 weeks later than *Phyllonorycter*. Majority of parasitoids probably are more adopt to *Phyllonorycter* species than to those of *Parectopa* and, thus the emerging of subsequent generations of parasitoids are synchronized with the life-cycles of *Phyllonorycter* species rather than with *Parectopa*. The mine structure and its location on the leaf are quite different in *Phyllonorycter* and *Parectopa* (Šefrova 2002, Tóth 2002). In the Hungarian fauna 18 native species of *Phyllonorycter* and only 4 *Parectopa* species (on *Vicia, Lathyrus, Pulmonaria, Laburnum*, etc.) are known (Szőcs 1977). Parasitoids trophically associated with *Parectopa* species are more specific than those on *Phyllonorycter*, thus the formation of the parasitoid complexes and host-shifting onto invasive *Parectopa* species supposedly will be a much slower process than in the case of *Phyllonorycter robiniella*. More of that, the pupation in the litter in *Parectopa* also increases the survivorship of this species in comparison to *Phyllonorycter*, pupae of which also exposed to parasitoids, which probably never or very rarely leave the tree canopy and, thus less affect the *Parectopa* pupae. These biological peculiarities somehow explain the much lower parasitization rate and less diverse parasitoid communities of *Parectopa* in comparison to *Phyllonorycter*.

Rate of parasitism and species composition prolong the season

The rate of parasitism in *Phyllonorycter robiniella* in different sampling sites appeared to be different. It was nearly the same prolong the season, across subsequent 1st to 3rd generations in the western Hungary (Koroncó and Lövő in 2003), but was essentially higher in the 1st generations in Gödöllő and Visonta (2001-2002). In *Parectopa robiniella* the parasitization level increasing prolong the season and higher in the 2nd generation (Koroncó and Csorna in 2003). Further sampling is necessary for appropriate understanding of this phenomenon.

In different sampling sites and years, the dominant parasitoid species were different in the same leaf-miner species and across the two species. In *Phyllonorycter robiniella* mines *Achrysocharoides cilla* appeared to be the dominant parasitoid species in Koroncó and Lövő (2003), while in Gödöllő and Visonta (2001-2002) *Pholetesor nanus* was the dominant one in the 1st generation. Later, the role of some other parasitoid species also increased (Figs 3-4). In *Parectopa* (Koroncó in 2003) *Pediobius saulius* and *Pnigalio soemius* were dominant at the beginning of the season, later *Achrysocharoides cilla* became the most abundant, while in Csorna - *Achrysocharoides cilla* was the most abundant species prolong the entire season, in both generations.

Parasitism rate and the population density of leaf-miners

In *Phyllonorycter robiniella* no correlation between population density and parasitism rate was found, while in *Parectopa robiniella* the parasitization level slightly increased with the leaf-miner density. However, these are only preliminary results and must be approved by further samplings.

Summarizing, it is clear that the two invading leaf-miners, *Phyllonorycter robiniella* and *Parectopa robiniella*, have recruited a parasitoid community of nearly the same size as native *Phyllonorycter* species on oaks have and that this process of shifting onto new hosts is quite rapidly occurred, during 10-20 years. The parasitoid communities of *Parectopa* are simpler than in *Phyllonorycter* and it is due, probably, to the different mine structure and ecology of two invading hosts.

Acknowledgements.

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Oral presentation

Biotic damage assessment in forest monitoring in Ukraine

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Abstract

The paper summarizes the most important types of biotic forest damage in Ukraine, and gives a list, how the different damage forms are monitored. The most significant damaging factors in the Ukrainian forests are the insects, followed by different pathogens. While pathogens play relatively more significant role in the conifer forest (ca. 40% of the total damage in 2003), insect play outstanding role in the deciduous forests (ca. 80% of the total damage in 2003).

Keywords: damage assessment, forest health monitoring

Among the agents that damage forests in Ukraine, insects play an important part. They may be the primary or secondary cause of forest decline as well as indicators of forest condition. Because of differences in geography, climate, and tree species, national lists of harmful organisms, symptoms and signs, as well as the dates for additional assessment must be determined for each country. Biotic damage assessment in monitoring plots must be carried out by two visits: one of them coincides with crown condition assessment, and another must be done when it is possible to see the main damage cause. The dates for such visits to monitoring plots in conditions of Ukraine are presented for the main species of foliage-browsing insects and stem-borers of oak and pine, which are the main forest-forming species over the largest part of Ukraine.

Sustainable forest management must be based on data of dynamics of forest condition and productivity as a result of environmental changes. Total area of forested land in Ukraine is 10.8 million ha, of which 9.4 million ha is forest-covered area. Part of the forest-covered land is 15.6% for whole country. In Steppe zone it is lower than 5%, in Forest Steppe it is 16%, in Forest zone it is 40% and in Carpathians it is 70%. Total growing stock is 1.7 billion m^3, average growing stock is 186 m^3/ha, and average increment is 3.8 m^3/ha. Coniferous forests occupy 42% of forest-covered lands, hardwoods occupy 43%, softwood broadleaf and shrubs occupy 15% (Short Reference book, 2003).

Quercus robur L. and *Pinus sylvestris* L. are the main forest-forming species over the largest part of Ukraine (National Report 2003). Large parts of these stands are located in the Forest Steppe and Steppe zone where natural conditions often are not favourable for forest (Meshkova 1998b).

An important source of information on forest-damage levels and causes is monitoring. In Ukraine, forest-monitoring has been carried-out since 1989 and takes into account European Program ICP Forests (Manual, 1986; Forest Condition 2003), and since 1995, the program of Forest Health Monitoring (FHM), developed by Forest Service, U.S. Department of Agriculture and U.S. Environmental Protection Agency (Tallent-Halsell 1994).

Both for coniferous and deciduous stands, insects and diseases are mentioned as the main causes of damage (Fig. 1).

Root rots caused by *Heterobasidion annosum* (Fr.) Bref. and *Armillaria mellea* (Vahl: Fr.) Karst. are the most widespread diseases.

Defoliating and stem boring insects are the most widespread insects in the monitoring plots.

Insects and diseases may be primary or secondary (direct or indirect) causes of forest decline. Foliage-browsing insects mostly attack the trees in the stands of low density, stem borers attack the stands damaged by defoliators, windstorm, fire, adjacent to clear-cuts etc. (Meshkova 2002).

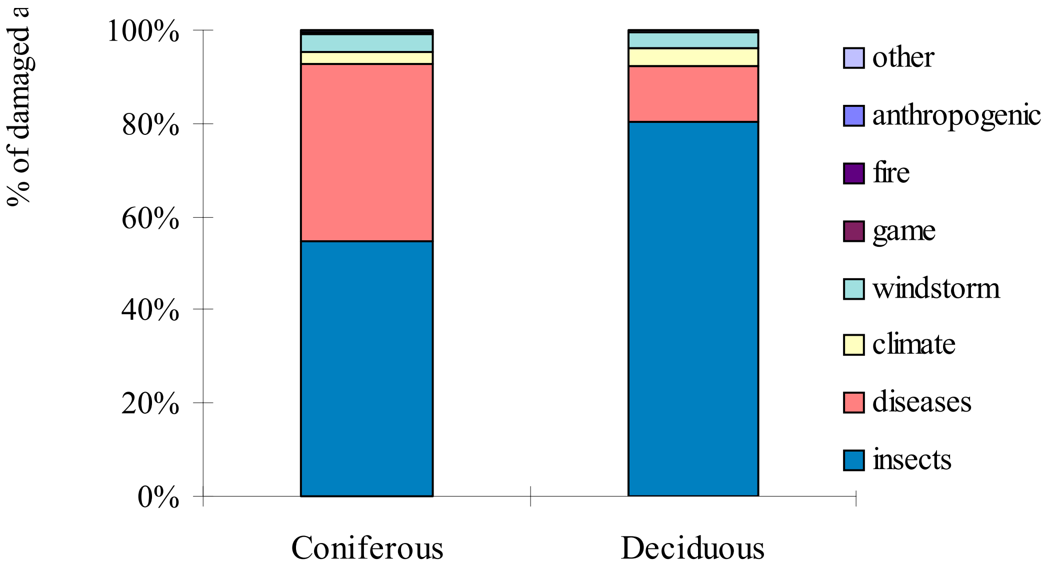

Fig. 1: Role of different factors in forest damage in Ukraine (2003).

The role of insects and diseases varies in different regions of Ukraine. The role of insects is higher in the southern and eastern parts of the country (Forest Steppe and Steppe zones) (Fig. 2), and the role of diseases is higher in the northern and western parts of the country (Fig.3). This may be explained by differences in climate, vegetation and stand structure (Meshkova 2002, 2003).

Monitoring of the 1st. Level includes mainly assessment of crown condition and group of damage causes. The aim of Level II assessment of damage causes is to find relationships between damage agent intensity and tree damage, that is, cause-effect mechanisms (Guidelines 2004).

Usually assessment of damage causes is carried out in monitoring plots simultaneously with crown condition assessment (July–August). However diagnosis of diseases or insects foresees cutting or felling trees or their parts, removing the bark, which cannot be done in the monitoring plots. For the trees in the plots we can see only those symptoms and signs that are visible, and to sample some parts of trees only out of plots. But in many cases additional visits for damage assessment must be made when it is possible to see the main damage cause.

Fig.2: Role of insects in forest damage in different regions of Ukraine.
(1 – 80–90%; 2 – 70–80%; 3 – 50–70%; 4 – 20–50%; 5 – 0–20%)

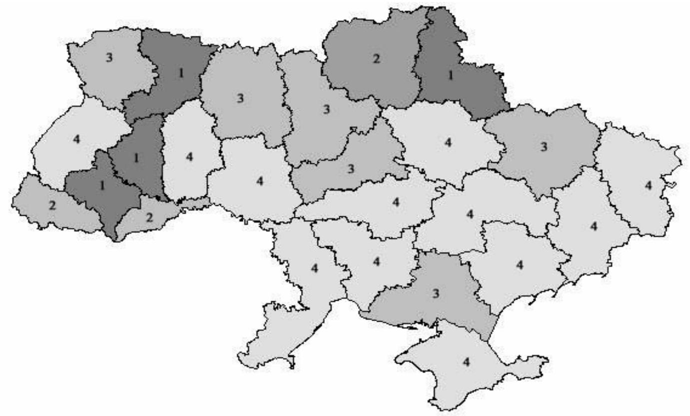

Fig.3: Role of diseases in forest damage in different regions of Ukraine.
(1 – 80–90%; 2 – 50–80%; 3 – 20–50%; 4 – 0–20%)

So we must answer questions:

– Which symptoms and signs are visible?
– Which species may be the cause?
– When and how to confirm the assumed cause?

Guidelines for the assessment of damage causes (Guidelines 2004˙) give comprehensive description of symptoms and signs of biotic damage. But because of differences in geography, climate and tree species, national lists of harmful organisms, symptoms and signs as well as the dates for additional assessment must be determined for each country.

In this paper we present dates of additional assessment for the main insect pests of oak and pine in Ukraine using our experience (Meshkova 1998) and publications (Gusev and Rimskij-Korsakov 1951; Stark 1932; Vorontsov and Mozolevskaja 1978). We selected two groups. One includes defoliators of oak (Table 1) and pine (Table 2), and another includes stem borers of these tree species (Tables 3- 4).

Species	Symptoms during crown condition assessment for ICP Forests program	Period of tree damage	Additional signs	Dates of assessment
Tortrix viridana L., Lepidoptera, Tortricidae	browsed foliage, secondary foliage, often damaged by powder mildew	middle of April–beginning of June	Caterpillars in rolled leaves	May
			Green moths on the trunks	end of May–beginning of June
			Foliage damage on the tops of trees, rolled leaves	middle of June
Archips crataegana Hb., Lepidoptera, Tortricidae	browsed foliage	middle of April–beginning of June	Rolled leaves	middle of June
			Typical white egg masses on the trunk and branches	July–April
Operophthera brumata L., *Erannis defoliaria* Cl., Lepidoptera, Geometridae	browsed foliage, secondary foliage, often damaged by powder mildew	middle of April–beginning of June	Browsed foliage	May
Lymantria dispar L., Lepidoptera, Lymantriidae	browsed foliage, secondary foliage, often damaged by powder mildew	middle of April–end of June	Eggs on the trunk	August-April
			Bits of leaves and excrements on the ground, caterpillars in the crowns	end of June
		middle of July	Noticeable females and egg masses	end of July-beginning of August
Thaumetopoea processionea L., Lepidoptera, Thaumetopoeidae	browsed foliage, web nests	May–June	Web nests with caterpillars or pupa on the trunks and branches, web tracks on the trunk from nest to crown	end of June-July
Euproctis chrysorrhoea L., Lepidoptera, Lymantriidae	browsed foliage, winter nests in the crown	1.middle of April – June; 2.August	White moths on the lower side of leaves, sometimes on the trunks	the 1st half of July
			Winter nests from dry leaves in the crowns	October–November
Notodonta anceps Goeze., Lepidoptera, Notodontidae	browsed foliage	June–July	Caterpillars and crown damage	July
Phalera bucephala L., Lepidoptera, Notodontidae	browsed foliage	end of June August	Caterpillars and crown damage	July, August
Altica quercetorum Foudras =Haltica, Coleoptera, Chrysomelidae	skeletized leaves, brown, dry	April–August	Beetles	July–August

Table 1: Symptoms, signs, and dates for oak-defoliator additional assessment.

Of the main oak-defoliators, *Tortrix viridana*, *Archips crataegana*, *Operophthera brumata* and *Erannis defoliaria* damage foliage in spring. According to the data of crown assessment, secondary foliage often developed and and often it is infected by powdery mildew. *Lymantria dispar* and *Thaumetopoea processionea* begin feeding early in the spring as above mentioned species, but their feeding period is longer. Therefore additional visits are necessary in May–June to foci of these insects to distinguish the cause of damage.

Euproctis chrysorrhoea has two periods of feeding – after hibernating in winter nests, and after hatching of larvae. So almost any time during summer, we can see some signs of this insect.

Notodonta anceps and *Phalera bucephala* damage foliage in summer, *Altica quercetorum* – from spring to end of summer and do not need additional visits to assess causes of damage.

Of the main pine defoliators, *Panolis flammea* damages young pine shoots at the beginning of the season, and during crown assessment it is necessary to look for its pupae in the soil to be sure of its presence. *Neodiprion sertifer* damages old needles in spring and from the middle of June its cocoons may be found in the soil. *Diprion pini* and *Dendrolimus pini*, which have 2 periods of feeding, as well as *Bupalus piniarius* can be assessed during monitoring of crown damage

Species	**Symptoms during crown condition assessment for ICP Forests program**	**Period of tree damage**	**Additional signs**	**Dates of assessment**
Panolis flammea Schiff., Lepidoptera, Noctuidea	browsed foliage	May–June	Damage of May shoots, excrements on the litter Pupae in the soil	June July–March
Neodiprion sertifer Geoffr., Hymenoptera, Tenthredinidae	browsed foliage	May- middle of June	Larvae in the crown Cocoons in the soil	May–beginning of June middle of June–August
Diprion pini L., Hymenoptera, Tenthredinidae	browsed foliage	June August	Larvae of the 1st generation Larvae of the 2nd generation Cocoons in the soil	June August October–April
Dendrolimus pini L., Lepidoptera, Lasiocampidae	browsed foliage	1. April–June 2. July–September	Caterpillars in the crowns Excrements on the litter Caterpillars in the soil	April–June July–September October–March
Bupalus piniarius L., Lepidoptera, Geometridae	browsed foliage	end of July–September	Damage of needles Pupae in the soil	August–September October–May

Table 2: Symptoms, signs, and dates for pine-defoliator additional assessment.

Species	**Symptoms during crown condition assessment for ICP Forests program**	**Additional signs**	**Dates of assessment**
Chrysobothris affinis F., Coleoptera, Buprestidae	boring holes, boring dust	Swarming	May–July
Agrilus viridis L., Coleoptera, Buprestidae	boring holes, boring dust	Swarming	end of May–August
Agrilus biguttatus F., Coleoptera, Buprestidae	boring holes, boring dust	Swarming, foliage browsing	end of May–beginning of August
Necydalis major L., Coleoptera, Cerambycidae	boring holes, boring dust	Swarming	beginning of August
Cerambyx cerdo L., Coleoptera, Cerambycidae	boring holes, boring dust	Swarming, feeding by sap	May–August
Cerambyx scopolii Fuessyl., Coleoptera, Cerambycidae	boring holes, boring dust	Swarming, feeding on pollen of grasses and shrubs	May–July
Scolytus kirschi Skal. Coleoptera, Scolitidae	boring holes, boring dust	Swarming	May–July
Scolytus intricatus Ratz., Coleoptera, Scolytidae	boring holes, boring dust	Swarming, feeding at base of young shoots	June

Table 3: Symptoms, signs, and dates for oak stem-borer additional assessment.

Species	Symptoms during crown condition assessment for ICP Forests program	Additional signs	Dates of assessment
Spondylis buprestoides L., Coleoptera, Cerambycidae	boring holes in collar, boring dust	Swarming	June–September
Criocephalus rusticus L.=*Arhopalus rusticus* L., Coeoptera, Cerambycidae	boring holes in collar, boring dust	Swarming	end of June–end of August
Ancylocheira haemmorhoidalis Hbst., Coleoptera, Buprestidae	boring holes, boring dust	Swarming	end of July–August
Ancylocheira octoguttata L., Coleoptera, Buprestidae	boring holes, boring dust	Swarming	end of June–July
Melanophilla acuminata Deg., **Coleoptera, Buprestidae**	boring holes, boring dust, collar	Swarming	May – end of August
Blastophagus piniperda Eichhoff 1864 .=Tomicus piniperda L, **Coleoptera, Scolytidae**	shoots on the earth	Swarming renewal feeding of old beetles feeding of young beetles in the shoots	March–April beginning of June middle of July–September
Blastophagus minor Hart.=Tomicus minor Hartig, **Coleoptera, Scolytidae**	shoots on the earth	beetle swarming renewal feeding of old beetles feeding of young beetles in the shoots	March–April beginning of June middle of July–September
Ips sexdentatus Boern., **Coleoptera,**	boring holes,	additional feeding	April
Scolytidae	boring dust	feeding of young beetles	July
Ips acuminatus Gyll, **Coleoptera, Scolytidae**	boring holes, boring dust	additional feeding feeding of young beetles	April beginning of June
Sirex juvencus L., **Hymenoptera, Siricidae**	boring holes, boring dust	Swarming	July–August
Urocerus gigas L. **Hymenoptera, Siricidae**	boring holes, boring dust	Swarming	June–September

Table 4: Symptoms, signs, and dates for pine stem-borer additional assessment.

The main symptoms of stem borers are boring holes and boring dust; for *Blastophagus* sp. there are broken shoots on the earth. Additional signs for stem-borer assessment without felling or removing the bark, are adults, which swarm or feed on vegetation (*Scolytus intricatus, Cerambyx scopolii*), by sap (*Cerambyx cerdo*). Swarming of Siricidae, Cerambycidae and Buprestidae mostly continues to July–August and they can be seen during crown damage assessment. Swarming of Scolytidae is often observed in spring or early summer, except incidences of the second sister generations (see Table 3-4).

Thus, insect damage on monitoring plots must be assessed twice. The 1st time must coincide, for defoliators of the spring group, with the period of their feeding activity, and for Scolitidae – with swarming period. The 2nd time must coincide with crown assessment in monitoring plots.

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Oral presentation

Prediction of foliage browsing insect outbreaks

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Abstract

The scheme of prognoses for many years (strategic prediction), annual (tactical prediction) and seasonal (operative prediction) has been developed. Threat zones for geographical populations of foliage-browsing insects must be determined after climatic indices, and foci of outbreaks for ecological populations must be determined after forest site conditions. The next outbreak of foliage-browsing insects is recommended to predict after average interval between outbreaks and its confidential limits. Scheme and methods for determination of different pest control dates are presented.

Keywords: defoliating insects, prognosis

The aim of prediction in forest protection is to obtain the information regarding the beginning and development of insect pest outbreaks. This gives the possibility to determine in time the expediency of preventive or control measures and to realize them. Scientifically argued prediction is based on the analysis of space distribution and dynamics of pest foci, relations with different agents and processes. As we can't take into account all factors and natural processes, any prediction is realized with certain probability. Therefore, prognosis is judgement with certain probability about trends and perspectives of process development in future on the base of past and present (Reznikov 1982; Meshkova 2002).

Prediction of foliage-browsing insect outbreaks must answer the following questions: which species, where and when will outbreaks occur, what will be their intensity and duration. After a period of forestalling, prognoses may be created for many years (strategic), for one year (annual, tactical) and for season (operative) (Fig. 1–3).

From the analysis of insect outbreak history in Ukraine it follows that in deciduous forests, the subjects for prediction are *Tortrix viridana* L., *Archips crataegana* Hb., *Lymantria dispar* L., *Operophthera brumata* L., *Erannis defoliaria* Cl., *Euproctis chrysorrhoea* L., *Thaumetopoea processionea* L., *Malacosoma neustria* L., *Notodonta anceps* Goeze., *Phalera bucephala* L., *Dasychira pudibunda* L. In coniferous forests, the subjects for prediction are *Diprion pini* L., *Neodiprion sertifer* Geoffr., *Bupalus piniarius* L., *Panolis flammea* Schiff., *Dendrolimus pini* L., *Lymantria monacha* L. (Meshkova 2002b).

Two other issues of prognosis for many years are: where and when we must expect the next outbreaks (Fig.1). These issues can be decided on the basis of analysis of data bulk on pest foci distribution, spatio-temporal population dynamics and factors that influence on it. Prediction for many years may be realized only in research organizations (in Ukraine it is Ukrainian Research Institute of Forestry & Forest Melioration) on the basis of information, which is accumulated in the databases of Information & Search System "Forest Protection" (Meshkova 1998). According to this, the output information is transmitted to the State Committee of Forestry of Ukraine.

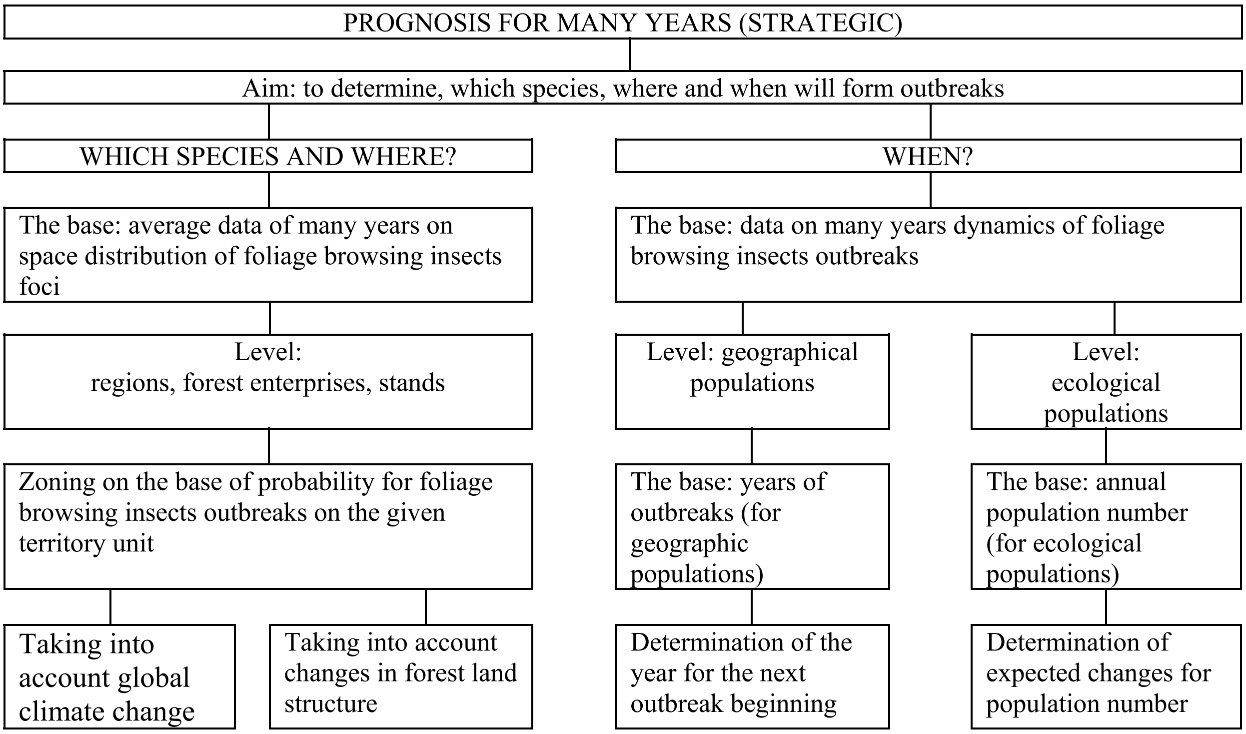

Fig.1: Scheme of foliage browsing insect strategic prognosis.

Ultimate aim of prediction for insect foci spatial spread is the zoning of territory on the basis of probability estimation for different pest outbreaks in different area units (regions, forest enterprises territories, stands). This probability is evaluated after average data for many years (Meshkova 2001b, 2002b). This allows the ground strategy of forest protection, including the changes in forest protection service, personnel training, financing etc.

If the repetition, intensity and duration of certain insect species outbreaks are greater in some regions (territories), then we can expect the more distribution of foci just in these regions (territories). The approach mentioned gives the possibility to determine the boundaries of zones of different threat for different pest outbreaks (Meshkova 2002b). These zones include the whole regions, since statistical reporting and financing distribution are connected with such units.

However, in the frame of regional forest sites, conditions are not similar. Taking into account established correlation of insect population dynamics with climate indices and fodder- tree distribution, the boundaries of insect foci spread zones are specified by the means of GIS (Bogomolov *et al* 2000; Meshkova 2001b).

Spread of foliage-browsing insects on a regional level can be influenced by the changes of forest structure as a result of forest management or climate change. Prognosis, which takes into account impact of such changes on insect foci distribution, is of rather low reliability (20–60% - Isajev *et al* 1984).

For forest protection strategy, it is very important to know the predicted rate of climate change. Slow changes will influence the correlation of seasonal development of fodder trees, phytophags and entomophags, through different changes in the rates of ground thawing and warming after winter in different locations (Meshkova 2003a). Fast climate changes can bring change to natural habitats, both for tree and insect species, or to insect adaptation to other fodder plants (Sidorov *et al* 1997). Taking into account the possibility of global climate change, it is necessary to intensify the survey of forest condition and pest distribution. In particular, the boundaries of insect foci threat zones must be revised every 10 years considering current meteorological changes and stand structure.

Taking into account the influence of site conditions to insect foci spread, we have developed an approach that is grounded on the number evaluation of different components (species composition of stand, age, density etc.) (Meshkova 2003c). This approach may be used for estimation of pest foci distribution, both on regional and local levels, as well as for new foci boundary estimation after the change of particular indices (part of oak in the stand, mean age etc.). This approach also allows determining potential insect foci area for certain stands or territory unit, using forest inventory databases.

Estimating the year when the next outbreak will begin is the most complicated task of prediction. Correlation of pest outbreaks with solar activity dynamics has been proved, particularly with the years of sharp changes of solar activity, which may be predicted for the successive cycle (Meshkova 2002b, 2004). But if solar activity would even been permanent, the climate in different regions of Earth as well as microclimate of different stand plots would be different depending on distance to sea bank, relief, soil etc. Differences in climate and microclimate determine the differences in forest site conditions, regimes of soil thawing, correlation between air and soil-warming rates as well as between development rates for tree species, phytophags and entomophags. That influences to a great extent the population dynamics (Meshkova 2002b). It is known, that reliability of weather prediction for one month forward is 50–62% (Reznikov 1982). Therefore reliability of prediction of insect outbreaks, which are under influence of many factors besides weather, is considerably less. Therefore, the next outbreak prediction may be based on the informational manifests of the correlation between population indices and factors, which influence on them (Druzhinin 1987).

Repetition of events as the manifestation of regularity is one of the necessary conditions of prediction. The events, which do not repeat, cannot be predicted. Outbreaks of foliage browsing insects are repeated, but intervals between them are not constant. Therefore we refer to these processes as cyclic ones, not periodic ones. Cycles of similar duration are well known in dynamics of cosmic, climatic and trophic factors, which influence directly or indirectly on insect population dynamics (Druzhinin 1987).

If the intervals between outbreaks were constant, the next outbreak prediction would not be difficult. At different intervals between outbreaks we can only evaluate the mean interval between the years of outbreak beginning and confidential limits of their changes (Meshkova 2002b). We have carried out statistical analysis of information on foliage browsing insect history in different regions of Ukraine. For every insect species the mean interval between outbreaks and confidential limits of its change were calculated at probabilities of 70, 80 and 90%. For example, after analysis of 32 *Tortrix viridana* populations, its outbreaks repeat, on average, every 10 years. On that basis, with a probability of 90% the next outbreak will not start earlier than the 7th year, and not later than the 12th year after former outbreak, and with a probability of 70% the next outbreak will not start earlier than the 8th year and not later than the 11th year after former outbreak (Meshkova 2002b).

Thus, prediction of insect foci space distribution is based on the mean data of population dynamics for many years, and prediction of the next outbreak-beginning year is based on the data about outbreak frequency and duration in different regions. Prediction of outbreaks after this approach was proved in 1999–2004 years in different regions of Ukraine.

Thus, on the level of geographical populations, we can predict the year of the beginning of insect population growth and maximal possible foci area. But global factors influence insect populations not only directly, but indirectly through dynamics of dates and rates of meteorological indices, forage and protective foliage properties, development of phytophags and entomophags. Because of variability of local conditions, the course of foliage browsing pest outbreaks is not similar in different populations and even plots of one stand as well as in one population during different outbreaks (Meshkova 2002b). Therefore it is very difficult to predict foci area or population number.

There were many attempts to create the models of population dynamics after data on specimen survival, death, propagation indices and the factors that influence them (Znamenskij and Lyamtsev, 1983), as well as simulation models based on the parameters from certain populations (Rubtsov and Rubtsova 1984). But really the reliability of insect population dynamics prediction does not exceed 40–80% (Isajev *et al* 1984).

We have developed the method of population dynamics prediction based on the separating of rhythms in it but the mean of spectral analysis of temporal rows (Meshkova 2002b, 2002c). The approach is based on the fact that, after components of rhythm one can determine the meaning of the variable index for every year in the past and in the future. Thus, from data of *Tortrix viridana* population dynamics in Kharkov region we have estimated parameters for predictive model and predicted outbreak in 2003. This approach can be used for population dynamics prediction, if we have data of many years, but the model must be used very carefully for prediction dynamics of another population of the same pest.

One must take into account that given model like many other models allows evaluating only the most probable qualitative changes in population dynamics, for example, the years of expected population growth. At the same time, a number of factors connected with population structure and environment can influence on population number. Therefore prognosis for many years without fail must be corrected at annual prediction.

The aim of annual (tactic) prognosis is correction of prognoses for many years, determination of the trends in certain ecological population dynamics; threat for stand estimation; decision-making about expediency of control measures (Fig. 2). Annual prognosis characteristics expected for the next year spread of different pests, population number in certain forest stands. Using data on certain insect population-spread, intensity of propagation, and survival of different stages, one can determine the trend of population dynamics and potential threat to stands in certain foci. Such prognosis is based on the data of survey and is necessary for ground, current planning and organization of forest protection measures. Annual prognosis is realized by forest protective enterprises. Reliability of it is 60–90% (Isajev *et al* 1984).

ANNUAL (TACTICAL) PROGNOSIS

The aim: correction of prognoses for many years, determination of the trends in certain ecological populations dynamics; threat for stands estimation; decision-making about expediency of control measures

Execution:

1. Using data on foliage browsing insects foci distribution in former years

2. Survey and inspection in the stands taking into account data of prognosis for many years using ordinary methods

a. Estimation of qualitative and quantitative indices of insect populations
b. Estimation of epizooties and entomophags distribution in the foci of outbreaks

3. Correction of prognosis for many years using data about coincidence of insect outbreaks with the years of sharp changes of solar activity

Fig. 2: Scheme of foliage browsing insect tactic prognosis.

Tactical prediction is based on the data of regular survey and inspection of the stands with estimation of quantitative and qualitative population indices, including spread of entomophags and entomopathogens. Methods of such estimation are rather well developed.

During tactical prediction one must correct prognosis for many years. As it was mentioned above, outbreaks of foliage browsing insects are repeated in different time intervals. After collapse of the previous outbreak we expect the next one in several years. Probability of intervals of different duration may be calculated. One must take into account that if outbreak does not begin in *n* years, then its probability in year *n+1* increases (Druzhinin 1987). From our estimation, from the previous outbreak of *Tortrix viridana* the next one will begin in 7 years with a probability 54.3%, in 8 years with probability 60.5%, in 9 years with probability 66%. It is clear that this information is insufficient for prognosis. To increase the reliability of outbreak prediction, it is necessary to use additional information. This is predicted data on solar activity dynamics and proof of coincidence of pest outbreak beginning with the years of sharp changes of solar activity. To correction insect outbreak prognoses for many years using data of solar activity dynamics a special table and nomogram were built. Calculations allowed predicting outbreaks of different foliage browsing insects for 2002–2005 (Meshkova 2002b).

One must notice that outbreak probability was calculated using mixed samples of data. Calculation of such probabilities for separate populations demands hundreds of years of observation. Therefore use of suggested methods do not decrease necessity of survey in potential foci of insect mass propagation.

In spite of numerous data about the influence of weather conditions on insect population dynamics, most of the determined correlations cannot be used for prediction because they do not precede the outbreak, but are observed simultaneously with it. For example, we know that an early start to feeding in spring is favorable for the survival of many foliage-browsing insects [Meshkova, 2003a]. It is proved, that it is possible to predict vegetation period duration and course of temperature in autumn after course of temperature in spring, but it is impossible to predict temperature course for next spring after its course in autumn of previous year (Davitaja 1964).

It was shown that the survival-rate of foliage-browsing insects, which hibernate as larvae or pupae, increases if there was warm and dry weather during their feeding-period in the previous year (May and June for *Panolis flammae*, at the beginning of vegetation period, and July–August for *Dendrolimus pini* and *Euproctis chrysorrhoea*). The survival-rate of most of the foliage-browsing insects increases in dry and warm years (Meshkova 2002b). Therefore in dry and warm weather, one must pay more attention to stand survey, first of all, in the periods when crown damage is better visible.

Seasonal (operative) prognosis allows correcting projected forest protective measures on the base of insect survival estimation in current year (Fig. 3).

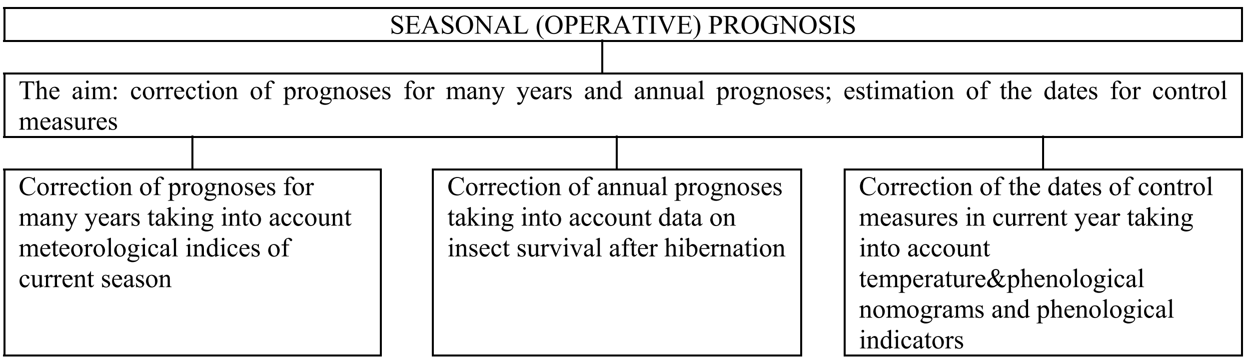

Fig. 3: Scheme of foliage browsing insect operative prognosis.

Reliability of such prognoses is 80–95% (Isajev et al 1984). Another task of seasonal prognosis is estimating the dates of control measures against certain foliage browsing pests that is based on the information about phenology of insects and foood plants (Meshkova 2001a, 2003b). Unsuccessful use of sum of effective temperatures can be explained by difficulties in considering of effective heat at the beginning of spring, or (for insects that hibernate in the soil) by differences in warming of soil and air.

Reliable correlation between dates of stable transition of temperature through 5, 10 and 15°C in spring and in autumn as well as parameters of respective regression equations were calculated (Meshkova 2002a), dependences of foliage browsing insects from temperature course were estimated (Meshkova 2002b). This gave the possibility to develop the scheme and methods of determination of feeding periods of foliage browsing insects and in time, control them (Meshkova 2002a). For example stands must be treated against *Tortrix viridana*, *Archips crataegana*, *Lymantria dispar*, *Operophthera brumata*, *Erannis defoliaria*, *Euproctis chrysorrhoea*, *Neodiprion sertifer, Panolis flammea*, *Dendrolimus pini* after stable transition of air temperature through 10°C, but not later than in the third week of May. Spraying against *Diprion pini* must be carried out not later than in the 2nd week of June, against *Bupalus piniarius,* second generation of *Diprion pini* and young caterpillars of *Dendrolimus pini* treratment must be carried out not later than at the beginning of September.

As it was shown, foliage-browsing insect outbreaks develop more often in the years when the vegetation period begins earlier (Meshkova 2001c, 2003a). It was proved that an earlier start to the vegetation period is also favorable for insects which consume foliage at the end of summer (Meshkova 2002b). The date of stable transition of temperature over 10°C in spring is predicted after the date of stable transition of temperature over 5°C (Meshkova 2002a). Therefore that is one of the meteorological indices, which may be used for insect population dynamics prediction, as opposed to a hydrothermic index and air temperature of certain months that may be calculated only after beginning these months.

Conclusion.

The scheme of contents and methods of prognoses for many years (strategic), annual (tactic) and seasonal (operative) has been developed.

The boundaries of threat zones for foliage browsing insects are proposed to determine on the basis of number evaluation of climatic indices for geographic populations and on the basis of number evaluation of forest site conditions for ecological populations.

The beginning of the next mass propagation of foliage browsing insects is recommended to predict after mean intervals between outbreaks. Approach for foliage browsing insect population number prediction is based on the analysis of rhythms of its dynamics.

Scheme and methods of feeding data determination for different foliage browsing insects are developed to use in time control measures.

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Oral presentation

Bark beetle outbreaks on different tree species in Austria

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Abstract

Since 1990 (after Storm Vivian) there have been problems with bark beetles in Austria. After reaching a peak of nearly 2 million m³ of bark beetle infested wood in 1993, this quantity decreased from year to year. During a severe storm in 2002, a large number of trees were thrown or broken, amounting to more than 5.6 million m³. The storm, together with other abiotic factors, such as frost, frost drought, periods of drought and heat during the last two years led to a critical situation. As the basic population of bark beetles was at least 3 times higher than 1990, the infested wood reached a level of 2 million m³ at the end of 2003. The development of the most important bark beetle species is shown by the illustrated maps from the documentation of the Forest Damage Factors, which provides data based on estimations of 67 damage factors assessed by forest officers from the forest districts. For *Ips typographus*, the most important bark beetle in Austria, the development of its population is shown in detail on maps from 2001 to 2003. They show a strong increase of infested wood since 2002. All other species were also increasing in the last years, but only *Pityogenes chalcographus* almost reaches the importance of *Ips typographus*.

Keywords: storm damage, bark beetles, *Ips typographus, Pityogenes chalcographus*

Introduction:

In the spring of 1990 a severe storm called Vivian caused a lot of damage across Europe. In Austria, the damage led to 7 million m³ of thrown or broken wood. Due to this incident, a mass outbreak of bark beetles started, which led to a peak of nearly 2 million m³ of infested wood in 1993. Then, from year to year this amount decreased continuously until 2002. After a slight increase in 2002, the situation "exploded" in 2003 and caused about 2 million m³ of sanitary felling due to bark beetle activity. Most of the affected wood is Norway spruce and the most important bark beetle *Ips typographus*, which affected more than 1 million m³.

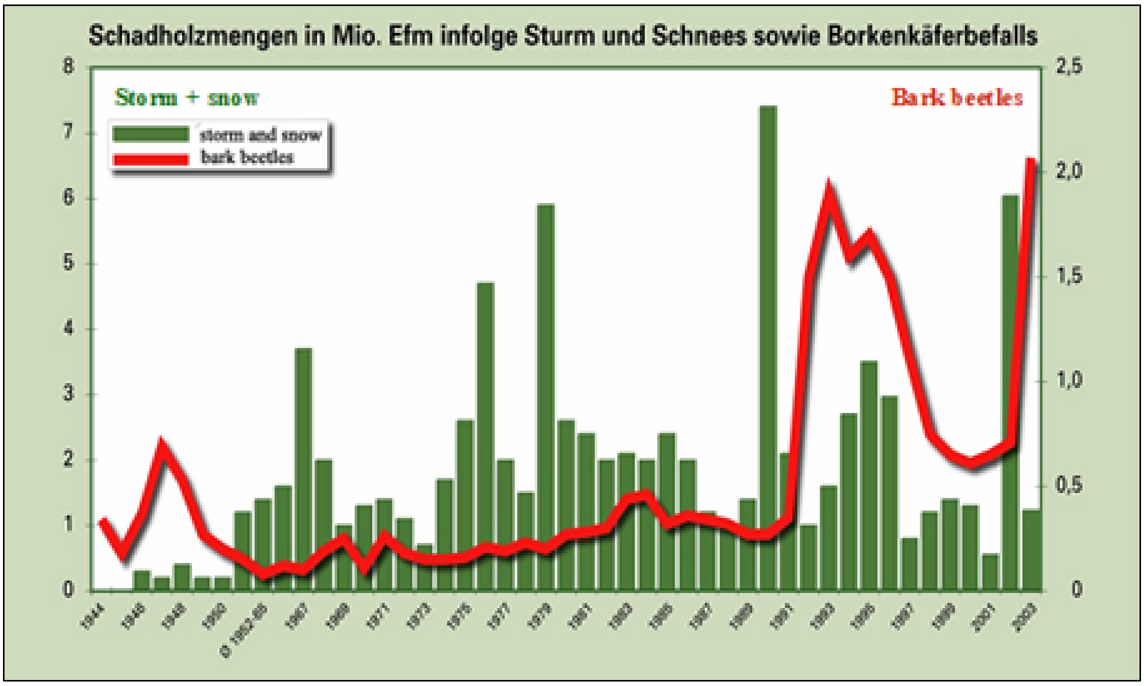

Fig. 1: Development of cut wood due to storm and snow and infested wood by bark beetles from 1944 to 2003.

Reasons for the outbreak

Forest protection Situation 2002

Annual mean temperature 1-1.5 °C above normal
More precipitation than normal (up to 180 %)
Big quantity of thrown and broken wood after a storm in November 2002
Generally a high basic population of bark beetles

Fig. 2: Example of forest stand after "Föhnsturm" in November 2002 in Central Austria.

Forest protection situation 2003

Frost and frost drought in late winter
2003 was the hottest and driest summer since the start of climate measuring
Summer middle temperature 3° to 5° C over normal
Only 40% to 70% of median precipitation

At least, in 2003 there was enough material left for breeding in the forests. Heat and drought favoured the development of beetles, but also decreased the health status of many trees suffering under that stress.

Because of a shorter duration of development under these warm and dry conditions in Austria, an increase in the number of generations per year could be observed. At low altitudes, 3 instead of 2 generations, and at higher altitudes, 2 instead of 1 generations completed their development.

Bark beetle situation in Austria 2003

Fig. 3-4: Typical infestations of *I. typographus* in spruce stands.


Fig. 5 (left) and 6 (right): Situation after removing the infested wood because of an outbreak of *I. typographus* in a non wind-affected area.

Data on important forest pest diseases and abiotic damage were collected through a survey on forest district basis. It has to be mentioned that some of these data are only estimations from district foresters, others are more or less reliable exact figures. The aim of the forest damage monitoring maps is to give an overview on the current situation in Austria and to provide the forest authorities, the forest land owners and others with basic information for forest protection measures. In the following section, the result maps of 2003 are presented for the most important bark beetles on Norway spruce, European larch, fir and pine-trees.

Ips typographus, the most important bark beetle in Austria is presented in the data from 2001 to 2003, to show detailed the development of this recent outbreak, and also to show how the monitoring improves from year to year.

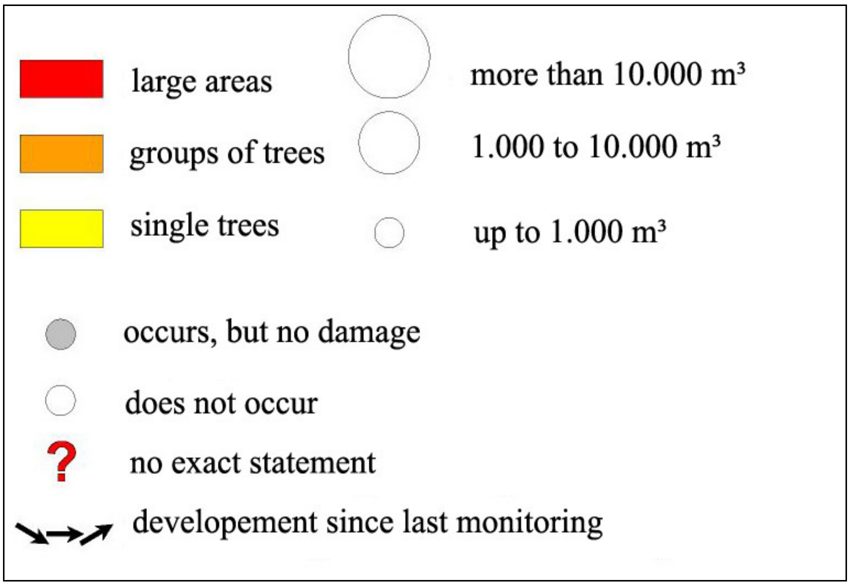

Fig. 7: Legend of the following maps, showing the results of the monitoring.

Ips typographus 2001 -2003

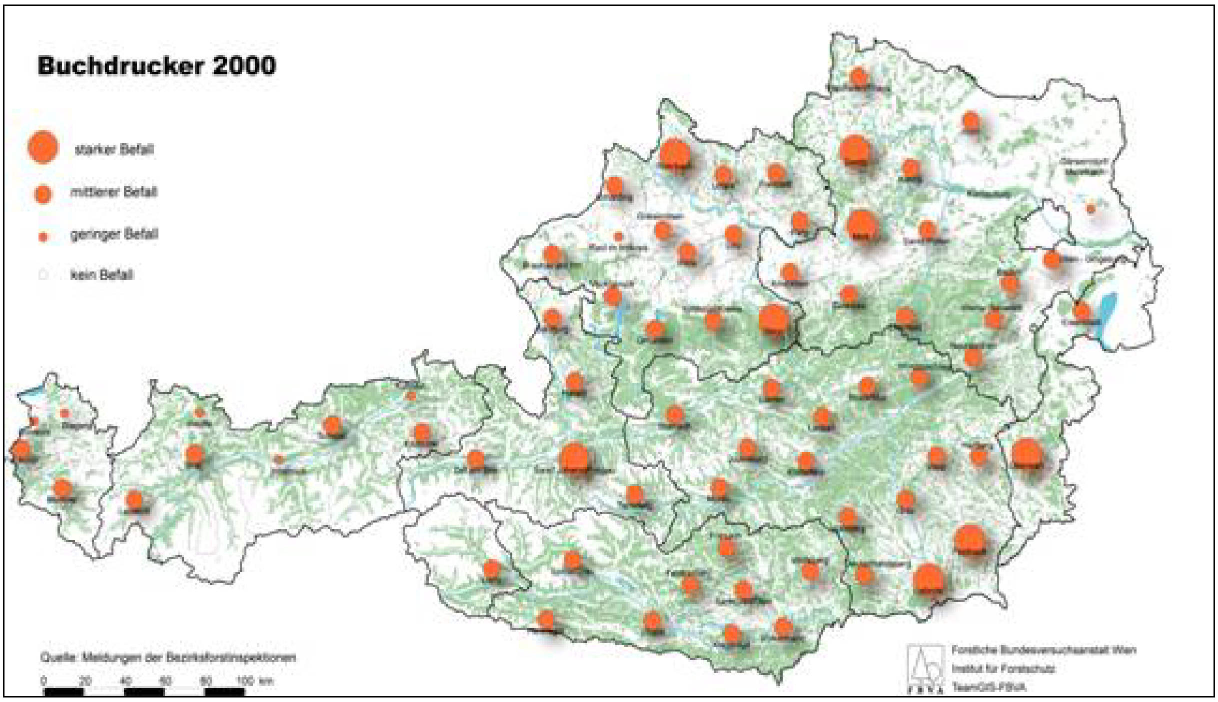

Fig. 8: Damage of *Ips typographus* in 2000 in Austria.

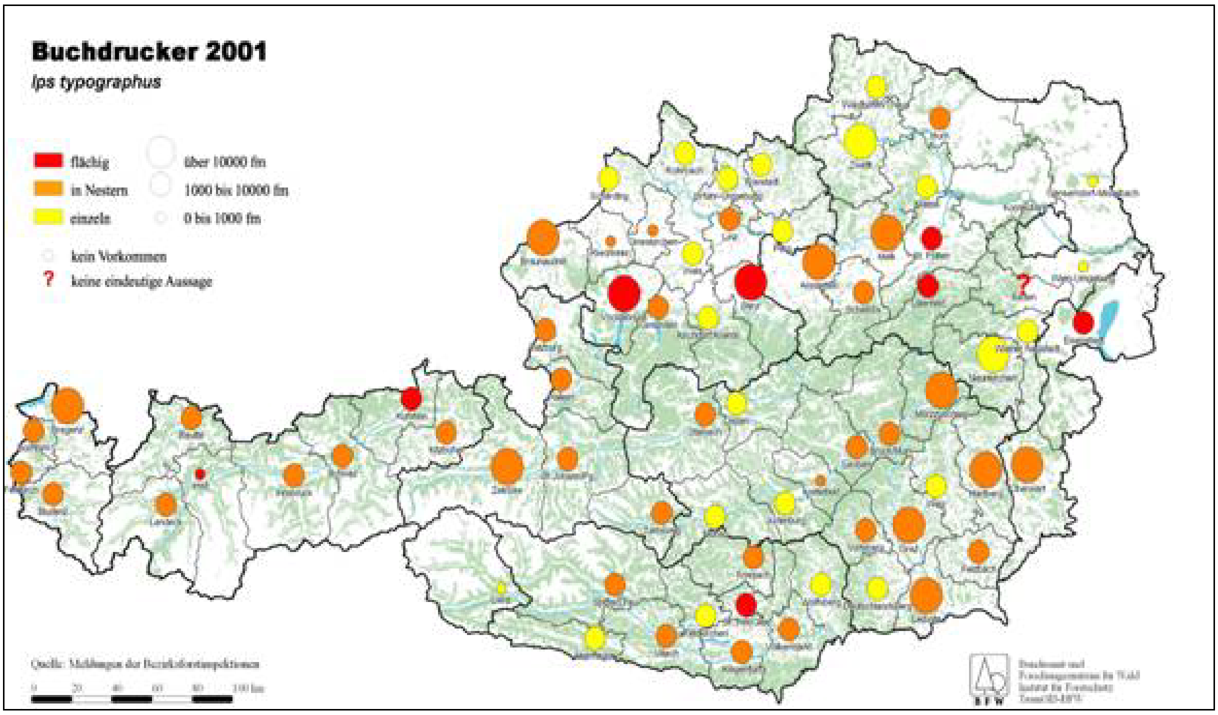

Fig. 9: Damage of *Ips typographus* in 2001 in Austria.

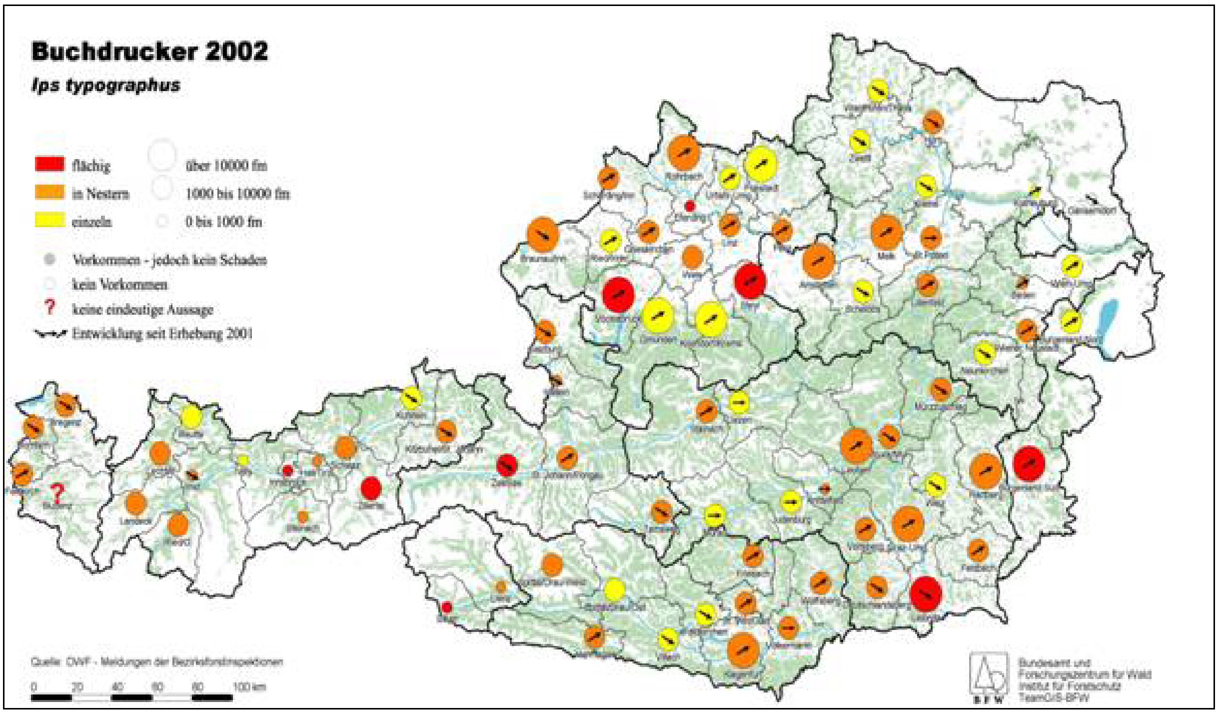

Fig. 10: Damage of *Ips typographus* in 2002 in Austria.

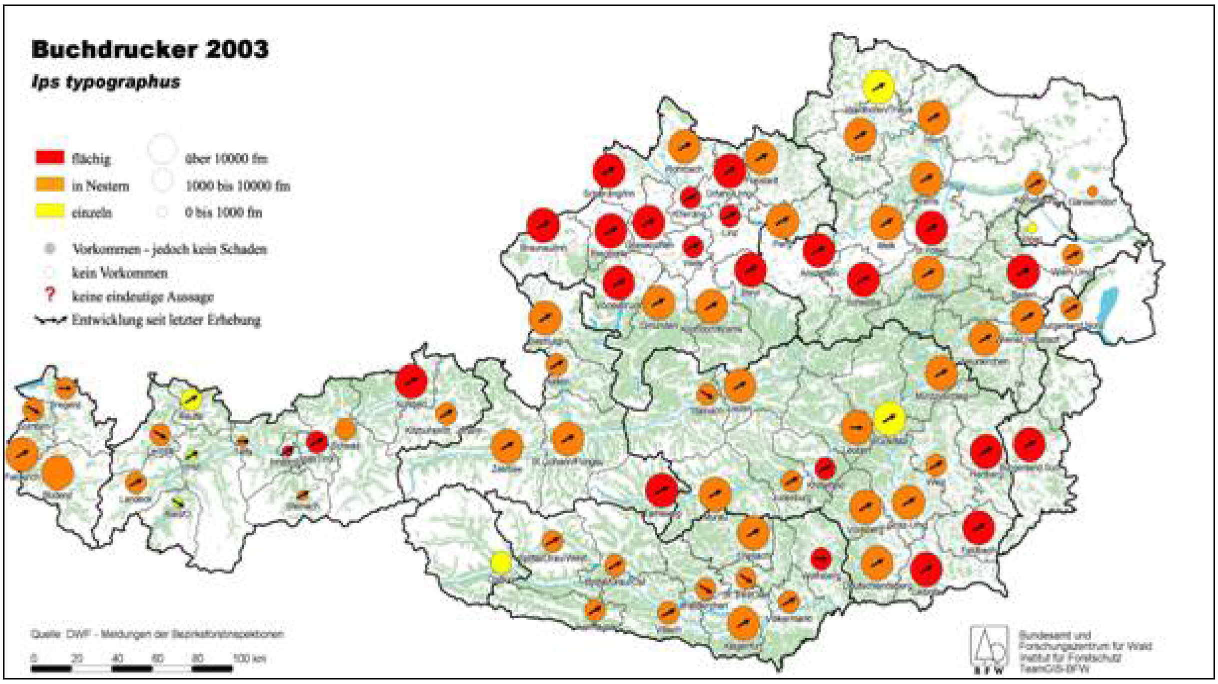

Fig. 11: Damage of *Ips typographus* in 2003 in Austria.

As the figures show, there is a remarkable increase in infested wood of the Norway spruce by *Ips typographus* from year to year. The increase in 2003 is extraordinarily high, not only because of the severe gale in the autumn of the year before, but also due to the weather conditions mentioned above. *I. typographus* is responsible for more than 1 million m³ of infested wood.

Pityogenes chalcographus 2003

Fig. 12: Young Norway spruce stand infested by *Pityogenes chalcographus.*

Fig. 13: Beetles of *P. chalcographus.*

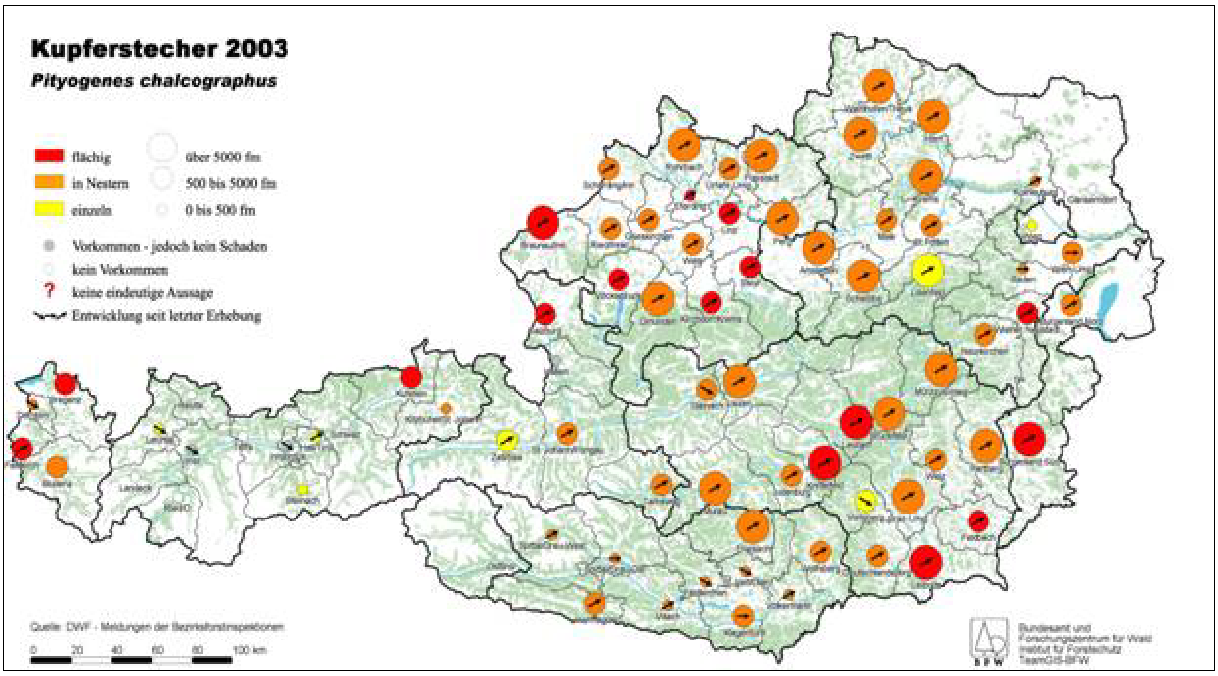

Fig. 14: Damage of *Pityogenes chalcographus* in 2003 in Austria.

The most important bark beetle besides *I. typographus* is *Pityogenes chalcographus*. The figure also shows an increase for this beetle. The amount of infested wood by *P. chalcographus* rose in 2003 from 60,000 to 440,000m³.

Ips cembrae -2003

Fig. 15 (left): Bark beetle infested Larch tree.
Fig. 16 (right, above): Galleries of *Ips cembrae.*
Fig. 17 (right, below) Larvae of *Ips cembrae.*

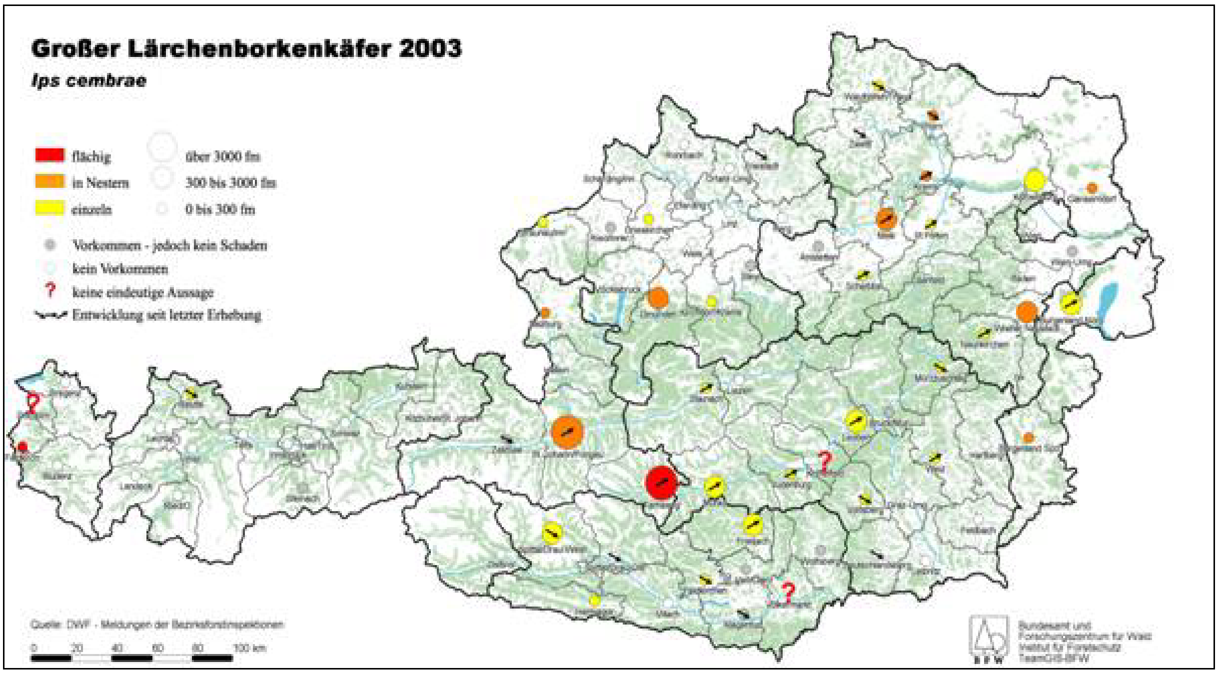

Fig. 18: Damage of *Ips cembrae* in 2003 in Austria.

The increase of *Ips cembrae* is mainly found in the region of the severe "Föhnsturm" of November 2002. In the eastern part of Austria, new outbreaks were found in some districts, due to the climatic factors of the last few years.

Bark beetles on pines - 2003

The total amount of beetle-infested wood over all pine trees increased like all others. It is remarkable, that *Ips sexdentatus* and *Ips acuminatus* were increasing, while the pine shoot beetles *Tomicus piniperda* and *Tomicus minor* became less important. Besides the predisposing factors mentioned, *Sphaeropsis* shoot blight played a strong role in Austrian pine, *Pinus nigra*-stands. There is a recent outbreak of *Sphaeropsis sapinea* on drought and heat stressed trees.

Bark beetles of firs

Fig. 19: Fir trees infested by bark beetles.

Bark beetles on firs didn't really increase until 2003, like the other bark beetles mentioned in this report. They remained at about the same level during the last years, because new areas of infestation were mentioned, while older outbreaks stopped.

Fig. 20: Fir trees infested by bark beetles.

Fig. 21: Symptoms on the surface of the stem.

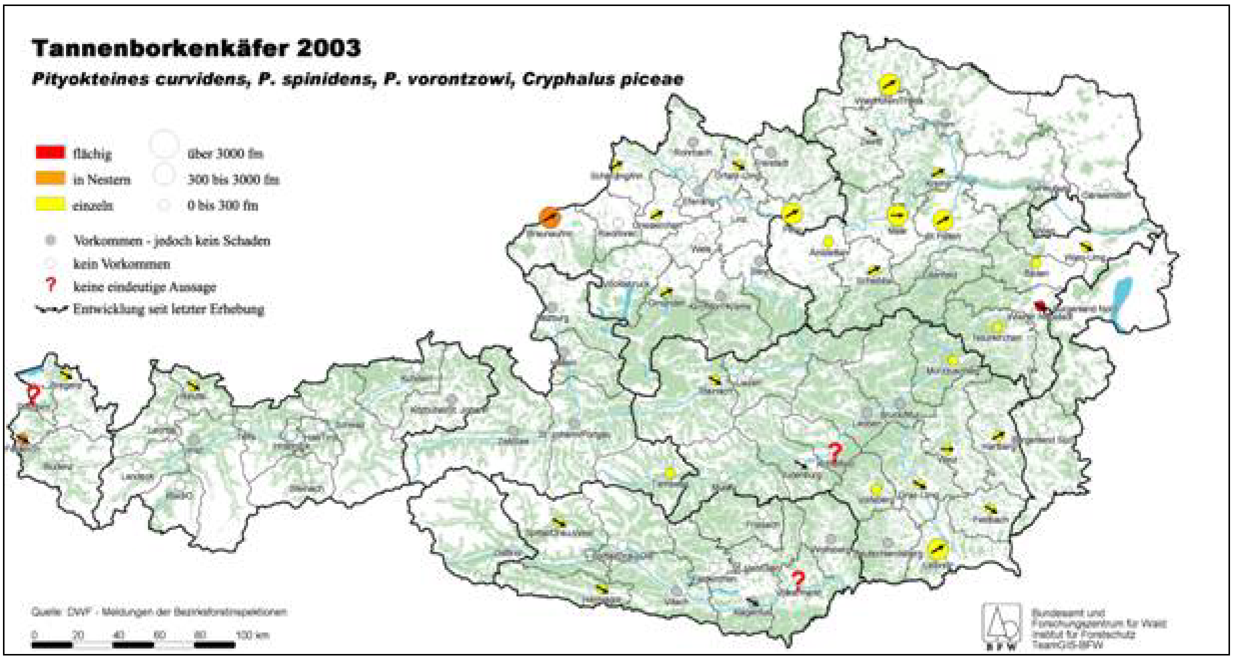

Fig. 22: Damage of fir bark beetles in 2003 in Austria.

Oral presentation

Oak dieback in decline in the UK

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Abstract

Dieback of pedunculate oak (*Quercus robur*) is a complex disease in which a number of damaging agents interact variously to bring about a serious deterioration in tree condition. Broadly similar symptoms have been recorded from many European countries. Initially there is a deterioration in the appearance of the foliage, and then, over several years, a progressive death of the branches. In some cases this leads on to the death of the whole tree. In the UK there was a major dieback episode during the 1920s in which defoliation by caterpillars of the oak leaf roller moth (*Tortrix viridana*) and damage due to oak mildew (*Microsphaera alphitoides*) were thought to play a critical role. Serious dieback occurred again in the 1989 – 1994 period and at this time drought damage was considered to be a key factor. Attack on weakened trees by the buprestid beetle *Agrilus pannonicus* along with other damaging agents contributed to tree death. Fresh occurrences of the disease have been reported since 1997 and research is continuing into the role of the various agents identified with particular attention being paid to the role of fungi in the genus *Phytophthora*.

Keywords: pedunculate oak, *Quercus robur*, oak dieback, *Microsphaera alphitoides*, *Tortrix viridana*, *Agrilus pannonicus*

Introduction

In the context of tree diseases, the words ‘dieback’ and ’decline’ are usually used for a problem of complex cause. Dieback and decline have been used in relation to pedunculate oak, *Quercus robur*, in the UK for at least 75 years. This paper outlines the history of the problem, evaluates available data on the causes and reviews the current research initiatives.

History of oak dieback in the UK

During the early 1920s aroused widespread concern in England (Day, 1927). Damage was thought to begin with the defoliation of trees in early summer by caterpillars of the oak leaf roller moth (*Tortrix viridana*), an insect which was very abundant in the years after the end of World War 1. By 1924 reports were coming in that oaks were dying in alarming numbers in certain sections of the defoliated woods. Considerable emphasis was also placed on the role of oak mildew (*Microsphaera alphitoides*), a fungus which had first appeared in Europe some 20 years earlier. The effects of this disease were particularly severe on the second crop of leaves that was formed after the first had been eaten by the caterpillars. A feature of many of the dead trees was the presence on the roots of honey fungus (*Armillaria* sp.) but Day thought that the role of this fungus was principally to kill off trees that were already 'irretrievably damaged'. By 1925 many sickly oaks, which had been kept under observation, showed a definite improvement in condition and it appears that this coincided with a marked reduction in the abundance of *T. viridana*.

Dieback in the UK since 1989

After the late 1920s, there were no reports of oak dieback for over 60 years. In the years after 1989, large numbers of reports of damage to oak were received by the Forestry Commission Research Division (now Forest Research) and a new project to examine the problem was created. Dieback occurred throughout Central, Southern and Eastern England and trees ranged in age from 40 to 200 years of age. Approximately half the sites reported were in woodland and half in parkland and they covered a range of soil types. The majority of trees were *Q. robur* but on a few sites hybrids between *Q. robur* and *Q. petraea* were affected.

Diagnosis

In the first stage, the symptoms to be recorded were the yellowing of the foliage closely by thinning of the foliage. Shortly after this some twig and small branch dieback occurs giving the crowns an open, thin appearance.

In the second stage yellowing and crown thinning increase with significant branch death. There may be some recovery growth along the major branches and 'tarry spots may also develop on the trunk. These 'tarry spots' may indicate that the tree has been attacked by *Agrilus pannonicus* and removal of the bark in the vicinity of the spots may reveal the larval tunnels (Fig. 2).

In the third stage there may be extensive recovery growth and if this dies back then the death of the tree will follow in 18 months to two years. If the tree has been attacked by *Agrilus* then the 'D'-shaped exit holes of the adults can be seen in the bark of the trunk.

Studies of oak decline 1989 – 1994

In order to obtain information on the development of the condition, ten plots, averaging 80 trees per plot, were established at affected sites to monitor changes in tree condition. These plots, set up in either 1990 or 1991, were surveyed each year until 1994, and Table 1 contains a summary of the data for various years in terms of both percentage of dead trees and the average percentage of dieback in the crowns of the remaining live trees. The mean percentage of dieback dropped slightly from 8.9% to 6.4%, but there was considerable variation between plots.

Fig. 1: Yellowing and thinning of foliage.

Fig. 2: Larval tunnels of *Agrilus pannonicus*.

Fig. 3: *Agrilus pannonicus* exit holes (arrowed).

Summary data from ten oak plots established in 1990 or 1991									
Location	**No of Trees**	**1990**		**1991**		**1993**		**1994**	
		% dead	% dieback in live trees	% dead	% dieback in live trees	% dead	% dieback in live trees	% dead	% dieback in live trees
Sherwood, Notts	57	2	26	2	20	2	13	2	13
Fanny's Grove, Notts	117	1	15	1	9	2	5	2	4
Crickley Hill, Glos	159	4	10	4	8	6	6	8	6
Everlands 1, Kent	35	11	8	11	10	14	5	14	5
Everlands 2, Kent	30	0	16	0	11	3	8	3	7
Tatton Park, Cheshire	100	-	-	0	5	9	1	8	2
Richmond Park, Surrey	109	-	-	4	8	12	6	14	5
Stixwold, Lincs	100	-	-	12	3	12	3	13	5
Emily's Wood, Norfolk	28	-	-	0	12	0	27	4	14
Scremby Park, Lincs	99	-	-	2	3	2	1	2	3
All Plots	**834**	**-**	**-**	**3.6**	**8.9**	**6.2**	**7.5**	**7.0**	**6.4**

Table 1: Survey data from oak plots.

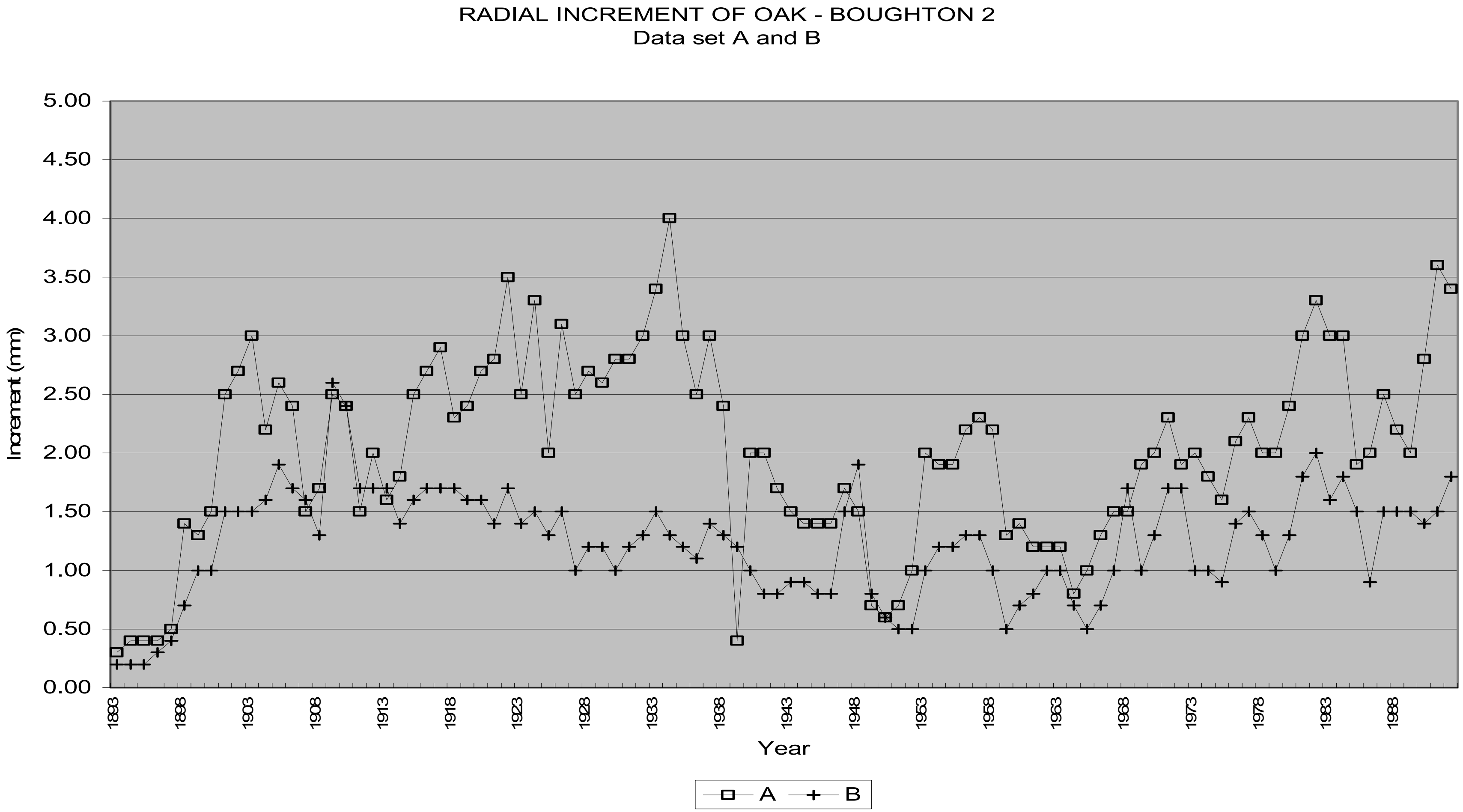

Fig. 4: Divergence of growth rates of affected and unaffected oaks.

Growth rates for both affected and unaffected trees were measured from Pressler cores. Figure 4 shows a typical pattern where the affected tree (B) shows a marked drop in growth rate compared with a healthy tree (A). It is also interesting to note that the trees showed a similar divergence in the 1920s.

Causal agents

The decline is thought to follow a three stage process with different damaging agents at each stage.

Primary

Severe climatic stress appears to be the main initiating factor and the recent run of paired drought years since 1975/76, at 6 to 7 year intervals, is the most likely stress factor. However recent work suggests that in some cases the main primary factor may be partial root killing by species of *Phytophthora*.

Secondary

These include severe, repeated defoliation by *T. viridana* and winter moth, oak mildew and attacks by the bark beetle *Agrilus pannonicus*.

Tertiary

These are the root killing pathogens such as *Collybia fusipes*, *Armillaria* species and *Phytophthora* species. Some consider that the most important of these are *Phytophthora* species which, though not killing the entire root system, can so seriously deplete the fine roots that survival is no longer possible. However, in some areas where no *Phytophthora* has been detected, there may be a greater role for *A. pannonicus* in providing the final blow.

Current research on oak decline

As a result of investigations in the UK, France and Germany an EU project, PATHOAK, was set up. Though the whole complex problem was studied, the main emphasis settled on the role of *Phytophthora*. This was particularly true in Germany where Thomas Jung had discovered a new species of *Phytophthora, P. quercina*, associated with the death of fine roots of oak. Following on from his work, inoculation trials were set up in the UK to determine the effect of different *Phytophthora* species on oak roots. Fig. 5 shows a photograph of the results of inoculations after 6 weeks and Fig. 6 shows a chart of the percentage reductions in root mass.

Future research

The role of *Phytophthora* will continue to be investigated under the auspices of the PATHOAK project. However, other factors will be studied, especially at those sites where no evidence for *Phytophthora* has been found. In particular, attempts will be made to discover whether *A. pannonicus* has become more aggressive and now vies with root pathogens as a major cause of death in trees.

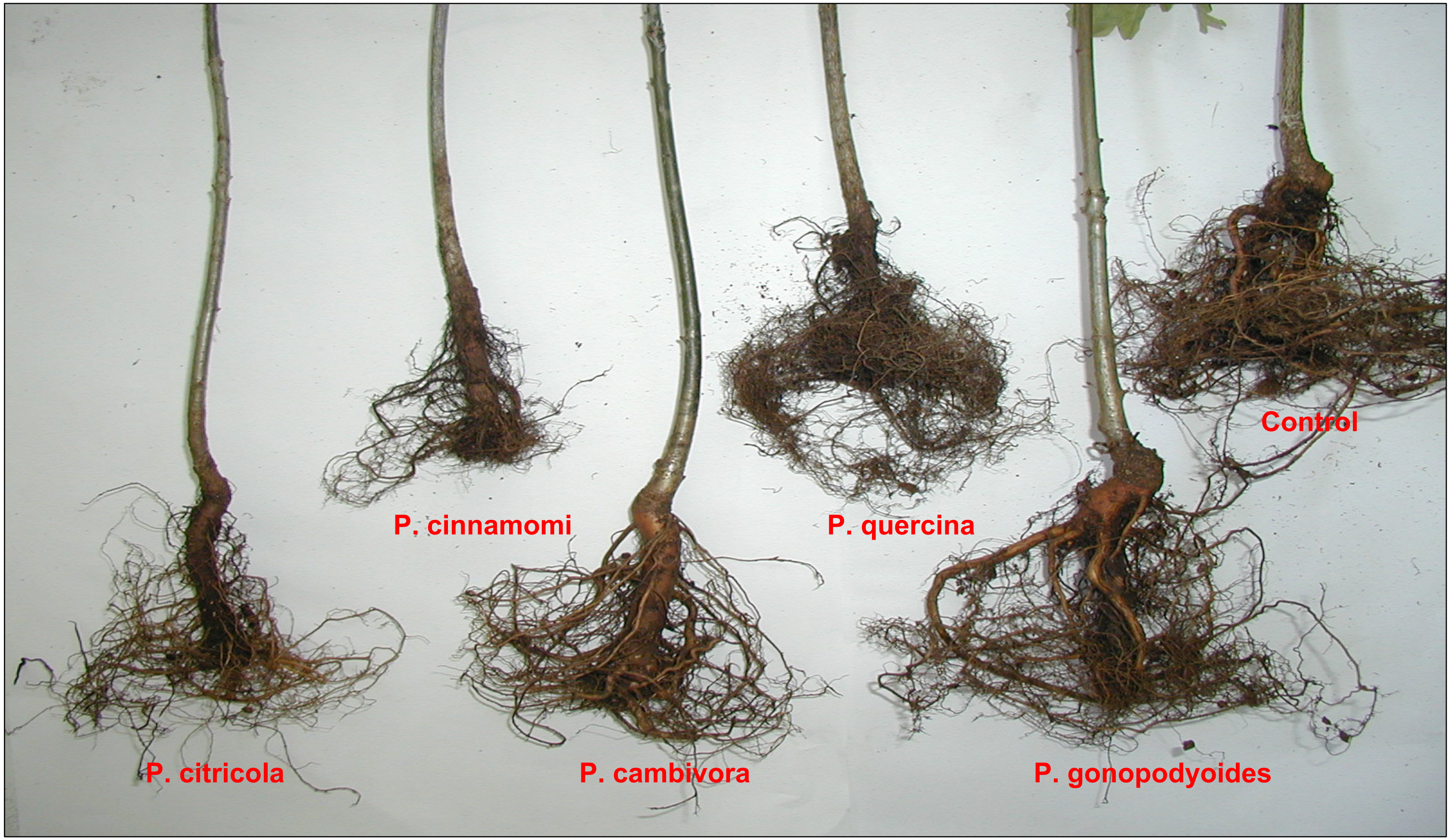

Fig. 5: Trees inoculated with various *Phytophthora* species.

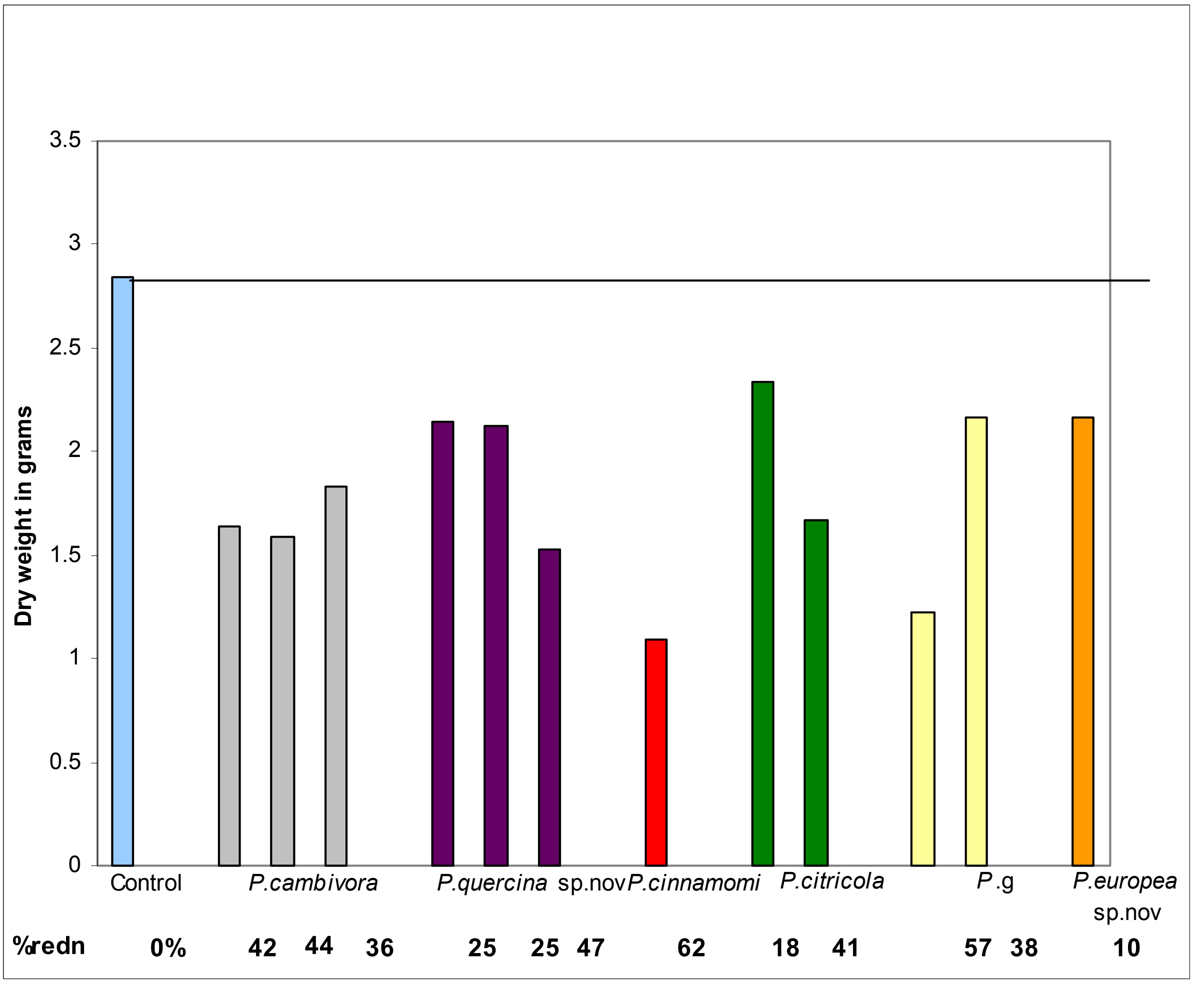

Fig. 6: Chart of root weights of oak after inoculating with *Phytophthora.*

Reference

Day, W. R. 1927: The oak mildew *Microsphaera quercina* (Sch. W.) Burrill and *Armillaria mellea* (Bahl) Qél in relation to the dieback of oak. *Forestry* 1, 108-112.

Oral presentation

Resistance and susceptibility of poplar species and clones to some important pests in Iran

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Abstract

Till now more than 200 species of animals have been collected and reported on different species of poplar in different areas of Iran. The insect species reported on poplar belong the orders Homoptera, Hymenoptera, Lepidoptera, Coleoptera, Hemiptera and Thysanoptera. Importance of the most significant pest species is discussed in the paper. Rsistance and susceptibility of different poplar clones agains the major pest species (*Paranthrene tabaniformis., Platymycterus marmoratus, Phloeomyzus passerinii, Melasoma populi)* is discussed in more details.

Keywords: poplars, *Populus*, insect pests, resistance, susceptibility, folivores, xylophages

Introduction

Reduction of the forest areas of Iran from 18 million hectares in the year 1948 (Saee 1948) to the present 12.4 million hectares, and daily increasing need of the country for wood and its products, has made the planting of fast-growing trees very important. Forest planting by fast-growing species, such as different kinds of pine and poplar, in suitable climates and areas for their establishment and growth, are successful methods for meeting the increasing needs of humans for wood.

Poplar-planting in Iran is one of the oldest traditional forms of agronomy, which from the very early years has been developed with the aims of wood production, shelter-belts, and even ornamental usage. With attention to great usage of poplar products in rural and urban buildings and the match-production industry of the country and its suitable characteristics such as species variation and adaptability of different poplar species to different climates of Iran, poplar plantation has been gratefully accepted by Iranian farmers and also wood and paper companies and factories.

Poplar trees, like many other plant species, suffered damage from different pests and diseases. The damage rate of these suffering factors on poplar trees in some poplar growing areas is so high that has made the farmers unwilling to plant these fast growing species. So, it is necessary to control pests and diseases of poplar which are important restrictive factors of poplar planting in Iran, by using the control methods which have the least environmental damage and pollution, are economically profitable, and effectively reduce the pest population to a level under the economic threshold.

Because pests cannot be controlled by just one method, integrated usage of different controlling methods, which are suitable for them, can be greatly effective. As various pests and pathogens cause damage to poplar, integrating various control methods according to the phenology of the targeted pests, so that it could reduce their economic damage and protect their natural enemies and other useful animals, would be possible with integrated pest management (IPM).

Numerous research projects have been done about introducing and controlling poplar species and clones in different provinces of Iran, and their results have been published. Different researchers have collected and reported the arthropod fauna of poplar trees. Afshar was the first person who studied the poplar pests of Iran in 1948 and published the result of his studies under the title "Important Pests of Poplar and Salix in Iran" (Shojaee 1984). After that, Farahbakhsh (1961) has named 104 animals for the poplar fauna of which the majority are arthropods, particularly insects. Abayi and Adeli in 1983 collected and reported 119 animal species,t most of them insects on poplar trees in different regions of Iran. Rezvani and Termeh (1983) have also reported different species of aphids on poplar trees. In a preliminary research, Babmorad (1993) has introduced 51 species of poplar pests and useful insects in Karaj. Babmorad *et al* (2000) collected 22 spider species and 2 species of parasitoid mites as predators and parasitoids of poplar pests. In another report (2000) they mention 9 insects as predators of the poplar lace bug. Biology, natural enemies and controlling methods of some poplar species such as *Melasoma populi*, *Gypsonoma aceriana*, *Nycteola asiatica*, *Cerura vinula*, *Steraunematus compressicornis*, Aeolesthes sarta, Monosterira unicostata and *Melanophila picta* have been studied by different researchers in different parts of Iran (Adeli 1967; Khial and Sadrayi 1984; Sadrayi 1994; Salehi, 2000; Salehi and Babmorad 1998; Sadeghi *et al* 2000, Sadeghi and Ebrahimi 2001; Sadeghi *et al* 2002; Sadeghi and Askary 2002; Babmorad *et al* 2000, Farashiani *et al* 2000; Kiadaliri *et al* 2000; Dordaee *et al* 2000; Davachi 1968).

Integrated pest management is based on qualitative and quantitative reconnaissance of the ecosystem. The biodiversity reconnaissance would be achieved by faunistic and floristic studies. The qualitative reconnaissance of the ecosystem, discovering the existing and ruling relations among biotic factors and studying the effect of abiotic factors in population fluctuation of the living members of ecosystem will provide another part of the necessary information to develop an IPM program. Studying various and customary methods to control the factors where their damage level is higher than the economic threshold level and are considered as pests, is of the other needs of IPM. In this program, those control methods are advisable in the practical and execution program that not only reduce the pest population to less than the economic threshold, but also do not have environmentally damaging effects compared to the other methods and would be economically profitable.

Poplar integrated pest management program that would be presented for different geographical regions of Iran, is based on the studies and research which have been obtained on different poplar species and clones in each region. As a result of these studies, part of the arthropod fauna of poplar which are about 200 species are collected and identified in different parts of Iran. In addition, important poplar pests in each region has been distinguished and biology, behavior, natural enemies, population density and damage level of some important pests in each which are concerned as key pests in each region have been studied.

In this article resistance and susceptibility of different poplar species and clones to their important pests have been studied in Northern provinces (Guilan and Mazandaran), Zanjan province, Hamedan province, Chaharmahal-Bakhtiari province and Tehran province of Iran.

Distribution of native poplar species in Iran

Plantation of poplar has been current from very early ages in Iran and in most regions from north to south and from east to west, different native or native-made species, self-growing or planted can be seen near the streams, rivers and lakes or as thick nurseries or wind breakers. In north of Iran the native species *Populus caspica* Bornm., in south and west the species *Populus euphratica* Oliv. and in most regions the species *Populus alba* and *P. nigra* are distributed and have different native names. *P. caspica* Bornm. can be named as a native species of northern areas which is distributed from Talesh to Gorgan. Some of the American poplar species, *P. deltoides* has been entered in Iran that their best growing areas are Guilan and Mazandaran provinces and coasts of the Caspian Sea. Some clones of the species *P. X. euramericana* have been successful in adaptability and growing rate in Iran especially in the coasts of Caspian Sea. Non-native clones of *P. nigra* from the countries Italy and Turkey which are planted in northwestern provinces, Hamedan, Tehran, Kermanshah and Zanjan provinces have high yield and are resistant to some pests.

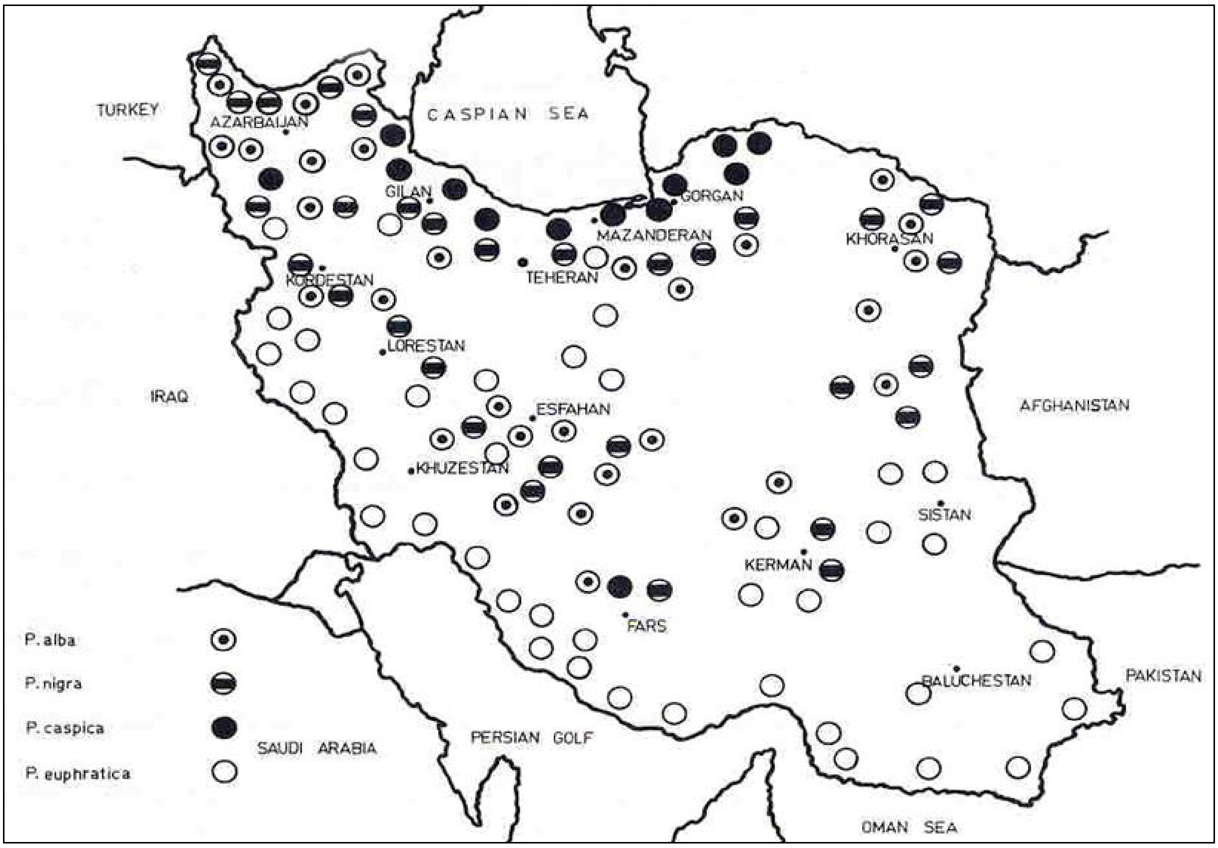

Fig. 1: Geographical distribution of native poplar species in Iran

Arthropod fauna of the poplars

Till now more than 200 species of animals have been collected and reported on different species of poplar in different areas of Iran. Most of these animals are present on *Populus* spp. and are polyphagous, but some of them have been collected just on one particular species of poplar on the basis of ecological role and kind of relation with poplar, these animals are classified in three groups:

pests (damaging factors on poplar), parasitoids and predators. About half of the collected species are poplar pests and the other half is contained of parasitic or predator arthropods. The ecological role of a number of the collected species in this ecosystem is not recognized. The insect species reported on poplar belong the orders Homoptera, Hymenoptera, Lepidoptera, Coleoptera, Hemiptera and Thysanoptera.

Distribution of important poplar pests in Iran

Among poplar damaging animals, insects have the most part in relation to the other arthropods. Among 100 insect species which as poplar pests or damaging factors feed on poplar organs (leaf, branch or trunk), just a few number of species are considered as important and key pests of poplar and their damage level is higher than the economical threshold level, while most pests do not make economical damage. Considering the distribution, some pests are present only in particular areas. For example *Platymycterus marmoratus* is only in Guilan province a serious pest and is not yet reported from other regions of Iran, or root worms of *Melolontha* spp. are in northern provinces of Iran considered as poplar pests, while xylophages like *Melanophila picta* and *Capnodis miliaris* are serious and important pests in dry regions like Tehran, Hamedan, Westazarbayjan, Zanjan and other provinces where poplar is planted (other than northern provinces).

A group of poplar related arthropods are generally distributed in Iran but they are just in particular regions considered as poplar pests. For example *Melasoma populi* or *Monosteira unicostata* are collected from most areas of Iran, but only in particular provinces like Tehran, Isfahan, Hamedan and Zanjan are considered as serious pests. Important poplar pests and distribution of each are explained in the following three groups:

Phyllophagous pests

A number of insect species of the orders Lepidoptera and Coleoptera feed at least in one of their growing stages (larvae or adult insect), on the leaves and leaf buds of different species of poplar. As a result of their feeding the photosynthetic area of the plant reduces. Some times the feeding rate of some of them is so high in nurseries that make poplar seedlings completely naked. So, the infected plants have to relive by growing leaves for the second time and this will cause physiological weakness of the infected trees and their capability to be attacked by xylophagous pests. So, although the damage of defoliating pests in relation to the xylophagous insects that directly attack the wood of these trees, attracts less attention, but according to their role in reducing photosynthetic areas and the wood yield (trunk diameter, height and wood mass) on one hand and their role in making the infected trees susceptible to be attacked by second pests and the xylophagous insects on the other hand, identification of the biological characters, natural enemies and finding a logical controlling method for these pests are unavoidable.

Around 30 species of arthropods with folivore activity has been collected on poplar which some of them are monophagous and feed on just one poplar species and some are oligophagous and feed on different poplar species and some are polyphagous which feed not only on poplar, but also on several other plant species.

Scientific name	Order/family	Distribution
Melasoma populi L.	Col.: Chrysomelidae	General distribution in Iran
Zeogophora scutllaris Suff.	Col.: Chrysomelidae	Northern provinces and Tehran
Gypsonoma aceriana Dap.	Lep.: Totricidae	Kermanshah, Markazi, Azarbaijan and Northern provinces
Lithocoletis populifoliella Tr.	Lep.: Gracilariidae	Kermanshah and northern provinces
Nycteola asiatica Krul.	Lep.: Noctuidae	Markazi and Azarbaijan provinces
Stilpontia salicis L.	Lep.: Lymantriidae	Markazi and northern provinces
Cerura vinula L.	Lep.: Notodontidae	Azarbaijan, Tehran and northern provinces
Lymantria dispar L.	Lep.: Lymantriidae	West-Azarbaijan and northern provinces
Euproctis chrysorrhoea L.	Lep.: Lymantriidae	Zanjan and Azarbaijan provinces
Platymicterus marmoratus	Col.: Curculionidae	northern provinces
Adoretus persicus Reiller.	Col.: Scarabaeidae	Azarbaijan, Markazi and northern provinces
Stauronematus compressicornis (F.)	Hym.: Tentredinidae	Northern provinces and Tehran

Table 1: Important poplar defoliating pests in different provinces of Iran.

Sucking pests

Some species of insects in the orders Homoptera, Hemiptera and Thysanoptera suck the plant sap inside their digestive system by penetrating their stylets in leaf tissues or in trunks of the poplar trees and obtain their essential nutrient materials. In some Homoptera species the surplus amount of the swallowed water and nutrient materials are repelled as honey dew from the terminal part of their bodies and this excreted honey dew attracts dust and the sooty mold fungi. Reduction of the photosynthetic areas of the plant and sometimes falling of the leaves are severe symptoms causing by these pests. *Pterocomma populeti* and *Chaitophorus populi* are examples of such pests.

Another group of these insects have some kind of compounds in their mouth that induce galls on petioles and leaves of the host plant. *Pemphigus* spp. can be named as example of this group. Species of the family Cicadellidae, tripses and *Monosteira unicostata* of the family *Tingidae* occur in some regions on some poplar species and by making necrotic spots and remaining excrements and pupa residues cause silver color of the leaf area, yellowing and early falling of the leaves and so cause severe damage on poplar trees.

Another example is *Phloeomysus passerinii* Sign. that establishes on trunk of the host trees and by feeding on the host plant sap and causing sutures in the bark of the host tree causes physiological disorders and weakness of the tree. The most important sucking pests of poplar are mentioned in Table 2.

Scientific name	Order/family	Distribution
Monosteira unicostata	Hem.: Tingidae	General distribution in Iran
Pterocomma populeum (Kalt.)	Hom.: Aphididae	Northern provinces
Chaitophorus populi L.	Hom.: Pemphigidae	Markazi, Azarbaijan and Guilan provinces
Empoasca decedens	Hom.: Cicadellidae	Markazi, western and northern provinces
Chionaspis salicis L.	Hom.: Coccidae	General distribution in Iran
Phloemyzus passerinii	Hom.: Phloemyzidae	Markazi, Azarbaijan, Hamedan and Zanjan provinces
Lepidosaphes ulmi L.	Hom.: Diaspididae	Markazi, Azarbaijan and northern provinces

Table 2: The most important sucking pests of poplar and their distribution in Iran.

Xylophagous pests

Important xylophage pests of poplar are of the two orders Coleoptera and Lepidoptera. The larvae of some of these species like *Polyphilla olivieri* feed on poplar roots and also cause weakness and drain of the host tree. Nymphs of *Cicadatra ochreata* have been also collected on roots of some poplar species. Xylophagous pests are of the most important pests of poplar in most provinces of Iran. Some of these pests cause severe damage in poplar trunks, so that in some regions of Iran this severe damage has caused unwillingness of the farmers in poplar planting. The best example of these pests is *Melanophila picta*. Table 3 shows the most important xylophagous pests of poplar in different provinces of Iran.

Distribution	Order/Family	Scientific name
General distribution in Iran	Lep.: Aegeriidae	*Paranthren tabaniformis* Rott.
Northern and Markazi provinces	Col.: Scarabeaidae	*Polyphylla olivieri*
Northern provinces	Col.: Scarabeaidae	*Melalontha* spp.
Northern and Zanjan provinces	Lep.: Cossidae	*Cossus cossus* L.
Markazi, Azarbaijan, Hamedan, Zanjan, Tehran and Isfehan provinces	Col.: Buprestidae	*Melanophila picta*
Markazi, Azarbaijan, Hamedan, Zanjan, Tehran and Isfehan provinces	Col.: Buprestidae	*Capnodis miliaris*
Khorasan, Isfehan, Markazi and Northern provinces	Lep.: Cossidae	*Zeuzera pyrina* L.

Table 3: The most important xylophagous pests of poplar and their distribution in Iran.

Resistance and susceptibility of poplar species and clones to important pests:

I. Northern provinces (Mazandaran and Guilan provinces)

Paranthrene tabaniformis Rott.

This pest which has been reported from most poplar planting regions of Iran containing Markazi, Zanjan, Guilan and Mazandaran provinces, is one of the most important poplar pests in northern provinces of Iran. Feeding of the larvae causes gall inducing in young seedlings and branches. Biology and natural enemies of the pest and resistance and susceptibility of the poplar species and clones to this pest have been studied.

Paranthrene tabaniformis (Lep.: Sesiidae) is one of the important poplar pests which causes a great damage on poplar species and clones in nurseries. The activity rate and the rate of damage of this pest are noticeable in Guilan province. Direct feeding of the larvae on center stem causes weakness and reduction of mechanical resistance of the seedlings so that winds and storms may cause breaking of the seed lings in the part where the gall is induced. The infection rate of the poplar species and clones to this gall inducing moth was studied in Poplar Research Center in Astaneh Ashrafieh in Guilan province during the year 1999. Cuts from 10 poplar clones were planted in March in randomized complete blocks design with 3 replications. The rate of survival was measured at the beginning and also in the end of the period. Then all of the growing seedlings were cut and taken to the laboratory. In the laboratory the healthy seedlings were separated from the infected ones (containing galls) and the infected seedlings were studied according to the activity of the gall inducing moth on each clone and species (infection rate), length of the larval tunnel, number of galls on each branch and percentage of the active galls (galls containing living larvae). The obtained data were statistically analyzed using the software SAS.

Results of the statistical analysis showed that the clones which were studied in the case of survival percentage, length of larval tunnel, percentage of the active galls and infection rate are significantly different, but the gall number on each infected seedling of the studied clones did not show a significant difference. Mean comparison of the infection of the clones which was done with Duncan's method showed that the clone *Populus deltoides* 73/51 and *Populus euramericana costanzo* have respectively the most and the least infection rate to this gall inducing moth.

Results:

Survival percentage: The clones are according to the survival percentage significantly different (P<0.0001) and the clones *P. euramerican costanzo* and *P. caspica* have respectively with 88% and 27% the most and the least survival percentage (tables 4 and 5). The clones P. e. triplo, P. d. 69/55, P. d. 77/51, P. e. 92/40, P. e. 45/51, P. d. 72/51, P. d. 73/51 and P. d. 79/51 are according to survival percentage placed in 4 middle groups.

Variation source	**df**	**SS**	**MS**	**F value**	**probability**
Replication	2	925.48	462.742	2.21	0.0675
Treatment	9	12552.46	1294.718	9.68***	0.0000
Error	17	2450.59	144.152		
Total	28	15928.53			

Table 4: Analysis of variance of survival percentage of the seedlings in different poplar species and clones.

Clone	**Group**	**Mean**
P. e. costanza	A	88.6
P. e. triplo	A	83.74
P.d. 69/55	A	74.24
P.d. 77/51	AB	72.23
P. e. 92/40	AB	69.45
P. e. 45/51	BC	51.11
P.d. 72/51	CD	40
P.d. 73/51	CD	72.23
P.d. 79/51	CD	34.72
P. caspica	D	26.95

Table 5: Mean comparison of the survival percentage of poplar seedlings on 10 poplar species and clones.

Gall number: Statistical analysis of the data according to the counted gall numbers on different poplar clones did not show significant difference (Table 6). But when the number of the counted galls containing larvae was statistically analyzed, a significant statistical difference (P<0.05) was proved (Table 7).

The studied clones were according to the number of larvae containing galls classified in 3 groups and the clones *P.d.*73/51 had the most and *P. caspica* had the least number of larvae containing galls. The number of the larvae containing galls were in clones of *P. deltoides* more than *P. euramericana* (Table 8).

Variation source	df	SS	MS	F value	probability
Replication	2	1.45	0.733	1.63	0.2345
Treatment	9	2.71	0.301	0.68 ns	0.7164
Error	17	7.52	0.443		
Total	28	11.68			

Table 6: Analysis of variance of gall numbers on infected seedlings of different poplar species and clones.

Variation source	df	SS	MS	F value	probability
Replication	2	144.56	72.282	0.59	0.5658
Treatment	9	2895.16	321.685	2.62*	0.0416
Error	17	2086.34	122.72		
Total	28	5125.97			

Table 7: Analysis of variance of active gall numbers on infected seedlings of different poplar species and clones.

Clone	Group	Mean
P.d. 73/51	A	40.55
P.d. 79/51	AB	36.87
P.d. 77/51	ABC	28.53
P.d. 69/55	ABC	28.38
P.d. 72/51	ABC	25.3
P. e. costanza	BC	16.95
P. e. 92/40	BC	14.77
P. e. triplo	C	13.89
P. e. 45/51	C	12.99
P. caspica	C	12.42

Table 8: Mean comparison of the active gall number gall on infected seedlings of different poplar species and clones.

Length of the larval tunnel: the length of the larval tunnel in clones showed a significant difference (Table 9). Mean of the larval tunnel length in *P. d.* 69/55 was the most while in P. caspica, it had the least length. The other studied clones were in middle groups (Table 10). As it is showed in table 8 the length of the larval tunnel in different clones of *P. deltoides* is significantly higher than the hybrids of the American clones.

Variation source	df	SS	MS	F value	probability
Replication	2	3.51	1.753	1.48	0.2565
Treatment	9	135.59	15.066	12.68***	0.0000
Error	17	20.19	1.188		
Total	28	159.29			

Table 9: Analysis of variance of the larva tunnel length on infected seedlings of different poplar species and clones.

Clone	Group	Mean
P.d. 69/55	A	8.89
P.d. 72/51	A	7.92
P.d. 77/51	AB	7.40
P.d. 79/51	AB	7.24
P.d. 73/51	BC	5.87
P. e. triplo	CD	5.12
P. e. costanza	CDE	3.91
P. e. 92/40	DE	3.69
P. e. 45/51	DE	3.60
P. caspica	DE	2.10

Table 10: Mean comparison of the larva tunnel length on infected seedlings of different poplar species and clones.

Infection rate: A significant difference was seen between the clones according to the infection with the poplar gall inducing moth (table 11). This study showed that the clone *P. e. costanzo* had the most and *P.d.* 73/51 had the least infection to this pest (Table 12). The clones of P. deltoids showed less infection than the *P. euramericana* clones.

Variation source	df	SS	MS	F value	probability
Repetition	2	415.62	207.81	2.60	0.1015
Treatment	9	4156.82	461.869	5.79**	0.0080
Error	17	20.09	79.983		
Total	28	6008.53			

Table 11: Analysis of variance of the infection rate of different poplar species and clones infected seedlings.

Clone	Group	Mean
P. e. costanza	A	47.26
P. e. triplo	A	45.48
P.d. 69/55	AB	36.77
P. e. 92/40	ABC	30.82
P. e. 45/51	BCD	25.30
P.d. 72/51	BCD	20.40
P.d. 79/51	CD	19.46
P.d. 77/51	CD	18.76
P. caspica	CD	19.65
P.d. 73/51	D	11.11

Table 12: Mean comparison of the infection rate of different poplar species and clones infected seedlings.

Platymycterus marmoratus

The poplar leaf feeder weevil, *Platymycterus marmoratus* (Col.: Curculionidae), is one of the important pests of poplar seedlings in nurseries of Guilan province. The leaf feeding activity of this pest on different poplar clones in the region Astaneh Ashrafieh has been noticeable in the recent years.

Because of the economical and environmental profits, using resistant species and clones of poplar as a suitable instrument in integrated control of this pest has attracted a great attention.

This study was done on 9 non-native clones of *Populus deltoides* and *Populus euramericana* and the native clone *Populus caspica.* 1440 poplar cuts which were 20 cm long and the diameter around 1.5-2 cm of the clones were planted in a 650 square meter land in randomized complete blocks with 3 replications, in Poplar Research Station of Safrabasteh of Guilan province. From the first of April until the end of September, during regulated weekly visits the number of active pests on the aerial organs of all seedlings was counted. In the region Astaneh Ashrafieh the activity of adult insects of the weevil began in the beginning of May and continued until the middle of September. The activity peak of the pest was in July. The result of the statistical analysis on the population of *Platymycterus marmoratus* adult insects which was done by MSTACT software, showed a significant difference between the studied clones. The most population density of the adult weevils was on *P. e. costanzo* and the least of it was on the native species *P. caspica*.

Variation source	df	SS	MS	F value	probability
Replication	2	6.237	3.118	0.2290	
Clone effect	9	491.378	54.598	4.0092	0.0059
Sampling date	16	1232.215	77.013	37.2585	0.0000
Interaction of clone x date	320	393.373	2.732	1.3216	0.0221

Table 13: Two ways analysis of variance (clone/sampling date) of the data obtained from adults of to *Platymycterus marmoratus.*

Clone	Mean ($\sqrt{x}$+ 0.5)	Group
P. euramericana costanzo	4.541	A
P. deltoides 69/55	3.718	B
P. euramericana triplo	3.586	B
P. deltoides 73/51	3.371	B
P. euramericana 92/40	3.131	BC
P. euramericana 45/51	2.535	CD
P. deltoides 77/51	2.391	D
P. deltoides 79/51	2.298	D
P. deltoides 72/51	2.083	D
P. caspica	0.8684	E

Table 14: Mean comparison ($\sqrt{x}$+ 0.5) of population density of *Platymycterus marmoratus* on 10 poplar clones (α=1%).

Sampling dates	Group	Mean
29.6.2001	A	5.005
8.6.2001	A	4.967
22.6.2001	AB	4.670
15.6.2001	ABC	4.461
6.7.2001	ABC	4.347
1.6.2001	BC	3.994
13.7.2001	BCD	3.714
21.7.2001	CD	3.684
25.5.2001	DE	3
28.5.2001	EF	2.530
5.8.2001	FG	1.751
18.5.2001	GH	1.416
11.8.2001	GH	1.404
15.8.2001	GH	1.197
25.8.2001	GH	0.8190
11.5.2001	H	0.7883
1.9.2001	H	0.7390

Table 15: Mean comparison ($\sqrt{x}+ 0.5$) of population density of *Platymycterus marmoratus* on 17 sampling dates (α=1%)

Table 15 shows that the sampling dates have a significant effect on population density of the pest on the studied clones ($p=0$, $F= 37.25$). Mean comparison ($\sqrt{x}+ 0.5$) which was done by LSD method showed that in first decade of July the population density of the adult weevils was the highest and in second decade of April and first decade of September was the lowest.

Table 13 shows that there is a significant interaction between the two studied factors, clones and sampling dates ($p< 0.0221$, $F= 1.3216$).The interaction between the two studied factors tells that in different dates, variation of the population density of the pest on studied clones was significant.

Fig. 2 shows the population fluctuation of the adult insects of *Platymycterus marmoratus* on the studied clones. This figure shows that in the second and third weeks the highest population of the weevils is on *P. triplo* while during the forth week until the sixteenth week the highest density of the pest is observed on P. e. costanzo. High population of *Platymycterus marmoratus* on the clone P. triplo at the beginning of the growth season is because of the early leaf growing of this clone which is earlier than the other clones and when the leaves of all other clones grew (the third week and later), the weevil prefers to transfers to the clone P. e. *costanzo* that the highest population density of this pest during the season is on it.

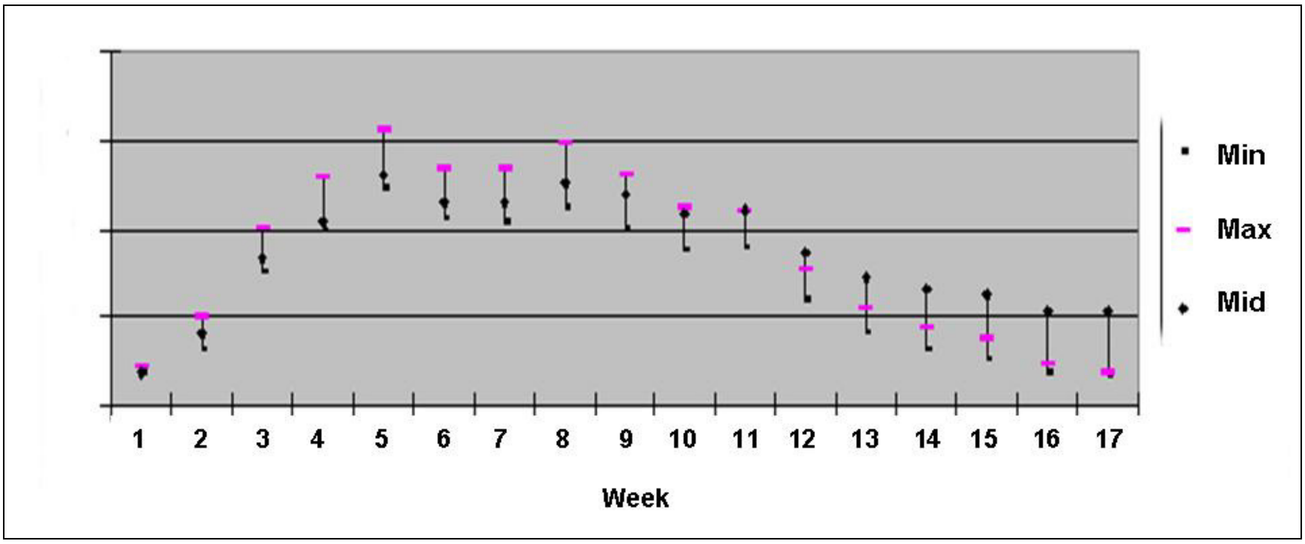

Fig. 2: Population fluctuation of adult insects of *Platymycterus marmoratus* Fst. in Guilan province.

II. Hamedan province:

Interaction of poplar species and clones with poplar wooly aphid, Phloeomyzus passerinii and its associated natural enemies

Poplar wooly aphid, *Phloeomyzus passerinii*, is considered as an important and serious pest of poplar in Iran and many countries. As resistant clones have many environmental and economic advantages, this genetic controlling tool has a special place in integrated management of the pests. In the period of 2002-2003, resistance and susceptibility of 12 poplar clones to poplar wooly aphid were evaluated in the field of Hamedan province of Iran. The clones, *Populus alba* 58/57, *P. deltoides* 72/51, *P. deltoides missoriensis*, *P. X. euramericana* 214, *P. nigra* 62/72, *P. nigra* 62/140, *P. nigra* 62/149 were not infected at all with the pest, but the resting *P. nigra* clones, were infected differently. Number of formed aphid colonies that were found inside of sample unit was counted three times during growth seasons. Analyses of variance conducted on obtained data, revealed a significant difference (α=1%) between the clones. Infestation mean of *P. nigra* 56/72 clone was significantly higher than other studied clones. In all sampling dates, this poplar clone was more infested than other clones. Infestation mean of branches (situating on four main geographic direction of tree) were significantly different in first sampling dates, but in two others, there was not any difference.

Natural enemies of the pest collected in the region were *Exochomus nigrimaculatus* Goeze*, Chilocorus bipustulatus L., *Sympherobius pygmeus* (Rambur), *Anthocoris* sp. *Orius* sp. and *Chiracanthium* sp. The two predaceous species, *Exochomus nigromaculatus* and *Sympherobius pygmeus* are reported for the first time on *Phloeomyzus passerinii*. The two parasitoid species *Thaumatomyia elongatula* (Becker) and *Pachyneuron* sp. are reported for the first time on this pest from Iran. Density means of natural enemies collected on every tested poplar clones were compared statistically. Density means of *T. elongatula* fly and *S. pygmeus* lace winged species were higher than other natural enemy species and placed in same LSD test class. Density mean of the parasitoid wasp was less than those of other natural enemies, while lady beetles and predator bugs were placed in intermediate LSD test classes.

III. Zanjan province

Resistance and susceptibility of eleven poplar clones to poplar wooly aphid, Phloeomyzus passerinii

Wooly poplar aphid is considered as one of the most important pests of poplar plantations in the Europe as well as Iran. As poplar clones resistant to pests have several environmental and economic advantages, this study was carried out to evaluating the susceptibility of ten clones of black poplar species *P.nigra* as well as one *P. alba* clone in Zanjan region. Poplar tested clones were planted in complete block design. In the time of sampling these trees had 5 and 6 years olds in 1999 and 2000. In each design plates, number of infested and non-infested clones to this aphid was recorded two times in each year of studies. In addition, in the year 2000, five level of bark infestation to the aphid was considered. The data of each year were then be transferred as √X+0.5 and separately analyzed.

The analysis of variance conducted with MSTATC software showed significant difference among tested clones. LSD Test Method, indicated P. n. 42/78 and P.n.42/51 as susceptible clones and *P. n* 62/154 and *P. alba* 58/57 as resistant clones. Results obtained in the first year were confirmed by the two sampling methods used in second year. *P. nigra* 65/71 clone, showed a more and less resistance.

Means	**Groups**	**Poplar clones**
8.34	A	*Populus nigra 42/78*
7.752	AB	*Populus nigra 42/51*
7.410	AB	*Populus nigra 56/72*
6.523	ABC	*Populus nigra 65/51*
6.337	ABC	*Populus nigra 56/52*
6.210	ABC	*Populus nigra 56/75*
4.817	ABC	*Populus nigra 49/5*
3.910	BCD	*Populus nigra 65/68*
3.210	CD	*Populus nigra 65/71*
0.7100	D	*Populus alba 58/57*
0.7100	D	*Populus nigra 62/154*

Table 16: Poplar clones infestation means comparison studied in the year 2000 (data transformed in √ X+0.5).

Prob.	**F Value**	**MS**	**SS**	**DF**	**Source**
0.0007	10.67	7.166	14.33	2	Block
0.0000	54.31	36.48	364.80	10	Clone
		0.672	13.435	20	Error
			392.575	32	Total

Table 17: ANOVA table for the evaluation of the poplar clones resistance to *P. passerinii* in the year 2000 (data transformed in √ X+0.5).

Prob.	F Value	MS	SS	DF	Source
0.0019	8.67	10.592	21.185	2	Block
0.000	12.7	15.507	155.070	10	Clone
		1.222	24.440	20	Error
			200.694	32	Total

Table 18: ANOVA table for the evaluation of the poplar clones resistance to *P. passerinii* in the year 2001 (data transformed in √ X+0.5)

Mean	Groups	Poplar clones
6.690	A	*Populus nigra 42/78*
6.583	A	*Populus nigra 56/75*
6.540	A	*Populus nigra 49/5*
6.440	A	*Populus nigra 56/52*
6.140	A	*Populus nigra 42/51*
6.090	A	*Populus nigra 65/68*
5.820	A	*Populus nigra 56/72*
5.557	AB	*Populus nigra 65/51*
3.803	B	*Populus nigra 65/71*
0	C	*Populus alba 58/57*
0	C	*Populus nigra 62/154*

Table 19: Poplar clones infestation means comparison studied in the year 2001 (data transformed in √ X+0.5)

IV. Tehran province:

Melasoma populi L.

Feeding preference of poplar leaf beetle, Melasoma populi on four different poplar species

Poplar leaf beetle is considered as a major pest of poplar species in Iran. Adult and larval instars, attack young stands (1-5 years old) in the poplar nurserieses and native plantations. During sever infestation, adult and larvae are capable to heavily defoliate host trees.

Our field studies, in 1999, showed that the damage rate caused by this insect was varied among different poplar species and clones. In the base of these field observations a number of experiments were prepared. Poplar species used in this study included *Populus nigra*, *P. alba*, *P. simonii* and *P. euramericana*. In spring of 1999, a pair of newly emerged beetles were restricted to a 30 centimeter branch of each poplar species by a loose tissue cage. These beetles were permitted to feed for a 20 day period, until they died. Total leaf area fed by each pair of beetles in their tissue of total fed leaf area, showed a significant difference (P< 0.001) between these four poplar species. *Populus nigra* and *P. euramericana* were preferred host species compared to *P.alba* and *P. simonii*.

Quantitative differences in poplar leaf beetle Melasoma populi (Col. Chrysomellidae) oviposition on four poplar species

When a pair of female and male was placed on poplar branches which were fenced by lace and egg masses laid by females were collected and counted daily to estimate hatching percentage on the plant species. Experiment carried out with four replications.

Data analysis related to female oviposition showed a significant difference ($P<0.01$) between poplar species. Females showed a significant preference for egg laying on P. nigra. The mean of eggs in a cluster, mean of hatched-eggs percent, and total deposited eggs were 49.88, 2, 76.2% and 1095 respectively. *Populus americana* had the second place in terms of oviposition by female. The mean of egg laid by each female (x s.d), incubation period and total eggs deposited on this poplar species were 43.7, 8.1, 85.5 and 429 respectively. Preference of female to oviposit on *P. simonii* was slight and total counted eggs were 83. *P. alba* did not show any preference for female oviposition.

Monosteira unicostata (Mulasant & Reg)

Poplar lace bug: Monosteria unicostata (oviposition on different poplar species and clones in laboratory and field conditions

Poplar lace bug is considered as an important pest of poplar species and clones in some part of Iran. Evaluating resistance and susceptibility of poplar species and clones to the pest in an important point in producing resistance transgenic poplar as well as developing IPM programs. In laboratory condition, two series of experiments were carried out. In the first, oviposition rate was studied on poplar cuts placed singly in breeding cages. In second, the cuts of whole clones were placed together in the cages. In the cages the experiment, one and ten pair (male and female) of the insect was released in first and second experiment was repeated ten times. The poplar species and clones used in the study were, *Populus nigra* 63/135, *P. euramericana triplo*, *P. alba*, *P. trichocarpa*, *P. deltoides* 77/51, *P. e. verniruben* and *P. trichocarpa* and *P. e. triplo* were most and less preferred host respectively in terms of oviposition site. Obtained data from field sampling, were the same as those of those of laboratory experiments

V. Chaharmahal-Bakhtiari province:

Introduction of Empoasca decedens Paoli (Hom. Cicadellidae) as pest of poplar and evaluation of its density on poplar clones

This pest is reported for the first time in the world as a pest on poplar trees in Chaharmahal-Bakhtiari. This research was carried out on 35 different poplar clones in Boldaji Research Station. The obtained results showed that among the 35 studied clones, the clones: *P. alba*, *P. d. marilandica*, *P. e. gelrica*, *P. e. vernirubensis* and *P. n. betulifolia* were highly infected to this pest and there was a significant difference among the infected clones ($p<0.05$, $F=10.79$). The results showed that the clones *P. alba* and *P. d. marilandica* with the mean of 2.84 ± 0.11 and 2.37 ± 0.16 insects per each leaf area unit respectively had the most infection rate and were placed in a similar statistical level and were significantly different from the other clones. The other clones *P. e. triplo*, *P. e. gelrica*, *P. e. vernirubensis* and *P. n. betulifolia* were placed in a similar statistical level and were significantly different from the two first clones ($p<0.05$).

With attention to the importance of this pest and its damage especially on the native clone of this province, *P. alba*, further studies about identification of biology and natural enemies of the pest and introducing the best controlling method for it are needed.

Variation source	Df	SS	MS	F
Treatment	5	229.84	45.96	53.73**
Error	378	323.42	0.85	
Total	383	553.27		

Table 20: Analysis of variance of *Empoasca decedens* population density on different poplar clones in Boldaji Station.

Clone	Block	Mean & Error
P. d. marilandica	64	2.84±0.11[a*]
P. alba	64	2.37±0.16[b]
P. euamericana triplo	64	1.24±0.13[c]
P. e. gelrica	64	1.2±0.8[c]
P. e. vernirubensis	64	1.05±0.14[c]
P. nigra betulifolia	64	0.66±0.01[d]

Table 21: Mean comparison of *Empoasca decedens* population density on different poplar clones in Boldaji Station.

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Oral presentation

Temperature and winter activity of the pine processionary moth, *Thaumetopoea pityocampa* (Lepidoptera, Thaumetopoeidae)

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Abstract

We studied the effect of temperature on the activity of the winter feeding larvae of *Thaumetopoea pityocampa* in order to develop a temperature-based model to identify areas which may be invaded by the expanding Mediterranean pine pest in future This model includes the topoclimatic conditions of the terrain, the deviation between air and nest temperature, and the physiological constraints for feeding activity and cold tolerance limiting the survival of the larvae during winter. In a first step, the freezing tolerance of the larvae was studied by measuring their supercooling point (SCP) in various instars. Extended diapause, which was found in 36% of surviving pupae by determination of their respiration rate, may be an important adaptation to avoid local extinction by developmentally unfavorable winter periods.

Keywords: *Thaumetopoea pityocampa*, *Pinus*, winter activity, supercooling point

Introduction

The processionary moths of the genus *Thaumetopoea* live on various host plant species in Africa, Asia and Europe, but only a few species among them may colonise conifer trees. These species can be further subdivided in those feeding in summer ('summer species' such as *T. pinivora* on Scots pine in Europe, *T. bonjeani* on Cedrus in N Africa and Middle East) or in the winter period ('winter species' such as *T. pityocampa* and *T. wilkinsoni*) (Démolin and Frérot 1993). The winter feeding species are commonly defined as 'pine processionary moth' (PPM), which in Asia and Middle East are represented by *T. wilkinsoni* and in Europe and Africa by *T. pityocampa*. The two species were considered as synonyms for a long time but their separation became recently evident due to an intensive genetic study (Salvato *et al* 2002).

Thaumetopoea pityocampa is a univoltine insect that is oligophagous on *Pinus* spp., but it can attack *Cedrus* spp. and the introduced *Pseudotsuga menziesii* as well (Roques *et al* 2002). The phenology varies with climatic conditions (Démolin 1969). Emergence of adult moths varies from end of June - in colder mountainous regions – up to beginning of October - in areas with Mediterranean climate. The females are very short living, oviposition happens just after emergence and mating mainly within the first night. The larvae hatch about 30-40 days after oviposition. They are gregarious and rest during the daytime within a nest which is more and more enlarged during their development through five instars. Larvae feed nocturnally on the needles throughout the winter period, as long as the temperature is above 0°C (Huchon and Démolin 1971). The larvae can tolerate temperatures as low as -16° for several days provided that the colony is numerous and the nest is well constructed. In late winter or spring the larvae form a procession and move to the soil to pupate. A variable proportion of the colony enters an extended diapause in the pupal stage which may last up to six years (Démolin 1969).

Thus, the life cycle of the moth depends mostly on winter temperature and on the conditions inducing an extended diapause in the pupal stage. As a general rule, at upper elevation and latitude the feeding ends in late spring, diapause is frequent, moths emerge in early summer. At lower elevation/latitude the feeding ends in winter or early spring, diapause is facultative, moths emerge in late summer.

Apparently, the increase of temperature observed in the last decades may have promoted the spread of the processionary moth, both in its range to upper latitude and elevation (Battisti *et al* 2005). Large outbreak areas have been observed in regions where the pest was absent or rarely recorded, e.g. in central France and in the Alps, where outbreak affecting also pine species which were previously little concerned (Scots and mountain pine) (Benigni and Battisti 1999; Goussard *et al* 1999).

T. pityocampa is generally considered among the most important limiting factors for growth and survival of pine forest ecosystems in southern Europe and Mediterranean countries. Although in most cases trees recover from defoliation outbreaks areas are a risk of secondary attack for the trees by other pests and of soil degradation and desertification, especially in the Mediterranean region. The function of these defoliated forest ecosystems is affected among other things by lower carbon fixation and higher soil respiration that again affects the climate in a feedback effect.

However, there is another problem which is sometimes more important than defoliation: the public and animal health risk (contact dermatitis) due to the urticating hairs produced by larvae from the 3rd instars on (Lamy 1990). Dermatologists call these symptoms "lepidopterism" (Maier *et al* 2003). The tiny microscopic hairs are about 150 – 250 µm and are located on the larval dorsal abdomen. Human contamination with hairs may occur without any contact to the larvae, only by wind dispersal of hairs in heavy loaded air. The urticating hairs can be activily tossed off by the larvae under disturbance (Lamy 1990). Contamination may cause a more or less strong dermatitis and even asthmatic reactions are observed. Hairs are keeping the urticating power for many years and therefore even older, already left nests that are full of larval exuvia, are a public health risk.

Our objective was to assess the risk of outbreaks in new regions by a temperature-based model. Therefore, the impact of minimum temperature thresholds on the range and expansion of PPM was estimated in order to identify areas susceptible to be invaded in future. Having identified the physiological constraints, the application of scenarios of future climate change enables the potential distributional change to be estimated. Modeling and mapping of the range of PPM using GIS is therefore a useful tool for estimating the actual and future impact of the range of PPM on forest management and their socio-economic implications.

Materials and Methods

Developmental conditions

The Venosta Valley has an east–west orientation with opposite-facing slopes (Hellrigl 1995). On the southern-facing slope, mainly plantations of *P. nigra* cover the altitudes between 750 m and 1,250 m; they are intermixed with native *P. sylvestris* stands occurring up to 1,500 m. The stands on the northern-facing slope are composed mainly of native *P. sylvestris*, reaching a maximum elevation of 1,200 m.

We established two altitudinal gradients on the opposite slopes: from 960 to 1450 m on the southern slope, and from 810 to 1190 m on the northern slope. Each gradient involved three sites (on the southern slope, 960 m, 1,210 m, 1,450 m; northern slope, 810 m, 1,010 m, 1,190 m), representing the core, expansion, and external zones, respectively.

In order to compare air and nest temperature at the selected sites we collected nests from the natural populations of PPM at the southern slope in Venosta Valley in the respective zones and established them at the corresponding sites along each gradient on the northern slope. The data of air and nest temperatures at the three different altitudes at each of the slopes were used to develop a topoclimatic model that again should reflect the developmental conditions during the feeding period of the larvae. The model for calculating minimum and maximum temperatures of each location in the study area was based on regression analysis of data recorded at the reference and the field stations (Fig. 1). Basic topographic parameters (elevation, slope, aspect) were derived from a digital elevation model with a resolution of 75 m for the local scale model at Venosta Valley.

Supercooling point of larvae

Supercooling points (SCP) of 2nd to 5th instars collected from nests at different altitudes of the southern exposed slope and at various times during the winter period of 2003/04 were analyzed. We used a micro-thermo element equipment (copper-constantan thermo element) combined to a multi-channel recorder (BBC Braun Boveri, Servogor 460) to determine the whole body SCP. The ambient temperature was decreased at an average rate of 1°C/min, starting at +10°C and ending at -25°C.

Feeding activity

Winter nests were collected at different elevations (850 - 1400 m) in Venosta Valley in January 2003. To study the effect of low temperatures on feeding activity of larvae a nest with larvae was incubated in a rearing chamber under short day (SD) -photoperiods (light from 8 am to 4 pm). A small potted tree of *P. nigra* was provided as food for the larvae. Night temperatures were kept constant at -3°C, 0°C, and +3°C, respectively, and day temperatures were increased every other day from +3°C in 3°C-steps up to +15°C and then decreased again to +3°C. Feeding was assessed indirectly by collecting faeces automatically at intervals of 90 min with a collector attached to an electric timer. Faeces production (fresh weight) was summed up for each time interval during two days, and divided by the number of larvae in the colony to obtain per capita faeces production.

Oxygen consumption rate of pupae

Pupae from the southern slope of Venosta Valley were stored inside their cocoons in a climate chamber at 18°C. Pupal weight and oxygen consumption were measured weekly from June to September 8(i.e., 11 times). At the beginning of September, cocoons were removed from remaining pupae in order to control mortality.

The rate of oxygen consumption was measured by an automatically registering micro-respirometer (modified after Pruscha, 1984) using the volumetric method of Scholander. The changes of the gas volume necessary to maintain constant pressure in the chambers were recorded in one minute intervals. The recording was stopped after 3-5 hours and the calculation of average rates of respiration was in µlO_2/h/mg pupa fresh weight.

Modelling nest temperatures and feeding ability

For a precise estimation of the relation between nest temperature, air temperature and solar radiation, air temperature as well as front and back nest temperatures were measured simultaneously with nests varying in size and number of larvae at the garden of the institute in Vienna. The nests were located at young pine trees and exposed southwards during the winter period 2002/03.

Feeding activity was estimated according to two conditions that have to be satisfied to enable the PPM larvae to feed: the temperature inside the nest during the day has to reach more than 9°C (activation temperature) and the air temperature during the following night must be above 0°C (potential feeding temperature). If one of these conditions is not fulfilled, starvation occurs.

Local and regional topoclimatic modelling

Study areas for topoclimatic modelling in complex alpine environment were selected where the translocation experiments took place (Venosta Valley). Basic topographic parameters (elevation, slope, aspect) were derived from a digital elevation model with a resolution of 75 m for the local scale model at Venosta Valley.

Result and Discussion

Nest/ air temperature

In contrast to the minimum temperatures, which correlated very close between air and nest temperatures (r = 0.99) at both slopes, from November 2002 up to March 2003 the average maxima of the nest temperature at the southern slope was significantly higher than the air temperature and differed also to the corresponding nest temperatures of the northern exposed slope (Fig. 1). In this winter period the minimum temperature did not exceed -16°, which is known as the lower lethal temperature of the larvae (Huchon and Démolin 1971).

The average monthly deviation between nest temperature and air temperature outside of the nest was always positive for the nests at the southern exposed slope during the winter period (Fig. 2). This was also true for the upper northern site, but not for the other sites at this slope. Here, the monthly average nest temperatures were significantly lower than the air temperatures from November up to February.

The topographic model, in which numbers of sunny hours are included, indicates the more eastern exposition of the upper northern site that caused a higher number of sunny hours per day on average and thus a positive monthly nest-air temperature deviation compared to the two lower, more shaded northern sites (Fig. 3).

The strong effect of irradiation on the nest temperature is influenced by the size of the nest and the number of larvae inside the nest (Fig. 4). On a sunny winter day, at an irradiation intensity of 330 Watt/m² and an outdoor air temperature of 0°C we measured +15°C at the inner part of the front side and +10°C at the inner part of the back side of a well developed nest containing 256 alive PPM larvae, while the nest temperature was clearly lower in a bigger nest with a sparse external silk layer and a lower number of living larvae.

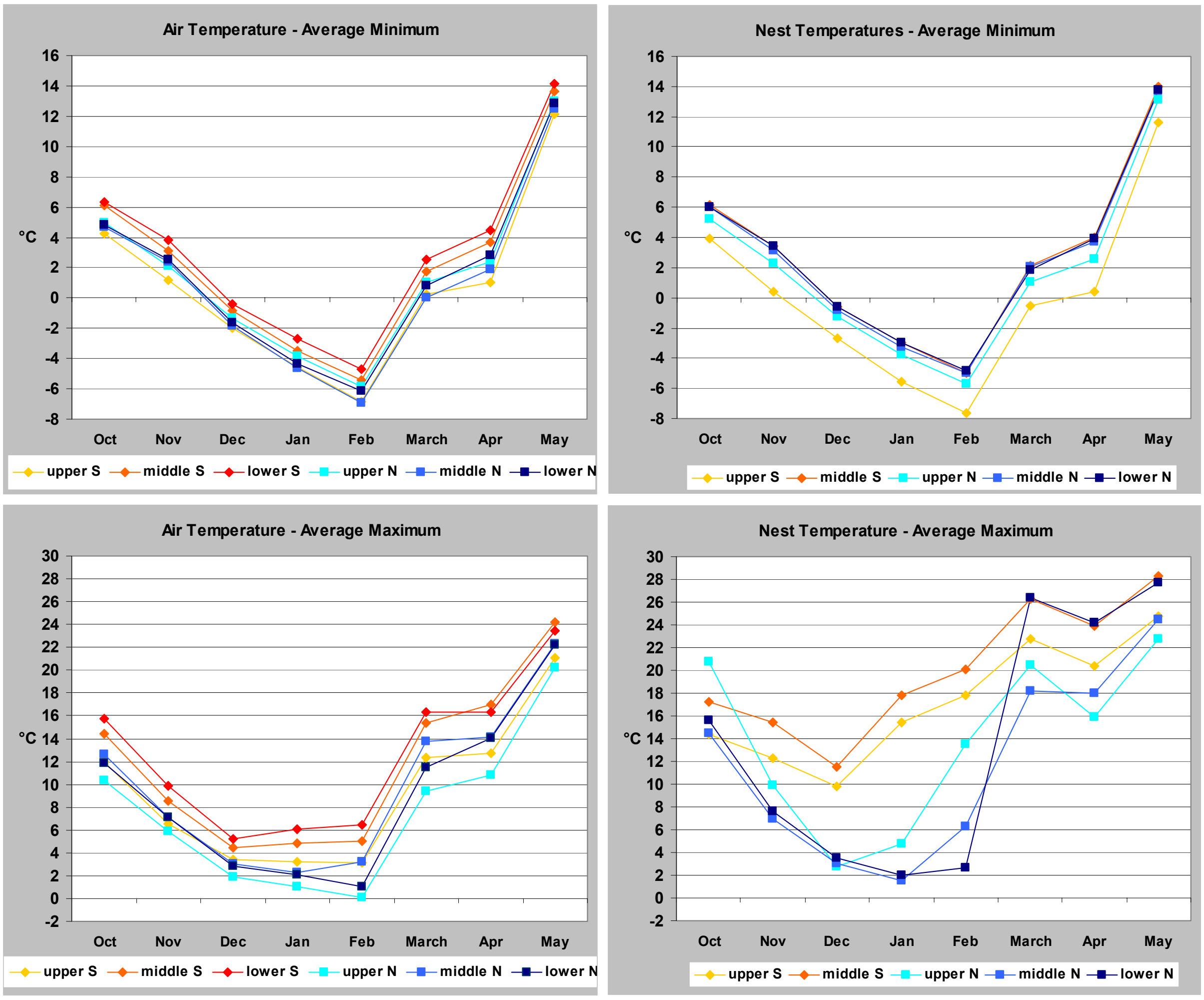

Fig.1: Averaged monthly minimum and maximum of air and nest temperatures at three sites of the southern and northern slope of Vinschgau/Venosta Valley during October 2002 to May 2003 (the nest temperature data of the lower site of the southern slope are missing).

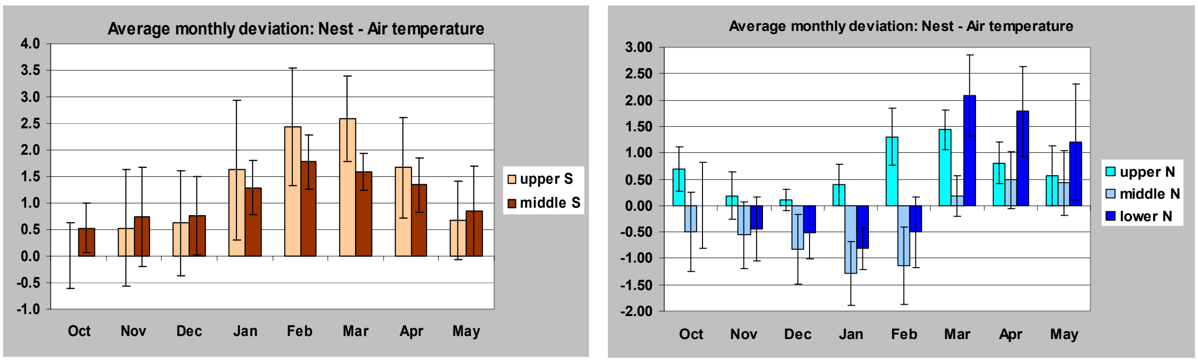

Fig. 2: Average monthly deviation between nest temperature and air temperature at the various recorded sites of the southern and northern slope of Vinschgau/Venosta Valley during October 2002 to May 2003.

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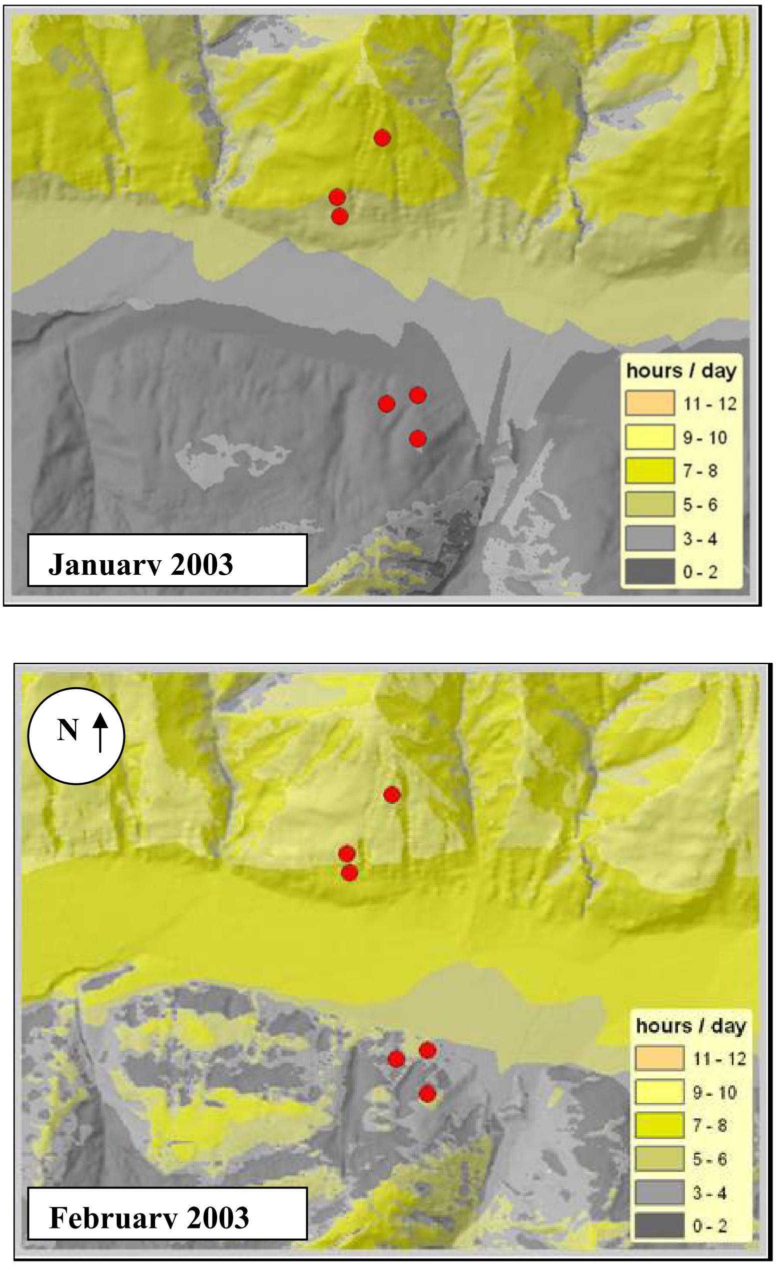

Fig. 3: Average number of hours with sunshine at Venosta Valley on January 15 and February 15, 2003; red points indicate the recorded areas at the southern and northern slopes.

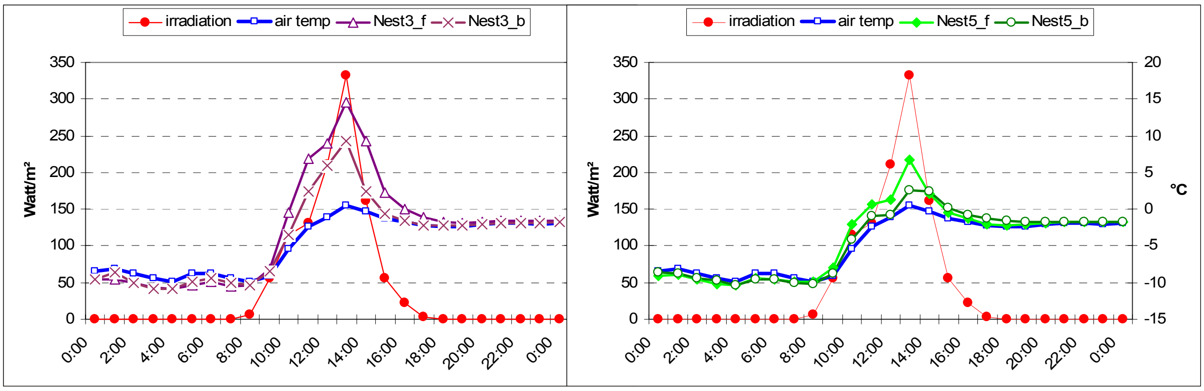

Fig. 4: Influence of irradiation intensity (Watt/m²) on air temperature and front and back nest temperatures of two different nests at outdoor conditions on January 25, 2003; nest 3 inhabited 256 living larvae and had a volume of 480 cm³; nest 5 inhabited 72 living larvae and had a volume of 720 cm³).

Feeding activity

Larvae tested at various thermoperiodic conditions in the lab did only feed at night, when the previous day temperature was+9°C or higher and the night temperature was above 0°C. No faeces were produced when the night temperature was –3°C. Faeces were never produced during the day, not even when the larvae starved during the night at low temperatures (Battisti *et al* 2005).

Threshold temperatures for larval activity during the cold period were found both with respect to induction of feeding (day temperature) and actual feeding (night temperature). A day temperature higher than +9°C was necessary to trigger feeding during the following night. The magnitude of induction varied with day temperature; feeding was significantly higher at higher day temperatures (Repeated Measures Anova, $F(2,109) = 4.95$, $p < 0.01$). Feeding occurred at night when the air temperature was above 0°C (PFT). No faeces were produced when the night temperature was –3°C. Under these conditions, faeces were never produced during the day, not even when the larvae starved during the night at the low temperature.

Transferring the results of the induction of larval feeding activity from the lab to the temperature conditions in the field reveals a crucial lower number of hours which may be used for feeding at the northern slope than at the southern slope for the cold period 2002/2003 (Fig. 5).

During the time from December 2002 to March 2003, the insolation at the southern slope was associated with a number of hours with nest temperature above the threshold of +9°C. However, the number of hours of predicted feeding was almost twice as high in the core site as in the site beyond the edge, because of the more favorable night temperature at the lower sites.

At the northern slope the insolation was about six times lower than at the southern slope because of the shading of the mountain ridge. Accordingly, the day temperature in the nest was much lower compared to nests at the southern slope resulting in a clearly more limited time for feeding activities.

Supercooling point

As a first step to investigate the strategy of the moth to survive low temperature periods, we measured the supercooling point of overwintering larvae at various stages. The SCP is defined as the point when body water of the insect begins to freeze, which is an exothermic process.

We tested all the various instars of *T. pityocampa* which might be faced to lower temperature conditions during their development. However, we found no special adaptation of any instar to low temperature by an increased SCP. The SCP varied to a high degree with a mean of about -8°C and a minimum value of -15°C. No significant effect was recorded between larvae from outdoor conditions (institute garden) and those kept continously at SD/+3°C in a climatic chamber (Fig. 6).

The high variability in the SCP might be due to the fact that larvae are feeding at favorable conditions during the winter and gut content is an important factor for providing ice nucleating material.

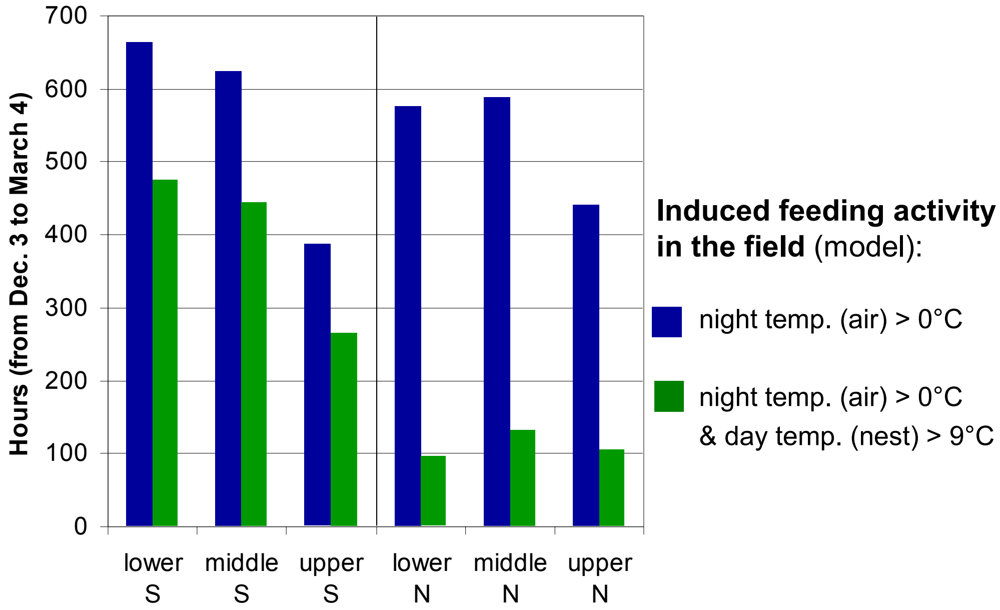

Fig. 5: Temperature condition, expressed as number of hours, experienced by the colonies at the different sites in the "cold period" - this was defined as the period during which the weekly mean of the minimum temperature was below 0°C, - i.e. from December 3, 2002, to March 4, 2003.

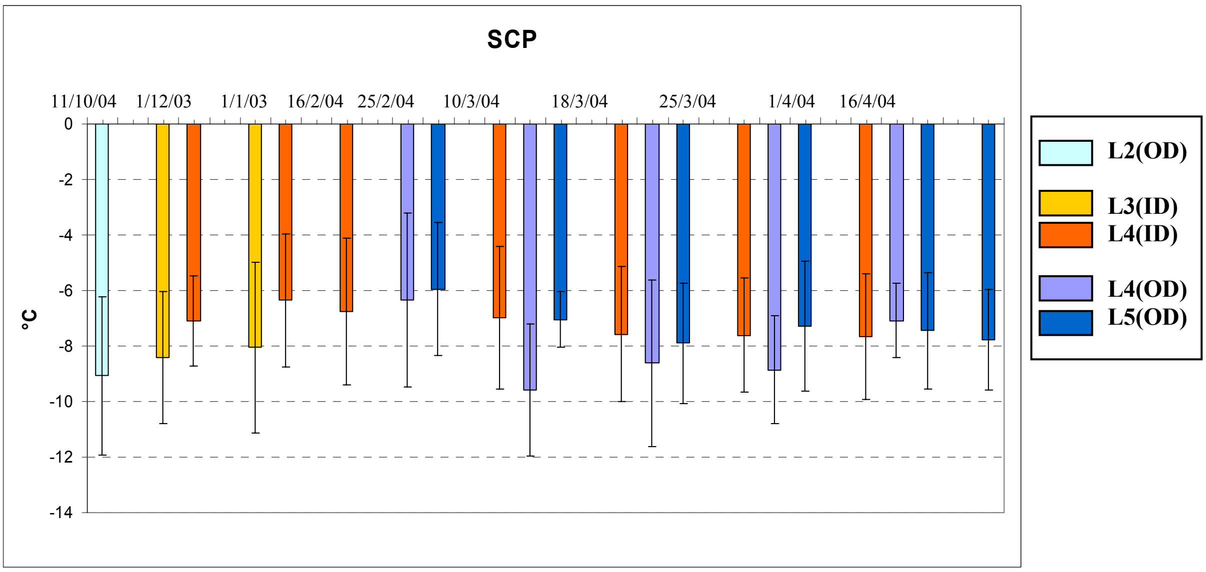

Fig. 6: Mean supercooling points (SCP; °C) of second to fifth instars of *T. pityocampa* assessed at various time during the winter period; before measurement the larvae were kept either at outdoor conditions (OD) in the institute garden or continuously at +3°C in a climatic chamber (ID).

Pupal diapause

Extended diapause appears to be a key adaptation for survival under extreme conditions, as it allows the spreading of the individuals originated from one colony over several years. This fact will increase consistently the probability of survival for the colony, but also has a crucial effect on control measurements of this insect.

From pupae collected in Venosta valley we recorded a total mortality rate of 23%. Moths eclosed out of 64% of the surviving pupae in the same year, while 36% of the pupae remained in an extended diapause stage (Fig. 7).

Surprisingly, in the same year we recorded 100% of pupae showing an extended diapause from a core population in Verona. The diapause stage is recorded by the respiration rate of the pupae, which is about 30 to 40 times higher in pupae one to two weeks before eclosion (Table 1).

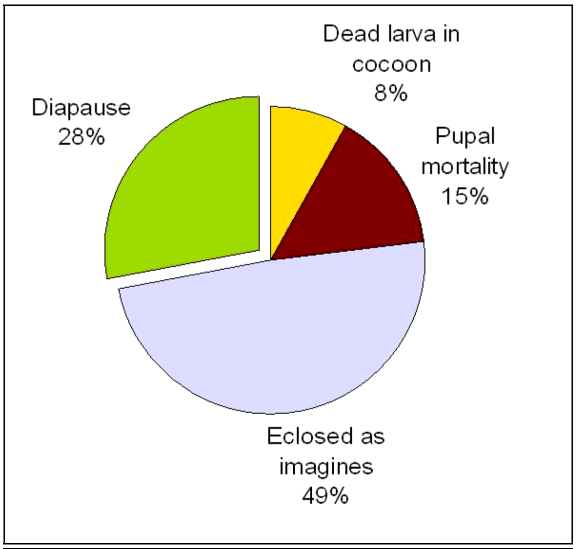

Fig. 7: Mortality rate, rate of eclosing moths, and rate of extended diapause stage from pupae collected in Venosta valley in spring 2003.

July 2003	Mean µg O_2/h/mg fw	S.E.	n
Eclosing pupae (Venosta Valley)	181.3	9.3	42
Diapausing pupae (Venosta Valley)	7.0	0.9	45
Diapausing pupae (Verona)	2.8	0.3	97
August/Sept- 2003	**Mean**	**S.E.**	**n**
Diapausing pupae (Venosta Valley)	8.1	1.9	45
Diapausing pupae (Verona)	2.7	1.1	15

Table 1: Mean respiration rate [µg O_2/h/mg fw] of pupae of *T. pityocampa* about 2 weeks before eclosion (July 2003) or of those with a prolonged diapause; pupae originated from Venosta Valley and Verona (measured in July and August/Sept. 2003).

Conclusions

Temperature greatly affects the growth and survival of *T. pityocampa* during winter. In general, colony survival in both expansion areas was reduced at sites with a lower number of hours of predicted feeding, showing the importance of winter feeding for *T. pityocampa* (Battisti *et al* 2005). Although the larvae may become quiescent during prolonged periods without feeding, thereby greatly reducing their metabolism (Leather *et al* 1993), they will face metabolic demands whenever their activity is induced by nest temperature higher than the threshold. Larval activity of *T. pityocampa* at temperature around 0°C was also observed by Fitzgerald and Blas (2003), who monitored the movement events under field conditions and showed that in induced colonies larvae leave the nest with the onset of darkness and return in the morning as long as the temperature is near 0°C.

Stochasticity in weather may affect larval survival even without reaching the minimum temperature. The predicted increase in the frequency of extreme weather events (Parmesan *et al* 2000, Bale et al 2002), which can cause massive mortality in young or starved larvae (Démolin 1969, Huchon and Démolin 1971), may then complicate predictive models of *T. pityocampa* expansion based on average minimum winter temperatures. As the SCP values observed were higher than the lower lethal temperature, the larvae may cope with several daily cycles of freezing during winter, which is a remarkable trait for an insect (Sinclair 1999). Finally, local extinction events due to the overcoming of the threshold could be offset by recruitment of diapausing individuals from the previous years. Therefore, it is reasonable to assume that the geographic range of *T. pityocampa* will continue to expand in response to increasing mean temperatures.

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Oral presentation

Different tolerance to rust infections on several poplar clones

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Abstract

Melampsora rust is one major foliar disease of hybrid poplar clones and the problem is most dangerous in nurseries and motherstands. The most important causel species are *Melampsora larici-populina* and *Melampsora allii-populina* and the 'result' of the attack should be an early leaf-losing, restrained growing and finaly an open way for other most serious damages, for example stamp-canker cousing by *Dothichiza populea.* In every time the main aim of poplar breeding and selecting is the tolerance or resistance to leaf-rust. There is a good method to investigate the poplar clones's behavior to rust infection on the base of fenotypic answer. Nowadays there are several molecular methods to exam the genotype of the varieties, it started with isozyme analysis and now thera are many good molecular technics to investigate the genom to understand the diferent answers to rust infection. Through our work RAPD (Randomly Amplified Polymorphic DNA) procedure was used to establish genetic diversity of 9 *Populus* clones. We used 6 primers found in the literature. We would like to find good primers to show polymorphism, easily detectable bands which sufficient to distinguish the genptypes. We would like to find a primer, which seem to be a good marker to show the different tolerance to *Melampsora* species. From the results it seems, that RAPD analysis should be promising to find markers.

Keywords: rust fungus, *Melampsora*, poplar clones, susceptibility, tolerance

Introduction

Melampsora rust is one major foliar disease of hybrid poplar clones. The problem is most dangerous in nurseries and motherstands. The most important cause species are *Melampsora larici-populina* and *Melampsora allii-populina.* The 'result' should be an early leaf lost, restrained growing and at least an open way for other most serious damages, for example stamp-canker caused by *Dothichiza populea.* In every time the main aim of poplar breeding and selecting is the tolerance or resistance to leaf-rust. There is a good method to investigate the poplar clones's behaviour to rust infection on the base of phenotypic answer. Nowadays there are several molecular methods to exam the genotype of the varieties, it started with isozyme analysis and now there are many good molecular techniques to investigate the genom to understand the different answers to rust infection

The aims

Our hypothesis was if there is a very good fenotypic answer we can show the difference in the genom using a molecular techniques.

- RAPD (Randomly Amplified Polymorphic DNA) procedure was used to establish genetic diversity of 9 *Populus* clones we used 6 primers from literature
- We would like to find good primers to show polymorphism, easily detectable bands which sufficient to distinguish the genotypes
- We would like to find a primer which seem to be a good marker to show the different tolerance to *Melampsora* species

Material and methods

Investigations of different phenotypic tolerance in nurseries

We made examinations in several nurseries on different poplar clones using the categories below:

1 (no infection):	there are no infected leaves
2 (low infection:	there are only some infected leaves and on the lower leaf-floor
3 (medium infection):	we can find infected leaves on higher leaf-floor also, but only some spots
4 (hard infection):	there are a lot of infected leaves on every leaf-floors, all infected leaf are full with orange coloured uredium
5 (very hard infection):	there are no a healthy leaf, this is the last stadium before the whole leaf-losing

The following clones were investigated:

1:	I-273	9.	Ghoy	17.	Agathe
2:	Koltay	10.	I-214	18.	BL
3:	Kopeczky	11.	I-45/51	19.	Raspalje
4:	Meggylevelű	12.	Kornik	20.	Robusta
5:	Pannónia	13.	Parvifol	21.	Sudár
6:	S-299-3	14.	S 298-8	22.	Unal
7:	Beaupre	15.	Triplo		
8:	Blanc de P.	16.	74 006		

Investigations of genotypes

The used method was following:

DNA isolation

- DNeasy Plant Mini Kit (Qiagen) were used
- The quality and quantity of DNA was controlled on agarose gel and it was the template DNA through the RAPD analysis

RAPD analysis

- For the RAPD *reactions* we used BioRad Cycler apparatus, with 0,2 ml-es PCR tubes
- *The components were:* template DNA, primer, PCR buffer, $MgCl_2$, dNTP, Taq polimerase (Promega).
- *The steps of the reaction*: 2 minute 94 °C and than 40 x repeated: 10 s 94°C 30 s 36°C 1 minute 72 °C and finally 2 minute 72 °C

Following the result of the phenotypic investigation we chosen next nine varieties and there pools:

Tolerant	**Susceptible**	**Very susceptible**
1. Pannonia	4. I 214	7. Agathe
2. Kopeczky	5. Ghoy	8. Raspalje
3. Hoogvorst	6. 76 004	9. Robusta

Next primers were used:

PRIMER	**SEQUENCE (5'-3')**	
OPU08	GGCGAAGGTT	Operon Technologies[1]
OPX11	GGAGCCTCAG	Operon Technologies[1]
OPZ14	TCGGAGGTTC	Operon Technologies[1]
OPK01	CATTCGAGCC	Operon Technologies[1]
OPD05	TGAGCGGACA	Operon Technologies[1]
OPA04	TGAGCGGACA	Operon Technologies[1]
OPG10	AGGGCCGTCT	Operon Technologies[1]
OPG18	GGCTCATGTG	Operon Technologies[1]
UBC354	CTAGAGGCCG	UBC[2]

Results

Matrix of genotypes from six primers' RAPD bands:

	OPD05	OPA04	OPG10	OPG18	OPX18	UBC354
1	A	A	A	A	A	A
2	A	A	A	A	A	B
3	A	A	A	B	B	C
4	B	A	B	C	C	D
5	C	A	C	A	C	B
6	D	C	A	C	D	C
7	E	A	D	C	E	B
8	D	A	A	B	B	C
9	E	B	D	C	C	B
10	A	A	A	A	A	A
11	C	A	C	A	B	D
12	D	C	D	C	C	B

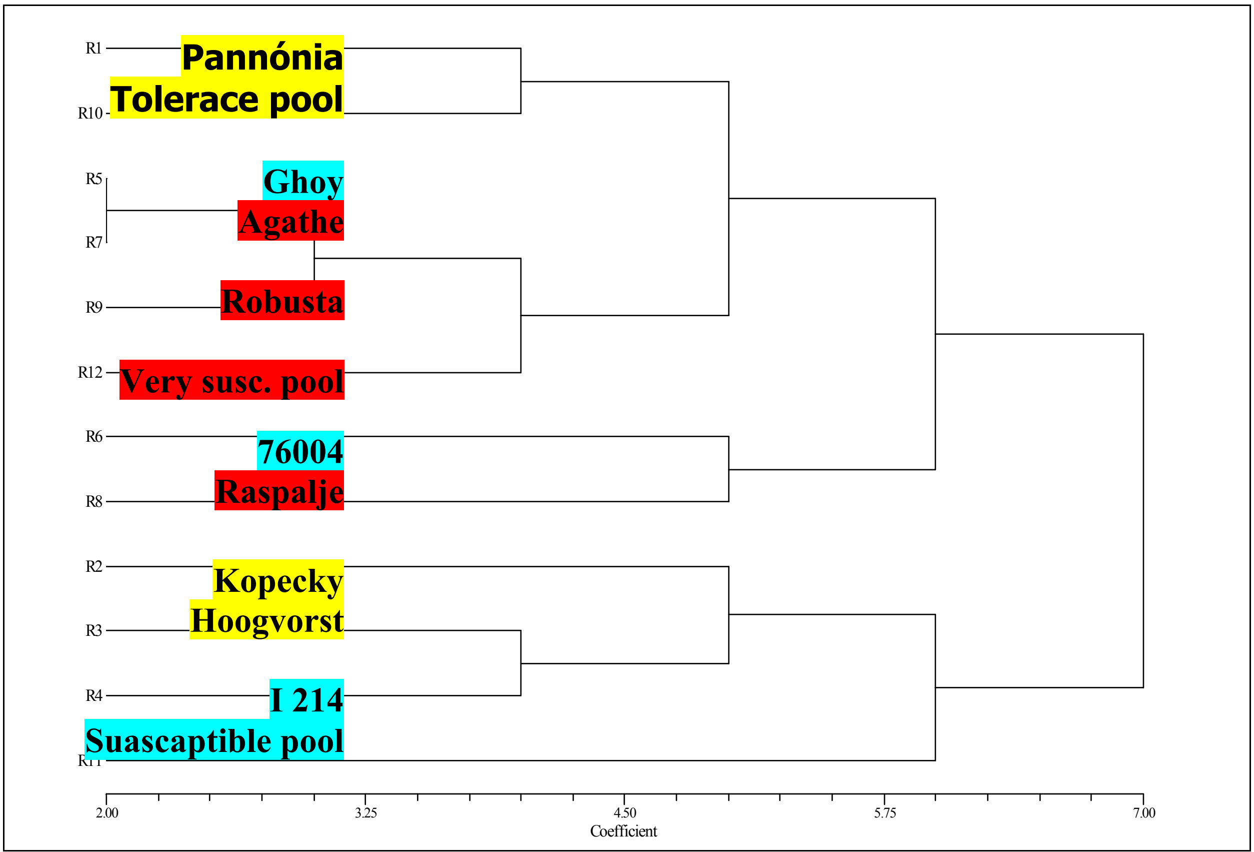

Fig. 1: Dendrogram of the poplar clones and the pools after UPGMA cluster analysis with six primers data.

Summary

Phenotypical answers:

A. we established the different tolerance of several poplar clones' to rust infection
- in nurseries
- in laboratory using leaf disc method

B. we make three susceptible categories from the investigated clones:
- tolerant
- susceptible
- very susceptible

Investigation of genotypes:

C. following the results of phenotypes' investigation it have been chosen nine different clones, isolated DNA and prepared their pools, the used method was RAPD analysis
- ten primers were used
- six were usable and gave result
- These six primers' results have been summarised in matrix and dendrogram

Conclusions

- the result of the cluster analysis shows that all very susceptible samples are in one branch of the tree, so the used method (RAPD analysis) should give results to find markers
- the used 10 primers were not enough to find markers
- in the near future necessary to try other primers or other PCR-techniques

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Oral presentation

Pest status of *Cameraria ohridella* (*Lep., Gracillariidae*) in natural stands of horse chestnut in Bulgaria

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Abstract

As a part of European research program, CONTROCAM, phenology and impact of horse – chestnut leafminer *Cameraria ohridella* Deschka & Dimic were studied in "Dervisha" reserve, a natural stand of *Aesculus hippocastanum* L. in Bulgaria. The observations were conducted during 1999-2004. The development of immature stages was followed by regular dissection of mines during three seasons with different infestation levels. First season – before the total defoliation of the reserve (2001), second season - total defoliation of whole reserve in July (2002), and third season – after the total defoliation of the reserve (2003). There were three generations of *C. ohridella* in Dervisha reserve. The infestation levels did not influence the number of generations. During epidemic seasons, the development of the population was almost interrupted in August because of the fact that more than 90% of pupae from second summer generation entered diapause and emerged-moths died due to of lack of leaves. Only later-emerged moths infested leaves from the second bloom in late autumn. Total defoliation in August (second summer generation) occurs every three years. The level of infestation of *C. ohridella* decreases gradually from low to upper part of the reserve. The most infested is the low part of the forest.

Keywords: horse chestnut, *Aesculus*, *Cameraria ohridella*

Introduction

The horse-chestnut *Aesculus hippocastanum* L. is a major urban tree in most of Europe. In urban settings, damage caused by *Cameraria ohridella* Deschka et Dimic is restricted to premature loss of leaf area in adult trees, thereby preventing proper contribute to a balanced urban microclimate, and to aesthetical problems with defoliated trees.

This plant species is endemic to the Balkans where a few natural stands remain. In the native region of horse-chestnut in South-eastern Europe, tree recruitment in the endemic forests occurs naturally either by seed, or vegetatively by shoots growing from the roots of established trees, and therefore, they may be affected by leafmining (Thalman *et al* 2003). All studied natural stands of the plant are infested by *C. ohridella,* causing concern for the survival of this rare tree species (Trenchev *et al* 2000, Avtzis 2001).

According to Thalman *et al* (2003), *C. ohridella* negatively affected seed and fruit- weight of *A. hippocastanum*. *C. ohridella* mining affects seed quality but not seed quantity. The reduced seed-weight may severely impair growth and survival of horse chestnut seedlings and thus may endanger the long term presence of *A. hippocastanum* in its endemic forests in South-eastern Europe.

As a consequence the long term natural succession in the forests of the Balkans may be altered by the moth, and may even lead to the replacement of *A. hippocastanum* in the last remaining endemic refuges of the species.

The six-year observation of phenology and infestation levels of *C. ohridella* in natural stands of *Aesculus hippocastanum* L. in Bulgaria (Dervisha reserve) is presented in this paper.

Material and methods

The Dervisha reserve is situated in the North-eastern part of Bulgaria. It is located in the Eastern part of the Balkan Mountains (7 km from the town of Veliki Preslav). The natural forest is 10.6 ha. It looks like a stripe about 30-50 m wide. The altitude increases from North to the South (from 300 to 450 m). Most of the horse-chestnut trees are 22 – 24 m. in height. A small river passes through the reserve. The forest is compact, but there are some single trees of *Fagus sp*., *Carpinus sp*., *Acer sp*., etc. The reserve is surrounded by 59.1 ha buffer zone.

The observations were conducted during the period 1999–2004. The phenology of *C. ohridella* has been followed by regular dissection of 500 mines (every two weeks) for 3 seasons (2001-2003). Only live stages found during the dissections were used for calculation of the proportion of the instars.

The reserve was divided into 5 sectors. Infestation of *C. ohridella* was classified into six infestation categories according to damage caused by the moth (leaf area infested, LAI): 1 – (<5% LAI); 2 - (5% - 25% LAI); 3 - (25%-50% LAI); 4 - (50%-75% LAI); 5 – defoliation (>75% LAI) and 6 – total defoliation.

Leaf area infested (LAI) was estimated visually on the basis of 40 compound leaves per sector at the end of each moth generation when the majority of leaf miners of the respective generation was in the pupal stage.

Results

The dissection of mines during 3 seasons 2001-2003 suggests that there are three generations of *C. ohridella* in Dervisha reserve (Fig. 1-3). The infestation level does not influence the number of generations. The comparison of Fig. 1-2 and Fig 3 shows that the proportion of different instars of *C. ohridella* was density dependent.

In each generation, a fraction of the pupae does not hatch immediately but stays in the leaves and enters diapause (Freise and Heitland 2001). During epidemic seasons, the development of the population was almost interrupted in August because of the fact that more than 90% of pupae from second summer generation entered diapause and emerged-moths died because of lack of leaves. Only later-emerged moths infested leaves from the second bloom in late autumn. Surprisingly only some of them were able to develop to pupal stage.

The dynamic of infestation of the forest is presented in Table 1. The level of infestation of *C. ohridella* increases gradually from low to upper part of the reserve. The most infested is the low part of the forest. Total defoliation in August (second summer generation) occurs every three years.

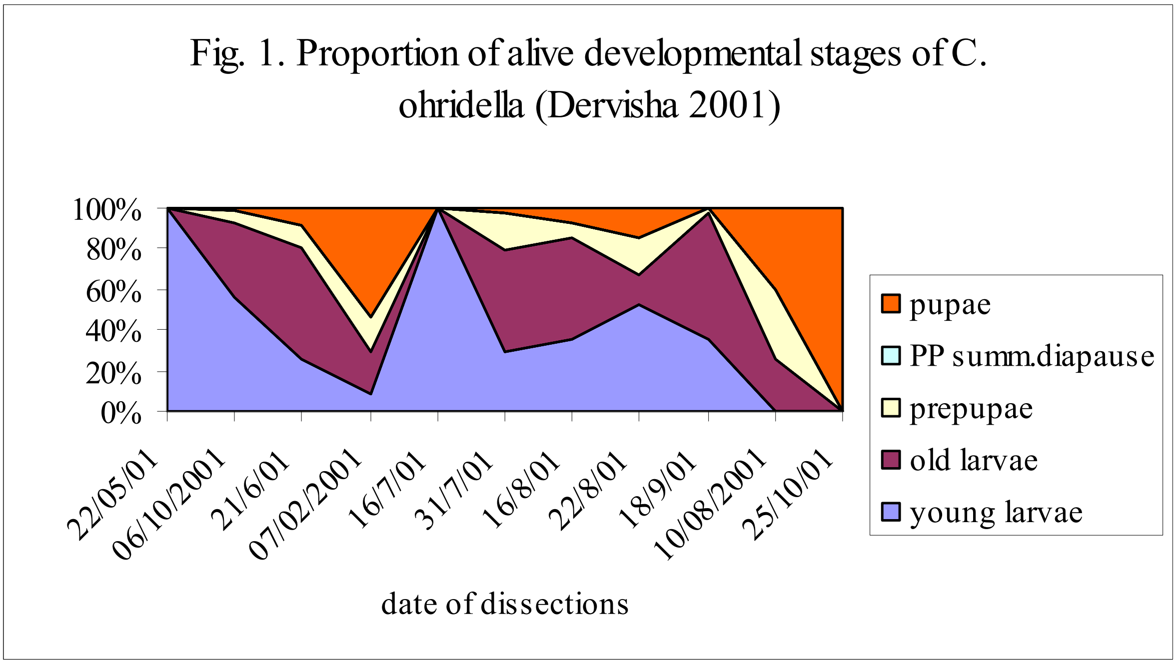

Fig. 1: Proportion of alive developmental stages of *C. ohridella* (Dervisha, 2001)

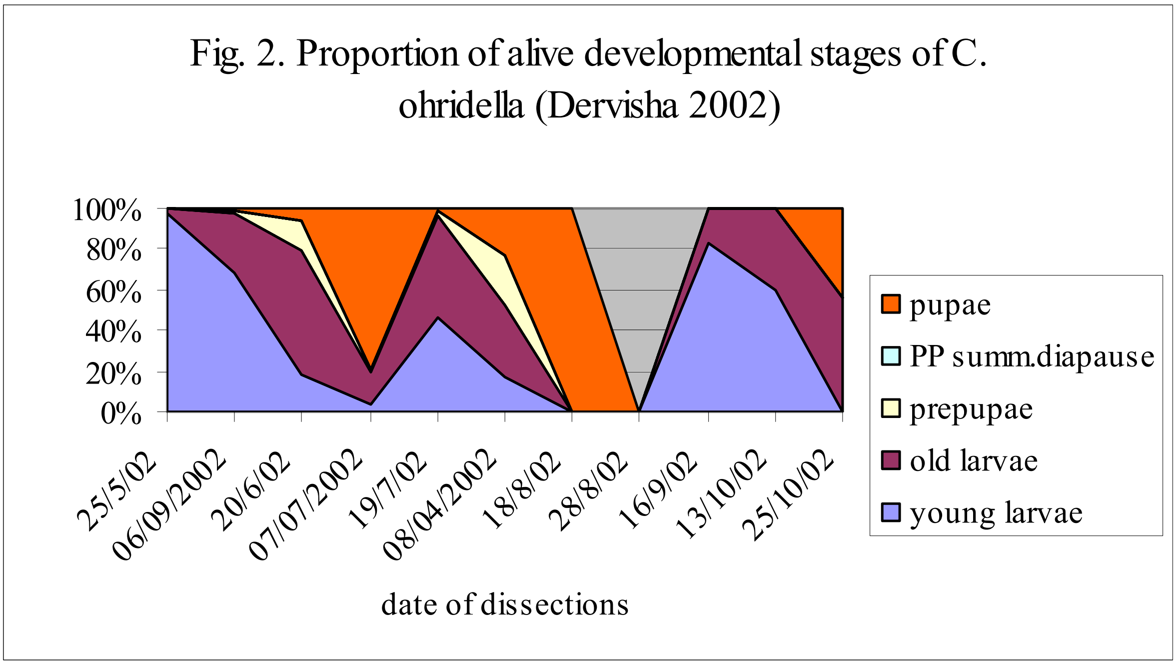

Fig. 2: Proportion of alive developmental stages of *C. ohridella* (Dervisha, 2002)

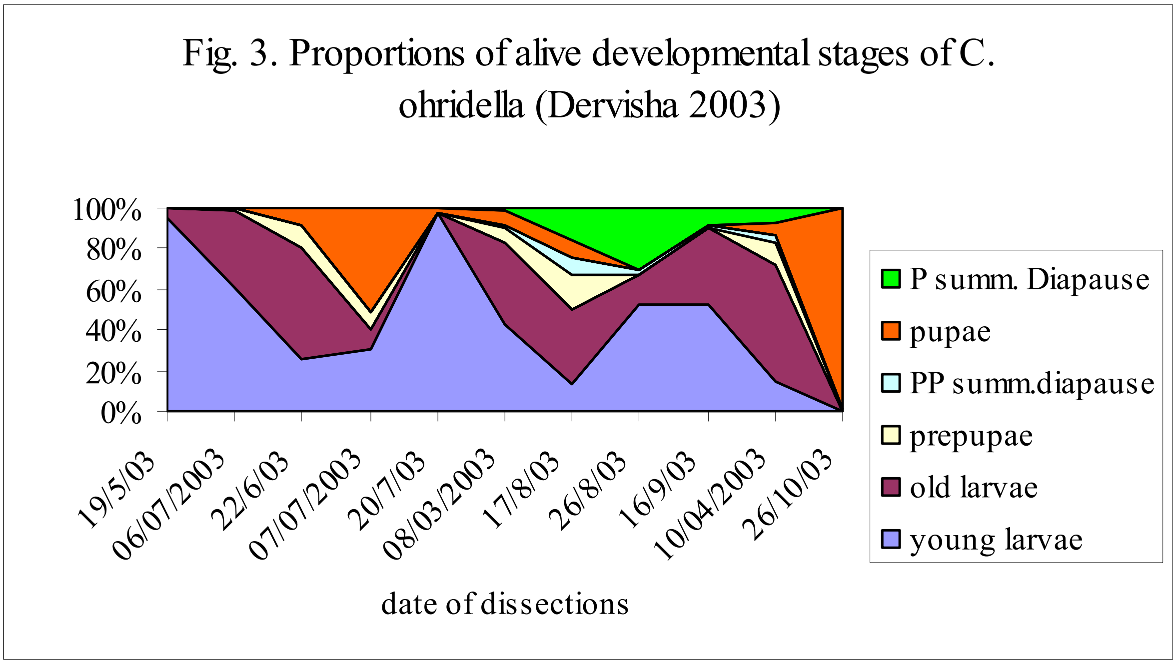

Fig. 3 Proportion of alive developmental stages of *C. ohridella* (Dervisha, 2003)

Year	Gen.	SECTORS				
		1	2	3	4	5
1999	1	(>75% LAI)	(>75% LAI)	(50%-75%LAI)	(50%-75%LAI)	(25%-50%LAI)
	2	Defoliated	Defoliated	Defoliated	Defoliated	Defoliated
	3	Defoliated	Defoliated	Defoliated	Defoliated	Defoliated
2000	1	(5% - 25% LAI)	(<5% LAI)	(<5% LAI)	(<5% LAI)	(<5% LAI)
	2	(5% - 25% LAI)	(5% - 25% LAI)	(5% - 25% LAI)	(5% - 25% LAI)	(<5% LAI)
	3	(25%-50% LAI)	(25%-50% LAI)	(5% - 25% LAI)	(5% - 25% LAI)	(5% - 25%LAI)
2001	1	(>75% LAI)	(25%-50% LAI)	(5% - 25% LAI)	(<5% LAI)	(<5% LAI)
	2	Defoliated	Defoliated	(>75% LAI)	(25%-50% LAI)	(5% - 25%LAI)
	3	Defoliated	Defoliated	Defoliated	(>75% LAI)	(50%-75%LAI)
2002	1	(>75% LAI)	(>75% LAI)	(50%-75%LAI)	(50%-75%LAI)	(25%-50%LAI)
	2	Defoliated	Defoliated	Defoliated	Defoliated	Defoliated
	3	Defoliated	Defoliated	Defoliated	Defoliated	Defoliated
2003	1	(5% - 25%LAI)	(<5% LAI)	(<5% LAI)	(<5% LAI)	(<5% LAI)
	2	(5% - 25%LAI)	(5% - 25% LAI)	(5% - 25% LAI)	(5% - 25% LAI)	(<5% LAI)
	3	(25%-50% LAI)	(25%-50% LAI)	(5% - 25% LAI)	(5% - 25% LAI)	(5% - 25%LAI)
2004	1	(>75% LAI)	(25%-50% LAI)	(5% - 25% LAI)	(<5% LAI)	(<5% LAI)
	2	Defoliated	Defoliated	(>75% LAI)	(25%-50% LAI)	(5% - 25%LAI)
	3	Defoliated	Defoliated	Defoliated	(>75% LAI)	(50%-75%LAI)

Infestation categories

(<5% LAI)	(5% - 25% LAI)	(25%-50% LAI)	(50%-75%LAI)	(>75% LAI)	defoliation

Table 1: Infestation levels of *C. ohridella* in reserve Dervisha during the period 1999-2004.

Disscussion

The observations of the Dervisha reserve began in spring 1999, when the over-wintering generation of season 1998 was sampled. 2000 leaflets were collected randomly from the ground. 100% of them were heavy infested.

Only 25% of leaflets collected during the next spring were very heavy infested. The rest of leaflets did not have any mines. This situation was similar to that of season 2002, when the reserve was totally defoliated in August. There was a second bloom in the middle of September and only a few leaves were attacked by *C. ohridella*. These results suggest that there was a total defoliation in August in 1999.

Leaf-dissections, and regular observation of the reserve during the period 2001-2004, suggest that a three-year cycle of total defoliation of the reserve during August, is in existence. These data fit very well my visual observations during 1999-2000. On the basis of these observations, it could be forecast that another total defoliation will occur in 2005.

It is difficult to discuss the future of the reserve since there are other factors affecting the condition of the trees. The fungus *Guignardia aesculi* (Peck.) is a very serious factor. There are many trees where *G. aesculi* is a more important reason for defoliation than *C. ohridella.*

Acknowledgements

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Oral presentation

Insects associated with forest communities in Iran

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Abstract

The survey carried out over 20 provinces since 1993 has so far revealed a number of potentially dangerous insects which at the moment are responsible for few damage as well as others which can be expected to cause problems in the future. Conventional collecting methods applied e. g. sweep net, hand picking, aspirator, pitfall trap and collections were made weekly during the spring and summer. Specimens were collected and sealed in plastic bags and returned to the lab, pinned or preserved in alcohol. Immature stages were retained until adult emerge. So far twenty five thousand specimens representing 4031 species and 18 orders were recorded of which, 500 species have been identified. Three categories of insects were distinguished: Key pest, predator or parasite of the key pest and occasional visitor. Important forest pests in northern Iran include: *Cryptococcus fagi*, *Tortrix viridana* and *Hyphantria cunea*. Key pests in western oak forest include *Leucoma wiltshieri*, *Porthesia melania*, *Euproctis chrysorrhoea* and *Balaninus glandium*.

Keywords: forest fauna, pest, Iran.

Objectives:

Each of the different ecological zones and special forest type of Iran present special challenges in terms of forest entomology. Entomological inventories are a fundamental aspect and a basis for better understanding of biological diversity. As conservation of natural ecosystem and bio- diversity is an important mandate for Research Institute of Forests & Rangelands, a national project was initiated in 1993 to study forest insect fauna of Iran.

General information and background

I.R. of Iran is located in the North Temperate Zone from 25 to 40 degrees latitude and 44 to 63 degrees longitude, with a total area of approximately 1,650,000 km^2. A large area of the country is covered with high mountain ranges which amounts to about 50% of total land area, and large sections of interior is characterized by arid basins. Elevations range from 26 meters below sea level on the shores of the Caspian Sea to 5,860 meters above sea level at the Mt. Damavand.

Geologically, the Iranian Plateau dates from the Tertiary period, but older formation also exist in some certain areas. Due to the relatively young ages, the principal mountains are still settling which seem to be the causes of the earthquakes that rock the country frequently.

Climatic variations are also great in Iran. The main variation is between the dry, desert interior region and the humid Caspian coastal region. The Caspian region receives the larger part of the country's precipitation (2,400 mm), while the central desert receive 10mm. Mean January temperatures range from 20 degrees centigrade along the Persian Gulf region to minus 2 degrees in northwest of Iran. Extreme temperatures of over 50 degrees centigrade in the Persian Gulf region to minus 35 degrees centigrade in the northwest have been recorded.

The total forest area of Iran was estimated approximately 18 million hectares about three decades ago. Unfortunately, a tremendous proportion of those forests have been destroyed. The main factors in this destructive trend have been shifting cultivation and heavy overgrazing. Along the southern coastline of the Caspian Sea temperate to humid deciduous forests thrive. Drought-adapted woodlands cover the Zagros Mountains in the west and ranges of northern Khorassan. Thorn-cushion formations are dominant in the sub alpine zones of these mountains. Drier parts of the country are home to dwarf-scrub formation with many halophytic communities. On the coastline-of the Persian Gulf, semi-desert shrub lands belonging to the paleotropic kingdom thrive. With respect to the vegetations association, five different regional types of forest may be distinguished in I. R. of Iran which are as follows:

Caspian forests

These forests which also called the Hyrcanian forests-the most valuable forests in Iran-cover the northern slopes and foothills of the Alborz Mountain. In 1958 these forests were estimated at 3.4 million hectares, but currently is estimated around 1.9 million hectares (10). The most common trees are oaks (especially *Quercus castanaeifolia),* beech, hornbeam, ironwood, *Ulmus spp., Acer spp., Fraxinus spp.* and etc. Pure and mixed beech forests are of the most important, richest and most beantiful forests on the northern slopes of Alborz mountain range adjacent to the Caspian Sea coasts. The main tree species:

Carpinus sp. (hornbeam)	31.7%
Fagus sp. (beech)	31.2%
Alnus sp. (alder)	7.6%
Acer sp. (maple)	6.5%
Parrotia sp.(ironwood)	3.9%
Quercus sp. (oak)	8.5%
Tilia sp. (lime)	2.8%
Diospyrus sp. (lotus)	1.5%
Ulmus sp. (elm)	
Zelkova sp. (Caucasian elm)	
Fraxinus sp. (ash)	

Arasbaran forests

These forests are located in the extreme western corner of Caspian forests, the elevations there provide some of the last expands of the Oak-Juniper forests of north western of the country. However, in most parts of these forests land conversion and wood cutting for fuel are responsible of the sever degradation of Arasbaran Forests. The following plant species have been found in this region; *Quercus* *macranthera, Carpinus betulus,* C. *schuschaensis,* C. *orientalis, Acer campestris, A. monspessulanum, Fraxinus rotundifolia* , *Ulmus spp.,* and etc. Arasbaran forests have given protected region status and at the same time is one of mine biosphere reserves of Iran.

Zagros Forests

These forests cover a vast area throughout the length of the Zagros range, extending as far as Shiraz. These area once covered by dense forests (approximately 11300,000 ha.), but presently subjected to severe degradation. Thus, trees of timber dimensions are extremely rare. The mountains, where they have not been completely degraded, carry a very open crop of scrub-oak *(Quercus infectoria and Q. libani)* in extreme northwest along the Turkish and Iraqi frontiers, and *Q. persica* farther south around Shiraz. There are certain small trees and shrubs in varing parts in these scrub-oak forests such as: *Celtis Transcaucasia, Amygdalus spartioides,* and *A. orientalis, Daphne acuminata, Acer cinerascens, and Pistacia khinjuk.* These forests perform important protective functions by regulating water flow and helping to minimize soil erosion.

Pistachio Forests

They include scattered patches of open degraded forests, in the region of low rainfall (100 to 150 mm) of the central and southern parts of Iran (The Irano- Turanian region of arid and semi-arid part, approximately 3.1 million hectares) and on the eastern hills along the Afghanistan border. It has a few plant species mainly, *Pistacia mutica, Amygdalus* spp., and *Berberis* spp.

Forests of the Subtropical Region

These forests are situated in the south, along the coast of the Persian Gulf, and Sea of Oman and the border of Baluchistan province, where the annual precipitation is about 125 mm or less, and very high summer temperatures exist. They consist of Mangrove forest (about 0.5 million hectares) along the coasts. Other parts include chiefly of open, low thorn scrub with small trees such as *Tamarix articulata, Acacia spp. Prosopis spicigera, Zizyphus spina-christi,* and *Ficus* spp.

Type of Forests	**Location**	**Annual Rainfall (mm)**	**Area**	
			Million ha.	**%**
Caspian Forests	N.	600-2000	1.9	1.15
Arasbaran Forests	N.W.	400-700	0.2	0.12
Zagros Forests	W.	300-600	3.5	2.12
Central Forests Almond & Pistachio Forests Juniper Forests	C. S.W. N.E.	100-150	5.5	3.33
Subtropical Forests: -Mangrove -Others	S. S.	125 -	0.5 0.8	0.30 0.48
Total	**-**	**-**	**12.4**	**7.5**

Table 1: Different forest types in I.R.Iran

The total forest and woodland cover of Iran is estimated at 12.4 million ha (Table 1). Out of this amount 3.8 million ha is forest and the rest is categorized as woodlands. Most of the commercial forests of the country are located in the north. Recent studies indicated that out of 1.9 million ha of northern forests, only 1.2 million ha can rank as commercial forests.

Protected Area	Number	Total area (ha)	Average size (ha)	Minimum size (ha)	Maximum size (ha)
National Parks	7	14,075,300	153,614	9380 (SorkheHessar)	463,600 (Urumieh lake)
Protected Areas	42	5,031,905	119,807	4500 (Siake-sheem)	1 ,295,400 (Touran)
Wildlife Refuges	24	1,907,112	79,548	312 (kharko)	327,820 (Bakhtegan)
National Nature Monument	4	1628.2	407.05	0.6 (Sera)	1400 (Dehloran)
National Forest Parks	15	9631	642	7 (Fian)	4000 (Ashtian)

Table 2: Size of the protected areas

Biodiversity protection

Iran, among the southwestern countries of Asia, possesses the most diversified biological regions. In addition, the country is host to a great variety of animal species of the palaearctic realm as well as those of the Afrotropical realm (Oriental and Ethiopian).

Today, there are 77 protected areas including 7 national parks, 4 national nature monuments, 24 wildlife refuges and 42 protected areas which cover approximately 8 million hectares. Considering the country's pace of development, this plan appears to be the only means for adding more natural areas to the existing list.

Iran is located in the palaearctic realm and is considered the centre of origin for many genetic resources of the world. Biodiversity of the country is influenced by its various climates (from alpine *to* sub-tropical), altitude, geological formation and physiography. Many plant and animal species, some unique to Iran, thrive throughout the country. Almost any genus living in alpine to sub-tropical biomes of the world can be found in Iran.

Biogeogragraphical provinces of Iran include:

1. Pontic: Hyrcaman - 3.0896%; Arassbaranian - 0.16%
2. Irano-Anatolian: Irano-Touranian - 64.09%; Zagrossian - 6.57%
3. Nubo-Sindian and Arabian-Saharo -26.07%

At present, biodiversity protection of the country is basically confined to national and natural forest parks and protected areas. In the unprotected areas, the biodiversity is diminishing a remarkable rate. For example, during the last 30 years, 1.2 million hectares or 40% of Iran's deciduous temperate forests have vanished. Irrational land use practices and poor management are the chief causes of biodiversity loss in Iran. In addition, there still remains a great variety of plant and animal species which need to be protected and maintained.

Each of the different ecological zones and special forest types of Iran present special challenges in terms of forest entomology which account as a fundamental but often under-considered aspect.

Methods and process

The survey is based on a number of fixed locations distributed through the country to represent major vegetation zones of Iran, e.g., insects associated with oak forests. Each location (collecting stations) could be visited at least four times during the year to sample the changing fauna in different seasons; obviously this is not always possible. The chosen location, plantation or natural forest, all include good representative of the most important natural forest ecosystems, un modified or hardly modified by human activity.

To fulfil the study programmes various collection methods are applied over different regions. On each visit collections are made of all insects pests non-pests and beneficial arthropods, associated with chosen trees, whether they are responsible for obvious damage or not. Further to specimens collected by light trap and pitfall traps, insects resting on the plants were captured directly by hand or with an aspirator or by a sweep net. Where immature stages are gathered, these are taken back to laboratory for rearing. At the same time assessment of damage is made and if possible examples of damaged plant material are removed for inclusion in the collections at research centers in provinces. At centers material is pinned or preserved in a1chohol, immature stages are retained until adult emerge. Subsequently species are sorted and preliminary identification of selected arthropods group is performed followed by transferring to head office for further identification.

All material collected after coding and naming are included in the Forest Arthropod Museum housed at Alborz Research Complex in Karaj. The information's is supplemented by observations made in plantations and nurseries in different parts of the country. Special survey made of many plantations distributed through the mountains, foothills and plains allows comparison of the influence of climate and altitude on insect fauna.

Various mechanisms will be employed to identify specific insects including use of taxonomic keys, collaboration of the entomologist colleagues and contribution of national museums inside and outside of the country.

Further steps and outcomes

So far a vast number of insect specimens have been collected and are currently maintained at Forest Arthropod Museum housed in Alborz Research complex in Karaj (a city, half an hour drive by car far from Tehran).

The museum established in the year 2000 is the principal repository for forest insects in Iran. Significant strengths of the collection include Coleoptera (28%), Lepidoptera (31%). Each collection is presented with its code, Our current listing follow the 4- letter formula for codes of collection depositories. We use the letter abbreviations/ combinations to indicate a particular depository. A comprehensive data bank has established and a web link is under construction.

The program comprises more than 40,000 specimens, with references, geographic distribution and important ecological information. Several hundred original digital images are also available. A searchable database of user-oriented, call up any number of records from among over 50000 specimen's records. Records are chosen based on user- specified criteria such as province or collector name, elevation range, order and family of the species.

To some extent the content of our museum reflects the interests and expertise of the collectors and taxonomists who have been cooperating with us. Heteroptera have benefited from the presence of Dr. Armand Matoque of Paris Museum of Natural History in the year 2003. So far 200 species of 11 families of Heteroptera have been identified. Some are new record for Iranian fauna (Pictures).

Conclusion

Each of the different ecological zones and special forest types of Iran present special challenges in terms of forest entomology which account as a fundamental but often under-considered aspect. So far a vast number of insect specimens have been collected and are currently maintained at Forest Arthropod Museum. Our Research Institute looks in to the possibilities of collaborating in the field of forest insect survey and identification of Iranian specimens and has the request for exchange of insect materials with prestigious institutions in other countries.

Currently our museum contains over 620 drawers of insects. In all, the museum holds 50,000 pinned specimens. We would like eventually to get the entire museum collection property identified. To this end, we invite interested experts to cooperate with us. We are still in the process of sorting and organizing the collection and I hope one day to have much of the label information available on line. If you are interested in information or specimens from our insect museum, please contact the first author of this paper.

Subject	**results**
No. of specimens	25513
No. of data in bank	22482
Orders	18
Families	________
No. of genus & species	3500-4000
Percent identified at order level	100
Percent identified at family level	60
Percent identified at genus & species level	15
Most collected specimens belong to	6901 (Lepidoptera) 6848 (Coleoptera)
Anticipated number of insects species occuring in forests*	40000-45000
Provinces covered by the project	20

*above ground insect fauna associated with forest communities in Iran

Table 3: Results obtained following ten years survey of forest insect fauna of Iran (1994-2003)

	Order	**Species (estimated)**	**Specimen**
1	Lepidoptera	1000	6901
2	Coleoptera	1500	6848
3	Heteroptera	140	2930
4	Hymenoptera	500	2449
5	Diptera	350	1821
6	Homoptera	200	1400
7	Orthoptera	200	2043
8	Neuroptera	40	359
9	Odonata	28	326
10	Isoptera	6	106
11	Mantodea	12	94
12	Dermaptera	7	91
13	Blattaria	15	60
14	Tricoptera	12	41
15	Plecoptera	10	22
16	Mecoptera	5	7
17	Thysanura	4	11
18	Phasmida	2	4
	Sum	**4031**	**25513**

Table 4: Survey of forest insect fauna of Iran (1994-2003)
No. of insects specimens and species for different orders (June 2004)

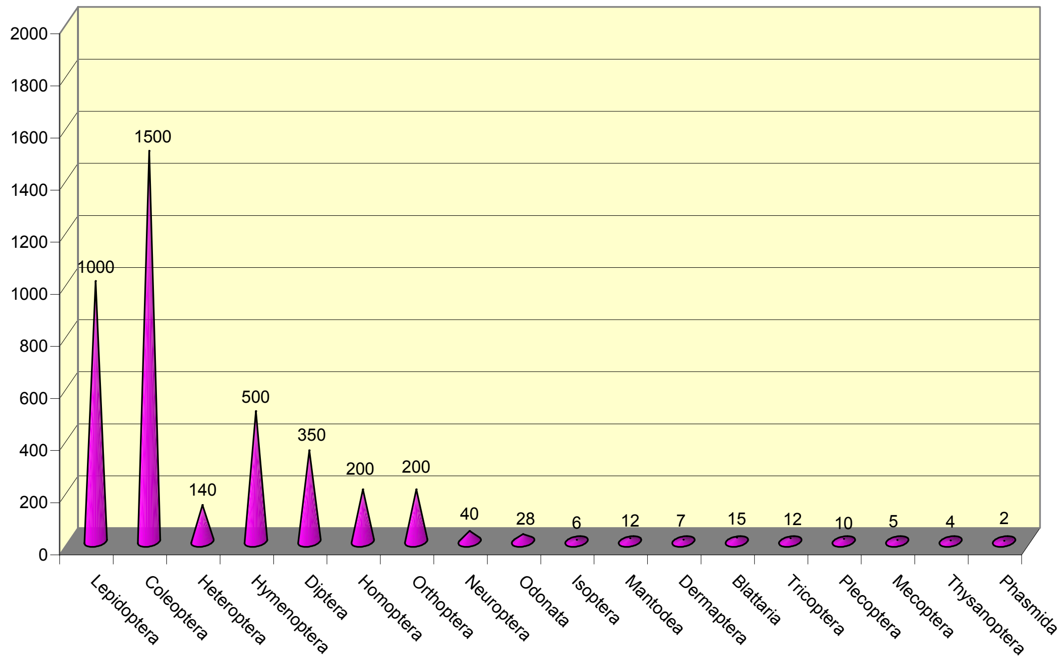

Fig. 1: Number of species in different insect orders (2004)

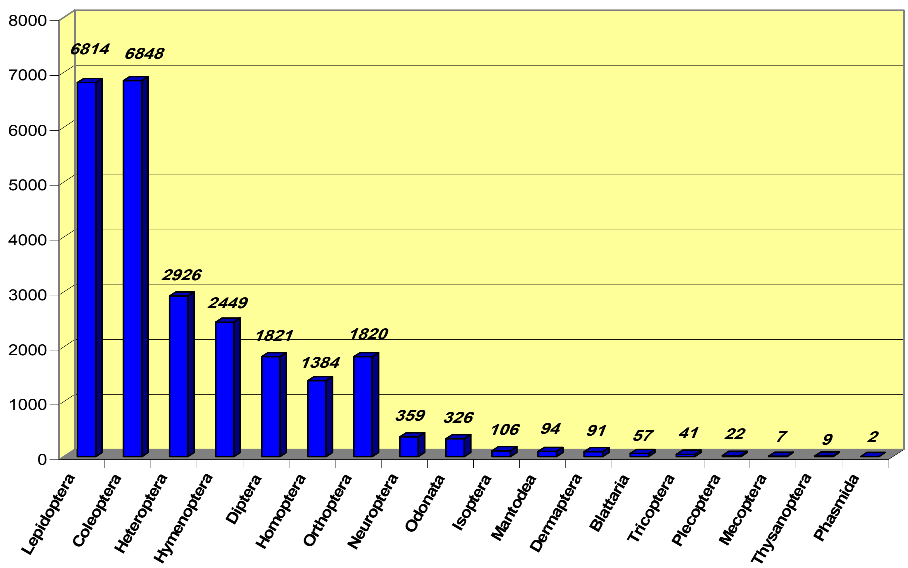

Fig.2: Number of specimens in collection belonging to different orders (2004)

Species	Major hosts	Current geographic distribution
1-*Lymantria dispar.*	Many deciduous & conifers	Northern, Central &Tehran provinces
2-*Cryptococus fagi*	*Fagus orientalis*	Northern provinces
3-*Phyllaphis fagi*	*Fagus orientalis*	Northern & Central provinces
4-*Hyphantria cunea*	Many deciduous trees	Guilan provinces
5-*Tortrix viridana.*	*Quercus*	North, South-West &Western provinces
6-*Euproctis chrysorrhoea*	*Quercus*	North- West, Tehran & Central provinces
7-*Portesia melania.*	*Quercus*	Western & South- Western
8-*Leucoma wiltshire*	*Quercus*	Fars, Khozestan, Kohgiluyeh & Lorestan provinces
9-*Laspeyresia fagiglandana*	*Quercus*	Western & South- western provinces
10-*Balaninus glandium*	*Quercus*	Zagros area
11-*Thaumetopoea solitaria*	*Pistachia mutica*	Western, Fars & central provinces
12-*Ocneria terebinthina*	*Pistachia mutica*	Western, South- western & Central provinces
13-*Eurytoma amygdale*	*Amygdalus sp.*	Generally distributed
14-*Megastigmus pistaciae*	*Pistachia vera*	Central
15-*Eurytoma plotnikovi*	Wild and edible pistachio	Fars, Khorasan & Central provinces

Table 5: Primary Insect pest problems in Iranian forests

The list of grasshoppers (*Orthopthera*) collected in the course of faunal survey

1-*Euchorthippus transcaucasicus* Tarb.
2-*Bufonocarodes intricatus* Mistsh.
3-*Paranothrotes sp.*
4-*Notostaurus anatolicus*
5-*Eremopeza carinatus*
6-*Dociostaurns hauensteini*
7-*Eremopeza cinerascens cinerascens*
8-*Polysarcus elbursianus*
9-*Oedipoda miniata*
10-*Sphingonotus nebulosus discolor* Uv.
11-*Calliptamus barbarus*
12-*Oedaleus decorns* Germ.
13-*Calliptamus italicus*
14-*Sphingonotus satrapes*
15-*Heteracris littoralis*
16-*Chorthippus brunnes* Thung.
17-*Oedipoda schochi*
18-*Pseudoceles inornatus*
19-*Platycleis sp.*
20-*Dociostaurus* near *tartarus*
21-*Charora persa persa*
22-*Sphingonotus coerulipes* Uv.
23-*Polysarcus elbursianus*
24-*Tettigonia niridissima*
25-*Paranothrotes gotvendicus* (I. Bol.)
26-*poecilimon Stshelkanovtzevi* Tarb.
27-*Truxalis robusta*
28-*Iranotmethis persa zagrosi* Uv.

New records from Arasbaran forests collected in the course of faunal survey

Lepidoptera

Noctuidae:	*Brotolomia meliculosa* L., *Acontia luctuosa* (Esp.), *Agrotis plecta* L.
Geometridae:	*Crocallis elinguaria* L., *Abraxas grossulariata* L.
Sphingidae:	*Sphinx ligustri* L.
Notodontidae:	*Notodonta anceps* Goeze
Phycitidae:	*Phycita spissicella* (F.)
Pyraustidae:	*Pyrausta sambucalis* Schiff., *Pyrausta purpuralis* L.
Pyralidae:	*Crambus pinellus* L.
Arctiidae:	*Endrosa irroerella* L., *Ilema complana* L.
Lasiocampidae:	*Gastropacha quercifolia* L.
Aegeridae:	*Synanthedon vespiformis* L.
Satyridae:	*Satyrus semele* L.
Nymphalidae:	*Clossiana euphrosyne* L.
Lycaenidae:	*Lycaena phlaeas* L., *Plebeius escheri,Cupido minimus* (Fassli), *Glaucopsyche cyllarus* Rott., *Lycaena arion*
Hesperidae:	*Hesperia sidae* Esp., *Augiades comma*
Zygaenidae:	*Zygaena transalpina* Esp.

Coleoptera

Staphylinidae:	*Staphylinus picipennis*
Harpalidae:	*Aristus obscurus* Dej.
Chrysomelidae:	*Chrysomela grossa* F., *Chrysomela polita* L., *Chrysomela menthastri* Suffr.
Scarabaeidae:	*Euonthophagus gibbosus* (Scribo)
Cetonidae:	*Cetonia carthami* Groy
Meloidae:	*Melo majalis* L.
Cerambycidae:	*Anisorus quercus* (Goetze), *Anastrangalia sanguinolenta* (L.), *Clytus rhamni* Germ., *Brachylepture cordigera* Fues.

Diptera

Syrphidae:	*Volucella bombylans* (L.)
Stratiomyidae:	*Stratiomyia chamaeleon*

Heteroptera

Pentatomidae:	*Pentatoma rufipes* L., *Rhabdomiris striatellus*

Homoptera

Cicadidae:	*Cicadatra persica* L.
Cercopidae:	*Cercopis intermedia* Kbm.

List of some mirids (Heteroptera) associated with forests of Iran

Cyllecoris histuomius (Linnaeus, 1767).	E.Azarbaijan
Deraecoris .sp.	E.A., Tehran, Arak, Isfehan
Adelphocoris lineolatus (Goeze, 1778)	E.A.Isfehan,Karaj,Hamedan,2350m..
A.vandalicus (Rossi, 1790)	Tehran, Karaj (Taleghan)
Acrorrhinium conpersum Noualnier	Hamedan, 2150m. July-15,1998.
Pasallus sp.	E.Azarbaijan.
Stenodema taeranieam Reter, 1904	Fars(Besat,1500m, June-30,1995.
Polymerus vulneratus (Wolff, 1801)	Tehran(Karaj)
Trigonotylus sp.	Tehran(Taleghan)
Pseudoloxopos sp.	Tehran
Lygus gemelatus (Herrich-Schaeffer)	Isfehan
Rhabdomiris striatellus Fabricus,1794	E. A. Makidee,1650m. July-23,1994
Oncotulus setulosus	Hamedan,Asad-Abad.2150m.

The last two species are new records for Iranian fauna.

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Oral presentation

Recent trends in occurrence of *Melolontha* species in Slovakia

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Abstract

Cockchafers are some of the most important forest insect pests of Slovakia. European common cockchafer (*Melolontha melolontha* L.), which was widespread everywhere up to altitudes of 600 m in the past, is becoming rare and being replaced by the forest cockchafer (*Melolontha hippocastani* Fabr.) in many places. Three main outbreak areas of cockchafers were selected in Western, Southern and Eastern Slovakia. Their population dynamics are confused in some areas. During the last decade, approximately 2000 ha of forest stands were treated with different insecticides against cockchafers. The pyrethroids are the most frequently used products in the control of cockchafers in Slovakia. They have proven highly effective. In situations when nature reserve organisations have to approve the aerial application, forest owners have to start thinking about new strategies in cockchafer control, using microbial and biological pesticides.

Key words: European common cockchafer, forest cockchafer, Slovakia, population dynamics, *Melolontha*

Introduction

In the Carpathian basin the two most important pest scarabs from the genus Melolontha are the European common cockchafer (*Melolontha melolontha* L.) and the forest cockchafer (*M. hippocastani* Fabr.).

In the sixties and seventies, the larvae of European common cockchafer were the most important forest pests. The species was widespread almost everywhere up to an altitude of 600-700 m.

Today the situation has changed. *M. melolontha*, until recently the most important pest of crops in shrub lands or areas being close to deciduous forests, has become rare, and today causes only moderate damage in Slovakia. This is most probably due to the widespread use of mechanical and chemical cultivation in agriculture, which kills the very fragile larvae, as well as changes to production systems. In many areas, *M. melolontha* has been replaced by *M. hippocastani*.

Technical norm number STN 48 2713 „Forest Protection Against Cockchafer And Shrubs“ in Slovakia has been still in force. It was adopted in the 60s and is based on even older information about cockchafer population dynamics (Zúbrik and Turčáni 1999). This norm is widely used in Slovakia in forecasting cockchafer outbreaks and cockchafer integrated pest management generally. Based on field observation, as well as exact data, we know that some older information about the cockchafers' tribes is no longer valid and in need of some revision.

Cockchafers in Slovakia

M. melolontha or *M. hippocastani* ?

It is difficult to distinguish European common cockchafer from forest cockchafer in the larval stage. The average length of the adult of *Melolontha melolontha* is 20-31 mm, and it is a little larger than of *M. hippocastani, which* is 20-26 mm long. The body of both species is very similar, cylindrical and of variable colour. The two species differ distinctly in the structure of the pygidium, which in *Melolontha melolontha* is elongated and gradually tapered, and in *M. hippocastani* is short, abruptly constricted, and terminated with a button-shaped dilatation.

Melolontha melolontha occurs in the whole of Europe except for the most northern and southern parts. The area of distribution of this species reaches Turkey and Iran. So generally, the area is smaller when compared with distribution of *M. hippocastani*, which is widely distributed in central and northern Europe, as well as in Siberia and Manchuria. It is more abundant in the forested areas unlike *M. melolontha,* which prefers agricultural lands.

Hosts

The cockchafer adults appear in April-May and after 10 to 12 days of feeding, the females acquire their sexual maturity and make the egg-laying flight. Adults feed on several forest and fruit tree leaves in Slovakia, but are only occasionally harmful. They prefer leaves of *Quercus,* especially *Q. robur* that develops earlier. They may also be found on the leaves of *Salix caprea, Betula verrucosa, Sorbus aucuparia, Fagus sylvatica, Carpinus betulus, Acer platanoides, Populus tremula,* some other species of *Populus,* and *Aesculus hippocastanum* in Slovakia.

The white grubs are much more dangerous than adults. During their first year of life, they feed in the firstly, on the humus and small tender roots, mainly of grasses and weeds. The older grubs injure the roots of seedlings and young saplings of almost all species of trees and shrubs.

Damage

Grubs in south-eastern parts of the country cause much damage. The sandy soils there are very suitable for pine (mostly *Pinus sylvestris*) stands. Intensive type of forestry requires the use of large area soil preparation. Different herbicides have been applied intensively to keep large areas without weeds. After such methods of soil preparation, one-year-old pine seedlings are planted. These are heavily attacked by grubs, which have no other food source except the roots of the young plants. Injured tissue can contribute to the development of bacterial or fungal diseases.

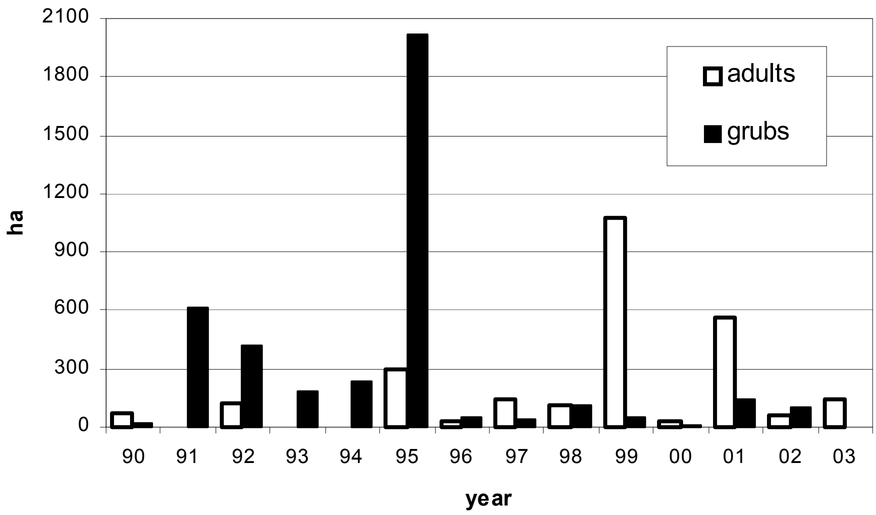

Fig. 1: The defoliation (in hectares) caused by cockchafer *M. melolontha* and *M. hippocastani* (beetles, grubs) during the period 1990-2003 (Varínsky *et al* 2004).

Areas of broadleaved stands defoliated by adults are not very large in Slovakia, and are much smaller when compared with infested forests in neighbouring countries like Poland and Hungary (Zúbrik *et al* 2003). Annual average of defoliated forest stands reached 191 ha and areas damaged by grubs 286 ha in Slovakia (data from last 14 years were used). In 1999, 1,045 ha were defoliated, and grubs damaged almost 2,000 ha in 1995 (Fig. 1).

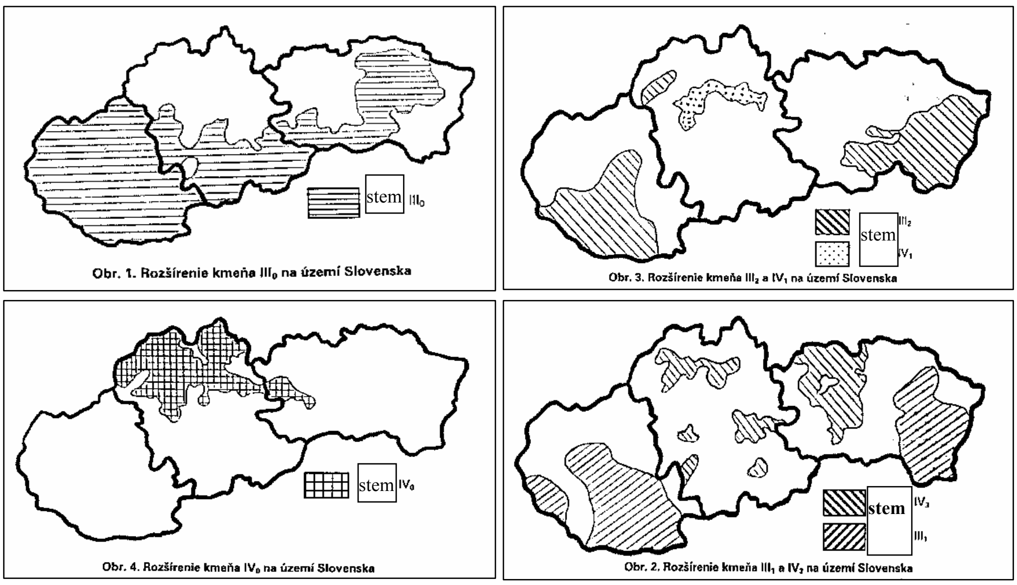

Fig. 2: Occurrence of the cockchafer's tribes in Slovakia based upon on the older information. (Directive ČSN 48-2713)

Several tribes of European common cockchafer have been very exactly picked out in the past in Slovakia (Fig. 2). Unfortunately today we cannot use the older information for decision-making because the situation of the occurrence of cockchafers has dramatically changed in Slovakia recently.

In this article we have tried to indicate how could look today areas with cockchafer occurrence in Slovakia. This was processed based on the information from the monitoring statistical documents as well as field observations. We used also some data from the neighbour countries. The minority cockchafer populations, which cause damage only very sporadically and in very small areas, were ignored. Finally three main outbreak areas were selected in Slovakia.

West Slovakia „Záhorie"

In the past only *M. melolontha* occurred here, a tribe with 3-year development cycle.

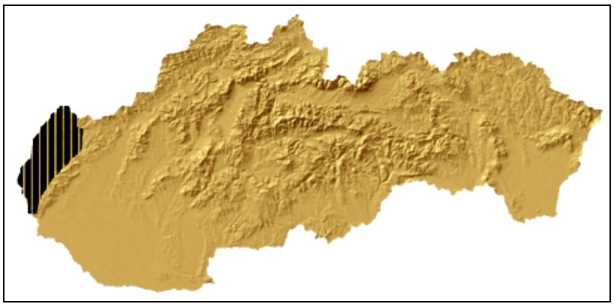

Fig. 3: Area of cockchafer distribution in Slovakia - region „Záhorie".

Today only *M. hippocastani* is known from "Záhorie". The centre of infestation is in Skalica, Gbely and Senica, as well as in Malacky and Bratislava (Fig. 3). This population of *M. hippocastani* is the largest in Slovakia and it occurs also in the southern Moravia (Czech Republic) – district Strážnice.

The development cycle lasts 4 years. The adults appear regularly in 4 years intervals in 1995–1999–2003 (Table 1). *M. melolontha* is extremely rare and occurs very sporadically here. Sometimes other scarab species cause a problem in this area – for example *Polyphylla fulo* L. or smaller *Hoplia* and *Phyllopertha* species.

	Years											
	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Melolontha hippocastani												
Adults												
Reality		■				■				■		
"New prognosis"		□				□				□		
Grubs												
Reality	■		▪	▪	■	▪		▪	■			
"New prognosis"	□		▫	▫	□		▫	▫	□			

■□ *adults – strong infestation, more than 100 ha injured forest stands in area.*
■□ *grubs - strong infestation, destroyed more than 10 000 plants or 100 ha defoliated forest stands in area.*
▪▫ *adults – medium infestation, less than 100 ha injured forest stands in area.*
▪▫ *grubs - medium infestation, destroyed less than 10 000 plants or 100 ha defoliated forest stands in area.*

Table. 1. The cockchafer in „Záhorie" with „new" short-term forecast.

Southern part of central Slovakia „Krupina and Rimavská Sobota“

In the past, two different stems of European common cockchafer were typical for this area. One strong tribe with 3-year development cycle and one weaker stem with 4-year development cycle.

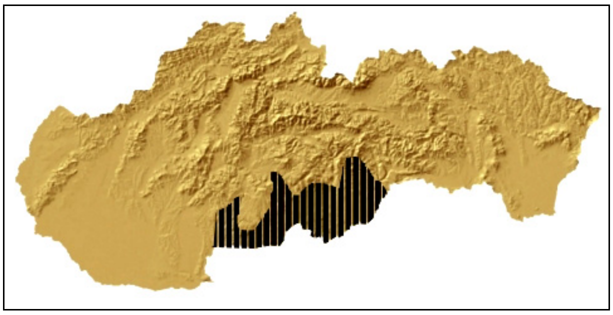

Fig. 4: Area of cockchafer distribution in Slovakia - region „Krupina and Rimavská Sobota“.

Both species, *M. melolontha* as well as *M. hippocastani*, occur in the southern part of central Slovakia. One very strong tribe of *M. melolontha* spreads to this region from the south (Hungary). It is a tribe with a 3-year development cycle with outbreaks in 2001-2004. It is spread from Rimavska Sobota through Lučenec, Veľký Krtíš, Revúca up to Krupina (Zvolen). Outbreaks of this species were extremely intensive in 2004. The stem of *M. hippocastani* is of medium power and we have registered outbreaks of this species in four-year cycles. The damage caused by grubs is not as regular as the damage by adults, which is confirmation of the fact that other tribes or populations of cockchafers also occur in this area. The stem of *M. melolontha* with 4-year development cycle is probably still present in this area.

	Years											
	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**200 5**
Melolontha melolontha												
Adults												
Reality						▪	▪	■	▪		■	
“New prognosis”		□			□			□			□	
Grubs												
Reality				▪		▪	■					
“New prognosis”	□			□			□			□		
Melolontha hippocastani and *Melolontha melolontha*												
Adults												
Reality			▪	■				■				
“New prognosis”				□				□				□
Grubs												
Reality		■	■				■					
“New prognosis”			□				□				□	

■□ *adults – strong infestation, more than 100 ha injured forest stands in area.*
■□ *grubs - strong infestation, destroyed more than 10 000 plants or 100 ha defoliated forest stands in area.*
▪▫ *adults – medium infestation, less than 100 ha injured forest stands in area.*
▪▫ *grubs - medium infestation, destroyed less than 10 000 plants or 100 ha defoliated forest stands in area.*

Table 2: The cockchafer in „Krupina and Rimavská Sobota“ with „new“ short-term forecast.

Eastern Slovakia „East Slovakian lowland"

In the past, two different stems of European common cockchafer with 3-year developmental cycles were apparent, separated from each other on the basis of the year of adult occurrence.

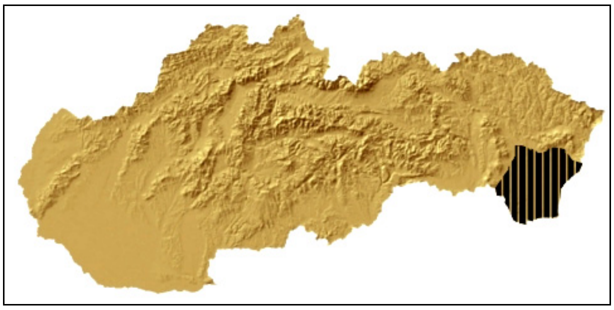

Fig. 5: Area of cockchafer distribution in Slovakia - region „ East Slovakian lowland ".

This area is related to East Slovakian Lowland (town Sobrance and surrounding territory). Occurrence of cockchafers is local in this area and they do not cause large damage now. The only heavy outbreak during the last ten years was recorded in 1998, less intensive than in 1997 and 1996. We do not have any information about the occurrence of *M. hippocastani* in this region. Several samples of beetles, which were processed at our department in previous years, only contained adults of the European common cockchafer. A strong tribe of *M. melolontha* with 3-year development cycle is known from neighbouring Hungarian areas. It is possible that this tribe has been penetrating areas in Slovakia. Generally we have very little information about cockchafers from this area and the forecast has not been processed yet.

	Years											
	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Melolontha melolontha												
Adults												
Reality			▪	▪	■							
"New prognosis"												
Grubs												
Reality												
"New prognosis"												

■□ *adults – strong infestation, more than 100 ha injured forest stands in area.*
■□ *grubs - strong infestation, destroyed more than 10 000 plants or 100 ha defoliated forest stands in area.*
▪▫ *adults – medium infestation, less than 100 ha injured forest stands in area.*
▪▫ *grubs - medium infestation, destroyed less than 10 000 plants or 100 ha defoliated forest stands in area.*

Table 3: The cockchafer in „East Slovakian lowland " with „new" short-term forecast.

Management tactics against cockchafers

Several strategies have a potential to minimize damage from cockchafer infestations and to contain or maintain cockchafer populations at levels considered tolerable. These strategies include monitoring cockchafer populations, using bio agents (*Beauveria brongniartii*) or soil pesticides against grubs and to protect tree foliage against adults. The method or combination of methods used will depend on the condition of the site and of the tree or stand as well as the density of the cockchafer population.

Monitoring

The forest owners dig a 1 square meter soil probe to find out how many larvae are in respective instars. The depth of the probe depends on the soil condition and the timing. It can vary from 30 to 70 cm. The number of the probes depends on the size of infested area and varies usually from 5-10 per 10-50 ha of infested stands. The best time for monitoring is from April to August. In late autumn the probes must be made deeper, because larvae are going deeper into the soil for over-wintering. It is not surprising to find adults being ready to hatch in September. The average number of 0.5 larvae of the 3^{rd} instar, or 1.0 larvae of the 2^{nd} instar or 2.0 larvae of the 1^{st} instar per one square meter is considered to be a limited number for making decisions about cockchafer control.

Grub control

In some areas of Slovakia, grubs are the limiting factor for the planting forest seedlings. The foresters are not able to reforest some places because of heavy infestation by grubs. Their control is complicated in forest plantations and in the field too.

We do not have any information about using bio control strategies against grubs in the forests of Slovakia until now. The foresters often use chemicals against this stage of the cockchafer.

Active ingredient	**Representative trade names**	**Notes**
dazomet	Basamid G	Two different application methods of these products are used. First, they are applied into the planting whole; second, they are distributed in rows and then are mechanically pre-treated by a rotary tiller (dose depends on the product). They start to be active in 1-2 moths and are persistent until 6-12 moths.
diazinon	Basudin 10 G	
Terbufos	Counter 3 G	
diazinon	Diazinon 10 G	
Carbosulfan	Marshal SusCon	Preferably used in the field to protect young seedlings. It is applied into the planting whole (8g/plant). Producer declares 2-year lasting persistency.

Table 4: The most commonly used chemical insecticide against cockchafers in Slovak forestry

Adult control

During periods when population density of adults is very high, pesticides may be the most effective method to reduce their quantity and protect the foliage of host trees. This method can also significantly reduce the density of the grubs in the future. Aerial application, using aircraft is an adequate control method. The best time for applying the pesticides is when the male – female ratio reach 1:1. For these purposes it is necessary to collect a certain number of adults (200-400 specimens) and check the current ratio. Initially the ratio is 3:1, later 2:1. Several days after the first adults had appeared, the ratio reached 1:1. Suitable time for application lasted only a few days.

An area of about 2,000 ha was treated by insecticides to prevent damage by cockchafers during last 10 years. In 1994, in the first larger aerial application, Boverol was used, and about 400 ha of forest stands were sprayed. This bio-pesticide contained the fungus *Beauveria brongniartii* and was applied on the foliage of trees.

The second application on a larger area was realized in 1999. About 500 ha of broadleaved stands, which sporadically occur in large pine areas, were selected as the target for the application of pyrethroids. Vaztak 10 EC in dose 0.3 l/ha + 100 l of water reduced the population density of the forest cockchafers radically. The helicopter was used for the spraying, and post-spraying investigations showed the high efficiency of the treatment.

Pest-monitoring in 2002 highlighted that population density of cockchafers increased significantly in west Slovakia. Therefore, aerial application of an area of about 700 ha has been under preparation in the cooperation between Forest Service, governmental organisation, forest users and owners. Because a considerable part of infested forest belongs to protected forest areas, state-owned and non state-owned, nature protection organisations attacked the proposed spraying of treatments. Finally, no control using aircraft was realised in 2003. However, some selected areas were treated with pyrethroids by ground application.

Year	**Active ingredient**	**Representative trade names**	**Treated area**	**Remarks**
1994	*Beauveria brongniartii*	Boverol	400 ha	Helicopter was used for application. Applied on the foliage of the trees – mostly oaks. The mycosis by *B. brongniartii* was recorded in 37 % of treated, but only in 0.5 % of the untreated cockchafers.
1999	Alfacypermethrin	Vaztak 10 EC	500 ha	Average number of 44.8 dead adults were found out on one square meter study plots established in the treated area two days after application. On non-treated territory the number of dead adults was 0.8.
2003	Cypermethrin	Cyples	100 ha	Ground application. The tests showed very high efficiency of the application (up to 98% compare to control).

Table 5: Some of field treatments, which have been realised in the forest practice against adults in the last 10 years and their efficiency.

Conclusions

The cockchafers are still very dangerous forest insect pests in Slovakia. Despite a relatively small area of infestation, they cause serious problems in some districts in Slovakia. The species structure has changed in the last several years. *M. hippocastani* is becoming much more important than before and has replaced the European cockchafer in many areas. The pyrethroids are still a good solution for cockchafer control. They are cheap, quite efficient, and easy to apply. As the experiences from 2003 showed, forest owners will have to modify their management strategy and use microbial and biological pesticides against cockchafers in near future.

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Poster presentation

Capture and monitoring of *Tortrix viridana* L. (Lep.: Tortricidae) by sex pheromone in Mazandaran province of Iran

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Abstract

Oak leaf roller (*Tortrix viridana* L.) is one of the important pests of oak forests. However this pest has been a quarantine pest for Mazandaran province on the Caspian coast till the year 2000, when it was detected in the area. Due to damage inflicted by the pest to forests in northern Iran, two pheromone products (a foreign product and an Iranian product produced by Pest and Disease Research Institute) were used for monitoring the distribution pattern of this insect. Pheromone traps were placed at various sites and altitudes in Mazandaran province. For this purpose the foreign product pheromone traps were used. For comparison of foreign and Iranian pheromones, nine traps of each product were placed in Zare Park and National Forest Park on 15 May 2002. Delta traps were placed on oak trees at a minimum distance of 50 m and 2-3 m height. Traps were collected on 25 May 2002 and male oak leaf roller and other moths were counted. This pest was trapped from Sari, Nekaa, Beh-shahr, Galandrood, Chalus forests, Ghaem-shahr Kalar Park and Noore Forestry Park. Population of the pest was more at National Forest Park (protected Forest of Environmental Organization) in Sari. A comparison of Iranian and foreign pheromone products to capture the male oak leaf roller showed that there was no significant difference between two products (p=0.3), but the two products were significantly different in the catching of the other moths (p=0.0027).

Key words: monitoring, pheromone, Mazandaran, biological control, *Tortrix viridiana*

Introduction

Oak leaf roller (*Tortrix viridana* L.) (Fig. 1) had long been a quarantine pest for northern forests of Iran (Abaie 2000), till it was detected near Sari in Mazandaran Province in the year 2000. Because of vast distribution of the forest and risk damage on oaks, monitoring of the oak leaf roller population was the primary step in developing a pest management program. Among different methods applied, the most effective one was application of sex pheromone. Sex pheromone of the female oak roller has been synthesized (Fig. 2) and used for monitoring or control of the adults in Poland and some other countries (Pascual *et al* 1994; Stocki 1994; Turcani 2000). Despite these efforts, there were no experiments or information regarding the use or evaluation of oak leaf roller sex pheromone in Iran. In this research, a product of the female sex pheromone (produced by the Plant Pest and Disease Research Institute of Iran) and a similar foreign product were used to determine pest distribution. The two products were also compared for capture-effectiveness relating to *T. viridana* and other moths.

Material and methods

Pest distribution

Pheromone traps were installed in a way to cover forest stands from west to east and at different elevations. Both delta and wing shaped traps were used and placed on trees (2 - 3.5 m. height from the ground) with a minimum distance of 50 meters from each other (Fig. 3a, b).

Evaluation of sex pheromone products:

Traps of each product (foreign and Iranian) were placed in two different forest stands (Zare Park and National Forest Park) on 15 May 2002. Delta traps were placed randomly on oak trees with a minimum distance of 50 m from each other and 2-3 m. height from the ground. After 10 days, both captured male oak leaf roller and the other moths were counted for each treatment and replication. Data were transformed $[(x + 0.5)^{1/2}]$ and means compared with Duncan's method after variance analysis.

Results

Pest distribution

Oak leaf roller moths were captured at most sites of Mazandaran Province (Table 1) from west to east and different altitudes from sea level. In forest stands near Sari, especially in National Forest Park, population density was higher compared to the other localities. *Tortrix* moths were captured by both delta and wing shaped traps.

Evaluation of pheromone products

Both products of sex pheromone were able to catch male moths (Fig. 4). Results showed that there was no significant difference between two products ($F=1.14$, $df=17$, $p=0.3$) (Table 2). Captured oak leaf roller moths in traps containing foreign product were 0 to 40 (mean 4.66 ± 4 moths/trap) and in traps containing the Iranian pheromone products were 0 to 220 moths (mean 27.6±24 moths/trap).

In some traps few species of *Archips* sp. were captured too [Foreign product=17-60, mean=38±4.8/trap; Iranian product=0-57, mean=11.5±5.8/trap ($F=12.6$, $df=17$, $p=0.0027$)], however there were no species of natural enemies (Table 3).

Discussion

Statistical analysis didn't reveal any significant difference between foreign and Iranian pheromone products in attracting the male oak leaf roller moths, but the products differed in capturing other moth species. It seems that the Iranian product acts more specifically and effectively compared to the foreign product. This can be attributed to two prime reasons. Firstly, it may be related to the genetic differences between oak leaf roller populations occurring in Iran compared to the other countries. Secondly, differences can be explained by the molecular components of each product (2, 4). Although the Iranian pheromone product consisted (Z)-11-Tetradecenyl acetate (Z-11-14-AC), but it was able to capture specifically more oak leaf roller moths in Iran. Results obtained in this study could be employed in developing complementary studies to improve the function of the Iranian pheromone product.

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Number of captured insects		**Height** From the ground level **(m)**	**Trap type**	**Region**
T. viridana	***Archips* sp.**			
2	45	3.5	Delta	**Sakou-tapeh**
1	45	2.5	Delta	**Sari**
3	8	3	Winged shape	**Beh-shahr**
2	5	3.5	Delta	**Holomsar 1**
-	5	3	Delta	**Holomsar 2**
1	31	2.5	Delta	**Holomsar 3**
5	17	2	Delta	**Holomsar 4**
1	3	3.5	Delta	**Holomsar 5**
6	2	3.5	Winged shape	**Nekaa**
10	30	2.5	Winged shape	**Ablounekaa**
3	20	3	Delta	**Holomsar 6**
1	24	3	Delta	**Ghaeem-shahr**
2	29	2.5	Delta	**Keshtgah**
6	17	3.5	Delta	**Iuke park 1**
30	35	3.5	Delta	**Iuke park 2**
2	13	3	Delta	**Nour park 1**
16	10	2.5	Delta	**Nour park 2**
46	6	3.5	Delta	**Tarbiat Modares University (forest)**
38	14	2.5	Delta	**Nour park 3**
14	32	3	Delta	**Semeskandeh forest 1**
2	60	2.5	Delta	**Semeskandeh forest 2**
53	17	3	Delta	**Semeskandeh forest 3**
6	13	3	Delta	**Darabkola forest**
50	15	3.5	Delta	**Zaree park**
65	-	3	Delta	**Nekaa forest**
1	-	3.5	Winged shape	**Savad Kouh**
1	21	2.5	Winged shape	**Golbagh Nour**
5	1	3	Winged shape	**Angataroud Nour**
1	15	3	Delta	**Chamestan Nour**
1	22	3.5	Delta	**Chamestan 1**
1	10	2.5	Delta	**Chamestan 2**
2	15	2.5	Delta	**Chamestan 3**
2	28	3	Winged shape	**Babol 1**
1	-	3.5	Winged shape	**Babol 2**
4	-	2.5	Winged shape	**Babol 3**
8	45	3	Winged shape	**Mian Kaleh Nekaa 1**
3	57	3	Winged shape	**Mian Kaleh Nekaa 2**
1	120	3.5	Winged shape	**Mian Kaleh Nekaa 3**
1	12	2.5	Winged shape	**Mian Kaleh Nekaa 4**
2	32	2.5	Winged shape	**Khansar forest 1**
1	32	3	Winged shape	**Khansar forest 2**
1	40	3.5	Winged shape	**Khansar forest 3**
1	33	3	Winged shape	**Khansar forest 4**
1	-	3.5	Delta	**Environmental Organization forest**
1	-	3.5	Delta	**Chalous 1**
50	1	2.5	Delta	**Chalous 2**
3	-	3	Delta	**Chalous 3**
1	5	-	Delta	**Neemat Abad forest**
3	7	-	Delta	**Nablar forest**

Table 1: Some local sites where oak leaf roller was collected in Mazandaran province.

Source of variance	Df	SS	MS	F
Treat	8	0.79	0.099	0.33 ^{ns}
Error	9	2.71	0.302	
Total	17	3.51		

Table 2: Variance analysis of the number of oak male leaf roller captured with two pheromone products.

Source of variance	Df	SS	MS	F
Treat	1	3146.88	3146.88	12.59 **
Error	16	3998.22	249.88	
Total	17	7145.11		

Table 3: Variance analysis of the number of other moths captured with two pheromone products.

Fig. 1: *Tortrix viridana* (male moth).

Tridecenyl acetate 11-- (E)

(Z)-11- Tetradecenyl acetate

(Z)-11-Tetradecen-1-Ol

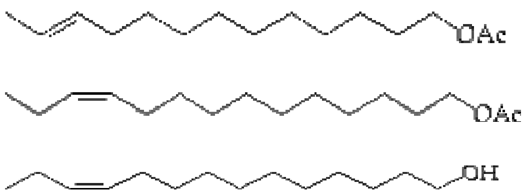

Fig. 2: Female sex pheromone compounds of *T. viridana.*

Fig. 3: Trap types: a-Wing shape, b-Delta Shape.

Fig. 4: Captured male oak leaf roller**s.**

Poster presentation

Occurrence of *Gasterocercus depressirostris* (Fabricius) (Coleoptera: Curculionidae) in lowland woods of Friuli Venezia Giulia (NE Italy)

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Abstract

In summer 2004 a strong infestation of *Gasterocercus depressirostris* (Fabricius) occurred in "Bosco Boscat" (Friuli-Venezia Giulia, North-eastern Italy). The incidence of *Gasterocercus depressirostris*, the emergence period, and other insects found in dying oaks are discussed here.

Keywords: dead wood, *Gasterocercus depressirostris*

Introduction

In summer 2001 specimens of *Gasterocercus depressirostris* (Fabricius) (Coleoptera: Curculionidae) were found in the Palude Moretto, a marshy area in the municipality of Castions di Strada (Udine, Friuli-Venezia Giulia, North-eastern Italy). In 2002 and 2003 further investigations to assess the presence of *Gasterocercus depressirostris* were carried out in the main lowland woods of North-eastern Italy (Bernardinelli *et al* 2003). In summer 2004 a strong infestation of *Gasterocercus depressirostris* was noted in a small wood ("Bosco Boscat") in the municipality of Castions di Strada.

The insect

Gasterocercus depressirostris (Fig. 1) is the only European species of the genus *Gasterocercus* and belongs to the subfamily *Cryptorrhynchinae,* that includes species which live in dead wood or dying trees (Hoffmann 1958).

Fig. 1: Adult and exit hole of *Gasterocercus depressirostris.*

Habitat and distribution

This species is known to live in trunks and large branches of dying *Quercus robur* L. and *Fagus sylvatica* L. (Hoffmann 1958) mostly in "primary forest" such as *Querco-Carpinetum*.

Nowadays those sort of woods are very scattered all over Europe and Italy. *Gasterocercus depressirostris* has been sporadically found in France, Germany, Romania (Hoffmann 1958), Ukraine (Kudela 1974), Moravia, Slovakia (Strejcek 1993), Hungary (Csóka and Kovács 1999) and Austria (Franz 1994).

In Italy this beetle was first found in 1993 in Basilicata (Southern Italy) (Caldara and Angelini 1997), then in 2001 in Friuli-Venezia Giulia (North-eastern Italy) (Bernardinelli *et al* 2003).

"Bosco Boscat" case study

In June 2004 a strong infestation of *Gasterocercus depressirostris* was noted in "Bosco Boscat", a small wood in Castions di Strada. This wood is a *Querco-Carpinetum,* rich in *Querus robur,* with an area of 2.5 hectares. Preliminary investigations were carried out to assess the incidence of *Gasterocercus depressirostris* damage and to study the weevil life cycle.
Materials and Methods

Field observations

A survey was carried out in "Bosco Boscat" where all the dead and dying oaks were observed to assess the presence of *Gasterocercus depressirostris.* On the whole, 45 dying oaks and 88 dead ones were studied.

Trunk window trap

To assess the period of emergence, trunk window traps (Fig. 2) were used to sample. Three traps were placed on the 2nd of June 2004 on dying oaks in "Bosco Boscat". Samples were collected every two weeks from 17th June to 9th September 2004.

Fig. 2: Trunk window trap.

Laboratory observations

In "Bosco Boscat", 9 sample logs were collected from dying oaks, on the 1st June 2004, for a volume of 0.07 m^3. This wood was kept in plastic boxes to collect all the emerging xylophagous insects.

Results and discussion

Field observations

62% of the observed dying oaks appeared to be infested by *Gasterocercus depressirostris*. 45% of the dead oaks appeared to have been infested by *Gasterocercus depressirostris* (Table 1). All the observed oaks have been infested by other xylophagous insects. A total of 10.4 m^3 resulted infested by *Gasterocercus depressirostris* on a total of 20.3 m^3 infested by xylophagous insects.

	Dead oaks		**Dying oaks**	
Ø cm	with *Gasterocercus*	**Total**	with *Gasterocercus*	**Total**
10	10	**39**	9	**14**
15	22	**33**	11	**15**
20	4	**7**	5	**8**
25	2	**4**	3	**7**
30	2	**3**		**1**
35		**1**		
40		**1**		

Table 1: Evidence of *Gasterocercus depressirostris* on dead and dying oaks of "Bosco Boscat".

Trunk window trap

The period of emergence was from June to August, with a peak in the second half of July (Fig. 3). One of the three traps captured almost all the specimens of *Gasterocercus depressirostris* suggesting that oaks are not equally attractive to the species.

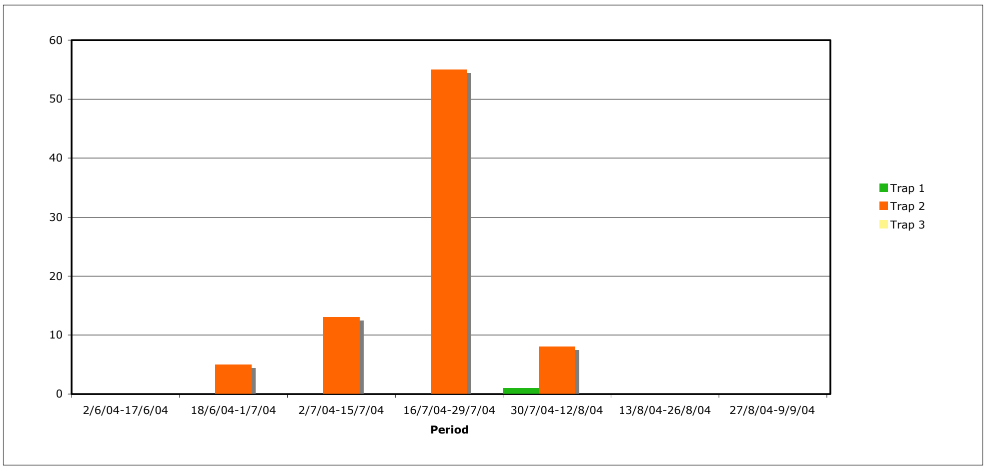

Fig. 3: Specimens of *Gasterocercus depressirositris* captured during summer 2004.

Laboratory observations

A large number of *Gasterocercus depressirostris*, as well as other xylophagous insects emerged from the logs kept in laboratory (Table 2).

Species	**Family**	**Specimens**
Gasterocercus depressirostris (Fabricius)	Curculionidae	140
Tremex fuscicornis (Fabricius)	Siricidae	77
Xylotrechus antilope (Schönherr)	Cerambicidae	32
Agrilus sp.	Buprestidae	31
Chrysobothris affinis (Fabricius)	Buprestidae	10

Table 2: Xylophagous insects collected in rearing boxes.

Research carried out within the project BAUSINVE – Direzione Centrale delle Risorse Agricole, Naturali, Forestali e della Montagna – Friuli Venezia Giulia – Italy. Further studies will be undertaken to assess whether *Gasterocercus depressirostris* is really playing a significant role in the death of oak in “Bosco Boscat”.

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Poster presentation

The main pests appearing on the purple osier in Moldavia (Romania) and the possible control measures against them

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Abstract

The paper shows the level of infestation with willow pests from osiers in the Eastern part of Romania (*Cryptorrhynchus lapathi, Aphrophora alni, Lamia textor* and so on). Field experiments set off that control of main pest *C. lapathi* can use with good results Karate Zeon and Calipso, substituting actual product - Sumithion.

Key words: purple osier, Moldavia, insects pests

Introduction

The crack willow culture has become again a present issue for the Romanian forestry sector, as the basketry products can generate important incomes. Therefore, the protection of these cultures against pests has new dimensions and needs a special attention.

The researches conducted in 2003 resulted in the inventory of the pests existing crack willow osieries. Also, there have been carried out experiments for controlling them using new more efficient products.

Methods

Pests infestation has been established in permanent control surfaces, each of them of 100 m^2. The control experiments of *C. lapathi* adults have been made in latin rectangular plots each product (insecticid) in 3 variants (doses) and 3 repetitions. The efficiency has been established comparing the infestations before and after treatment in treated and untreated plots.

Results

Infestation with main pests

The researches have been conducted in various osieries in Eastern Romania (Moldavia). Many of them are over 10 years old and present strong infestation with *Cryptorrhynchus lapathi* in stumps, as larvae and on twigs, after adult attacks. Osieries from Crasna - Vaslui, Dealul lui Stan - Roman or Traian - Bacau are in this situation (Table 1).

Frequent attacks have been registered in some old osieries due to a less known pest, that is *Lamia textor*, belonging to the Cerambycidae, which as larvae creates large galleries and contributes to stump loss of vitality, and as an adult leads to the rub of the twig bark.

The strongest attack occurred in Dealul lui Stan - Roman osiery. The pest was also found in the following osieries: Traian - Bacau, Izvorul Siretului - Pascani, Dumbravita - Focsani with frequencies up to 10%.

The pest *Aphrophora alni*, also very dangerous for willow twigs, has a lower frequency as compared to the previous years. Higher densities of its populations have been registered in Bacau (Traian) and Vaslui (Crasna).

The defoliating beetles (Curculionidae, Chrysomelidae) and defoliating caterpillar (*Orthosia* sp.) are less frequent in osieries lately and they have lead to less important attacks, because they are more sensitive to pesticides.

In some osieries (Trifesti - Iasi, Salcea - Suceava) as a new pests have been identified *Trypophloeus asperatus* (Col. Ipidae), which makes galleries between the bark and the wood and *Cyphocleonus tigrinus*, in Lac (Poenita) - Botosani osiery which attacks the willow twigs.

Field experiments with new insecticides

The new products tests in *Cryptorrhynchus lapathi* adult control pointed out that at the beginning of flight period (low infestations) can be applied with good results, at low doses, the products Karate Zeon-200 ml/ha, Samurai-250 ml/ha, Calipso-100 ml/ha, which proved a similar efficiency with that of the standard one Sumithion 50 EC, registered with a dose of 1000 ml/ha (Table 2).

Conclusions

Crack willow (*Salix rigida*) cultures are infested by specific pests, the level of infestation increasing with their age.

In the Eastern part of Romania have been identified as main pests the species *Cryptorrhynchus lapathi, Aphrophora alni* and *Lamia textor.*

To control the *Cryptorrhynchus lapathi* adults we can use with good results the insecticides Karate Zeon and Calipso, which can substitute the actual product - Sumithion.

Forest Direc-tion	Forest District	Data	Osier (PU,mu)	Total surfa-ce -hec-	Cultu-re	Instala-tion year	Divi-sion	Surfa-ce 100 m^2	Frequence of main pests and diseases (%)										Obs.
									Cryptorrhyn-chus lapathi		Aphro-phora		Lamia textor		Defoliators		Other pests		
									F-%	D-%	F-%	D-%	F-%	D-%	F-%	D-%	F-%	D-%	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Piatra Neamț	Roman	05.06.03	Dealul lui Stan(I,21)	9,0	Salix rigida	1982	I-III	900	1,0	0,01	-	-	2,0	0,03	0,7	0,1	-	-	Clorophanus viridis Orthosia, Earias
Vaslui	Vaslui	11.06.03	Crasna (I,85B)	11,0	Salix rigida	1982	I	1100	10,3	0,1	-	-	-	-	-	-	-	-	-
Iaşi	Paşcani	12.06.03	Zăvoaiele Siretului (III,14)	6,5	Salix rigida	2003	I	650	0,1	0,8	-	-	-	-	-	-	-	-	4% - forked
			Călugăra (III,14)	3,6	Salix rigida	2002	I	360	0,1	0,8	0,2	0,7	0,1	0,8	-	-	-	-	-
Bacău	Traian	17.06.03	Traian (IV,73P)	2,0	Salix rigida	1984	I	200	19,6	1,1	5,7	0,3	4,9	0,1	-	-	-	-	-
Piatra Neamț	Roman	18.06.03	Dealul lui Stan(I,21)	9,0	Salix rigida	1982	I	900	4,7	0,2	2,7	0,2	0,7	0,1	-	-	-	-	-
	Tg.Neamț	18.06.03	Dumbrava (II, 16 P)	3,1	Salix rigida	1987	I	310	-	-	2,0	0,1	-	-	0,3	0,4	-	-	Earias chlorana
	Gârcina	19.06.03	Bodeşti (IV,11)	10,5	Salix rigida	1986	I	1050	60,0	0,6	-	-	52,0	0,5	7,5	8,0	-	-	Hail - 14% Aphidae - 24%
Bacău	Traian	1.07.03	Traian (IV,73P)	2,0	Salix rigida	1984	I	200	9,0	1,7	3,0	0,1							
Vaslui	Vaslui	2.07.03	Crasna (I,85B)	11,0	Salix rigida	1996	I	200	14,0	0,1	2,0	0,1	-	-	85,0	-	-	-	14% hail

Table 1/1: Infestation of willow (*Salix rigida*) twigs with characteristic pests and diseases in some osieries from Moldavia in summer of 2003.

Vaslui	Vaslui	2.07.03	Crasna (I,85B)	11,0	Salix rigida	1995-1996	II	500	14,0	0,1	-	-	-	-	85,0	-	-	-	
					Salix rigida	1997	III	100	2,0	0,1	4,0	0,1	-	-	10,0	-	-	-	12% hail
					Salix rigida	2003	IV	300	-	-	-	-	-	-	-	-	-	-	
	Brodoc	2.07.03	Mărăşeni	7,0	Salix rigida	1995-1997	I-III	700	6,0	4,0	10,0	5,5	-	-	80,0	-	-	-	8% hail
Piatra Neamț	Roznov	18.07.03	Ciomeica	3,0	Salix rigida	2000	I	300	-	-	55,0	1,9	-	-	-	-	-	-	31% hail
			Jlabău	1,0	Salix rigida	2001	I	100	10,0	0,2	20,0	0,1	-	-	3,0	0,3	-	-	Earias chlorana
Vaslui	Vaslui	9.08.03	Crasna (I, 85 B)	7,6	Salix rigida	1995	I	500	52,0	2,8	-	-	-	-	-	-	-	-	
						1996	II	60	80,0	3,8	-	-	-	-	-	-	-	-	
						1996	III	200	100,0	16,8	-	-	-	-	-	-	-	-	
	Huşi	9.08.03	Stroeşti (IV,78)	60,0	S.rigida	2000	I	100	8,0	0,2	-	-	-	-	-	-	-	-	Aphidae, Orthosia
					S.viminalis	1998	II	300	10,0	0,2	-	-	-	-	-	-	-	-	Earias chlorana
					Salix rigida	1993	III	100	68,0	3,5	-	-	-	-	-	-	-	-	Phyllobius 80% hail
	Brodoc	9.08.03	Bârzeşti (IV,58A,C)	8,5	Salix rigida	1994	I	50	10,0	0,2	-	-	-	-	-	-	-	-	
					Salix rigida	2003	II	350	-	-	-	-	-	-	-	-	-	-	
			Mărăşeni (IV, 47 C)	7,2	Salix rigida	1994	I	720	92,0	11,4	-	-	-	-	-	-	-	-	
	Băceşti	9.08.03	Dumeşti (III, 6)	2,3	Salix rigida	1994	I	150	26,0	0,2	-	-	8,0	0,3	-	-	-	-	3% hail
							II	80	20,0	0,2	-	-	4,0	0,5	-	-	-	-	
Piatra Neamț	Roman	18.09.03	Dealul lui Stan (I,21)	9,0	Salix rigida	1982	I	300	74,0	2,5	12,0	0,3	18,0	0,7	5,0	0,2	-	-	88% hail
						1982	II	300	76,0	2,2	4,0	0,1	14,0	0,3	4,0	0,1	-	-	98% hail
						1997	III	300	46,0	1,3	20,0	0,5	20,0	0,5	2,0	0,1	-	-	96% hail + 2%Orthosia

Table 1/2: Infestation of willow (*Salix rigida*) twigs with characteristic pests and diseases in some osieries from Moldavia in summer of 2003.

Forest District	Osier (PU,mu)	Experimental variante (symbol, dose, consume norme)	Spe-cies Instalation year	Divi-sion 100 m²	Infestation before treatment		Efficiency % [(D_M - D_T)/ /D_M] * * 100	
					Frequence of damage (%)	Density of attack/ twig	la 17 days	la 40 days
1	2	3	4	5	6	7	8	9
Vaslui	Crasna (I, 85B)	V_{11} - Karate Zeon 200 ml/ha + 400 l water	Salix rigida 1996	0,25	0	0,0	100,0	82,6
		V_{12} - Karate Zeon 250 ml/ha + 400 l water		0,25	0	0,0	60,9	28,5
		V_{13} - Karate Zeon 300 ml/ha + 400 l water		0,25	0	0,0	66,9	44,9
		V_{21} - Samurai 250 ml/ha + 400 l water		0,25	0	0,0	100,0	27,9
		V_{22} - Samurai 300 ml/ha + 400 l water		0,25	0	0,0	100,0	12,7
		V_{23} - Samurai 350 ml/ha + 400 l water		0,25	0	0,0	86,0	26,5
		V_3 - Sumithion 1 l /ha + 400 l water		0,25	0,0	0,0	100,0	69,3
		V_{41} - Calipso 100 ml + 400 l water		0,25	0,0	0,0	100,0	42,5
		V_{42} - Calipso 150 ml + 400 l water		0,25	0,0	0,0	100,0	61,7
		V_{43} - Calipso 200 ml + 400 l water		0,25	0,0	0,0	100,0	18,8
		M - Control (untreated)		0,25	9,9	0,1	-	-
Traian	Traian (IV, 73P)	V_{11} - Karate Zeon 200 ml/ha + 400 l water	Salix rigida 1984	0,25	14,3	0,1	12,5	0,0
		V_{12} - Karate Zeon 250 ml/ha + 400 l water		0,25	25,0	1,4	100,0	0,0
		V_{13} - Karate Zeon 300 ml/ha + 400 l water		0,25	0,0	0,0	4,2	0,0
		V_{21} - Samurai 250 ml/ha + 400 l water		0,25	40,0	1,7	32,5	0,0
		V_{22} - Samurai 300 ml/ha + 400 l water		0,25	12,5	0,6	8,3	57,1
		V_{23} - Samurai 350 ml/ha + 400 l water		0,25	0,0	0,0	0,0	0,0
		V_3 - Sumithion 1 l /ha + 400 l water		0,25	0,0	0,0	0,0	0,0
		V_{41} - Calipso 100 ml + 400 l water		0,25	0,0	0,0	72,5	0,0
		V_{42} - Calipso 150 ml + 400 l water		0,25	0,0	0,0	27,5	25,9
		V_{43} - Calipso 200 ml + 400 l water		0,25	0,0	0,0	0,0	38,1
		M - Control (untreated)		0,25	0,0	0,0	-	-
Roman	Dealul lui Stan (I, 21)	V_{11} - Karate Zeon 200 ml/ha + 400 l water	Salix rigida 1982	0,25	0	0,0	0,0	30,6
		V_{12} - Karate Zeon 250 ml/ha + 400 l water		0,25	0	0,0	0,0	47,2
		V_{13} - Karate Zeon 300 ml/ha + 400 l water		0,25	0	0,0	0,0	0,0
		V_{21} - Samurai 250 ml/ha + 400 l water		0,25	0	0,0	0,0	0,0
		V_{22} - Samurai 300 ml/ha + 400 l water		0,25	0	0,0	0,0	19,4
		V_{23} - Samurai 350 ml/ha + 400 l water		0,25	0	0,0	0,0	5,6
		V_3 - Sumithion 1 l /ha + 400 l water		0,25	0	0,0	0,0	58,3
		V_{41} - Calipso 100 ml + 400 l water		0,25	0	0,0	0,0	27,8
		V_{42} - Calipso 150 ml + 400 l water		0,25	0	0,0	0,0	0,0
		V_{43} - Calipso 200 ml + 400 l water		0,25	0	0,0	0,0	27,8
		M - Control (untreated)		0,25	0	0,0	-	-

Table 2: Efficiency of experimental treatments against *Cryptorrhynchus lapathi* adults from osieries in the year 2003.
Date of the treatment: 18.06.2003 and 05.07.2003

Poster presentation

Carabid species with impact on defoliators in oak forests in the basin of Siret river, Romania

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Abstract

We estimated the defoliator populations, possible damage and, also, we studied the carabid populations from 11 forests with *Quercus petraea* in composition from the Siret river basin. There were estimated values for probable defoliation ranging from 7.6 % to 76.3 % and real defoliation values between 9 % and 34.7 %. In the studied forest ecosystem were identified 43 species belonging to Carabidae family. Out of this number 17 are very frequent for the studied stands and three species *Calosoma inquisitor*, *Molops piceus* and *Abax ater* are characteristically for carabid communities.

Key words: oak, defoliators, Carabids

Introduction

The faunistic structure or some groups represent important factors for the ecological balance, the knowledge of the correlations between populations play and important role in the measures taken for the efficient management of the pests' outbreaks. The oak forests frequently affected by some defoliator insects like *Lymantria dispar, Tortrix viridana, Erannis defoliaria, Erannis aurantiaria, Erannis marginaria, Colotois pennaria, Operophtera brumata* and, recently by *Apethymus filiformis* are extremely interesting for the natural enemies populations study. Knowing that among the predators of defoliator larvae are quoted some ground beetles species we studied the populations of carabids (Coleoptera: Carabidae) from different forests with high percentage of oak in composition placed in the Siret river basin, the eastern part of Romania. We aimed to study the carabids communities from the following points of view: species diversity, correlation with defoliator insects, the characteristic species.

Material and methods

The carabids fauna from the studied forests was captured with Barber traps as following: 12 Barber traps in each point (θ = 8-9 cm) cross placed around one tree. The material was collected once at 3-4 weeks.

The samples were collected from the 11 oak forests placed in the Siret river basin Table 1. In order to evaluate the defoliator populations, in the spring of 2002, were collected samples from the branches and was calculated the larvae density at hatching time, followed by another evaluation at the end of larval development. There also was estimated the probable defoliation and was determined the real defoliation (Table 1).

For every forest were calculated the average carabid abundance, the dominance, the constancy and ecological significance (Dzuba index) of each species. There were made correlations using Statistica 5 for the most abundant species in carabid communities from the studies stands.

Results and discussions

The densities of the pest larvae in the studied forests varied between 7 % to 55.7 % for *Tortrix viridana*, from 1 % to 37.8 % for the species belonging to Geometridae family, between 0 % and 5.4 % for the new pest – *Apethymus filiformis* – and for Noctuidae species ranges from 0.4 % to 6.7% (Table 1).

Forests direction	**Forest/ number of Barber traps batteries**	**Composition**	**Age (years)**	**Defoliator density (%)**					**Predicted defoliations %**	**Real defoliation %**
				Tortrix viridana	Geometridae	*Apethymus filiformis*	Noctuidae	total		
Botosani	1.Dracsani/3	10 Qp	60	18.4	36.1	0	0	54.5	33.3	24.9
	2.Guranda/1	3Qp7Dhs	70	14.0	4.0	0	0	18.0	10.9	10.0
Iasi	3.Popesti/3	7Qp2Qr 1Dhs	80	52.1	26.4	0	1.8	80.3	51.0	34.7
	4.Ghoerghitoaia/3	7Qp 2Cb1Fs	130	13.6	4.5	0	0.4	18.5	15.1	9.0
	5.Bacalu /3	5Qr2Qp3A	25	7.0	5.0	0	1.0	13.0	10.5	9.5
	6. Bunesti/3	7Qp1Tt2Dhs	125	21.0	74.9	0	2.0	97.9	51.7	28.8
Va	7. Dobrina/1	6Qp2Tt2Dhs	100	30.7	25.4	0	0	56.1	37.4	18.1
	8.Valea Teiului/3	8Qp2Dhs	40-130	55.7	25.3	0	6.7	87.7	56.4	*12.7
Baca	9. Paltinata/3	9Qp1Dhs	40-85	7.7	2.0	0	0	9.7	7.6	7.5
	10.Heltiu/5	10 Qp	85-150	4.0	1.0	5.4	1.5	11.9	9.2	10.8
	11.Cornatel/3	9Qp1Fs	45-80	68.4	37.8	0	0.9	107	76.3	34.5

Qp – *Quercus petrea*; Qr – *Quercus robur;* Dhs – different hardwood species; Fs – *Fagus sylvatica;* Cb – *Carpinus betulus*; A – *Acer* species; Tt – *Tilia tomentosa*

Table 1: Level of infestation with defoliators insects in oak forests from East part of Romania in the spring of the year 2002.

The real defoliation determinated after larval development of defoliators was smaller than the estimated value due to the action of some biological factors - like predators - among which carabids species.

At the level of carabid communities in the studied forests we identified a number of 43 species. The highest number of species was identified in Bacalu forest due to the interference between forest and open land ecosystem, being a very young stand with a well developed grass layer. Here were identified, along with species from *Carabus* genus, specimens belonging to *Amara* and *Harpalus* genera both in great number and high species diversity (table2). A particular case is represented by the forest Bunesti were the most part of carabid population is made up of *Carabus excelens* specimens, almost 50 %, being also recorded good diversity – 26 species. The smallest number of individuals was caught in Heltiu with a medium density of 21.5 specimen/battery and in Paltinata with 35,3 specimen/battery. This particular situation and the presence of the new pest *Apethymus filiformis* is due to the emplacement of these forests – on the Trotus valley downstream from the chemical factory from Borzesti.

Among the species identified for each forest we calculated Dzuba index for species significance (Table 3) and there were identified 17 species locally well represented, both from abundance and constancy point of view, in the studied forests. Among these the following three: *Molops piceus*, *Calosoma inquisitor* and *Abax ater* are characteristic species for the Siret basin oak stands, being registered with high values in over a half of the studied ecosystems (Table 3).

As a general trend can be observed a positive correlation between the density of defoliator insects and relative abundance of carabids species, their accumulation in studied oak forests being characteristic for progradation faze (Fig. 1).

Particularly, can be revealed the impact of some carabids like *Calosoma inquisitor*, which feeds especially in the crown of the trees, on *Tortrix viridana* caterpillars and *Carabus cancelatus*, which feeds at the soil level, on Geometridae and *Apethymus filiformis* larvae (negative correlations).

Conclusions

Out of the researches results that some carabids species, *Calosoma inquisitor*, *Molops piceus* and *Abax ater* are characteristically for the most of oak forests infested by defoliators (*Tortrix viridana,* Geometridae, *Apethymus filiformis*, Noctuidae) and can play an important role for natural control of these pests.

References

Ciornei, C.; Popa, N.; Ciuca, L. and Rang, C. 2003: The role of selective soil fauna as predators of *Apethymus abdominalis* Lep (Hymenoptera, Tenthredinidae), in oak forests the District Căiuți, Romania; Proceedings – Ecology, Survey and Management of Forest Insects, USDA Forest Service, Northeastern Research Station, General Technical Report NE-311, 121-123 pg.

Carabid species \ Forests	Paltinata	Heltiu	Cornatel	Dracsani	Guranda	Popesti	Gheorghitoaia	Bacalu	Bunesti	Dobrina	Valea Teiului
1. *Cychrus semigranosus*	1	1	2				4	4			2
2. *Carabus arvensis*	3	10					2				
3. *Carabus cancelatus*	2	4	12	103	26		1	12	6	5	55
4. *Carabus convexus*	1	5	2	13	2	4	6	8	20	5	15
5. *Carabus coriaceus*	26	22	3	18	5	6	94	21	116	3	3
6. *Carabus excelens*	1	1	4	2	5	1	2	19	670	35	10
7. *Carabus violaceus*				3		9	17	1	1		1
8. *Calosoma sycophanta*							4				
9. *Calosoma inquisitor*	1	4	31	315	81	29	30	365	234	41	30
10. *Leistus ferrugineus*						1		1			
11. *Leistus rufomarginatus*							2				
12. *Notiophilus biguttatus*	1	20	12	36		3	4	8	14		42
13. *Bembidium sp.*		12									
14. *Poecilus coeruleus*								1			
15. *Pterostichu cupreus*								2			
16. *Pterostichus madens*	1		41	13			7	7		1	1
17. *Pterostichus nigrita*								11	28		
18. *Pterostichus oblongopunctatus*	29	50	42				215	47			5
19. *Molops piceus*	5	58	85	39	38	13	47	15	125	35	288
20. *Abax ater*	8	20	12	52	1	3	19	56	84	12	152
21. *Abax ovalis*	2	14	21	13	23	8	19	52	8	2	26
22. *Abax parallelus*	1	9	3	1		1	1	10	13	1	
23. *Calathus fuscipes*								76	38		
24. *Platiderus rufipes*	1	13	15				1		2		
25. *Agonum dorsale*								14			4
26. *Amara aenea*	7	4					3	30	6		10
27. *Amara aequestris*									2		
28. *Amara communis*			1					3			4
29. *Amara ovata*				2				34	6		32
30. *Amara similata*						1		4			30
31. *Ophonus punctatulus*							1				2
32. *Ophonus azureus*								22	3		
33. *Ophonus maculicornis*								3			1
34. *Ophonus obscurus*								1			
35. *Ophonus puncticollis*								1			
36. *Ophonus sabulicola*									1		
37. *Harpalus calceatus*	13	21	2	11	1		8	49	8		7
38. *Harpalus griseus*	1	3	4	66	13		1	24	21		8
39. *Harpalus pubescens*	2	6	19	12	4		2	57	23	1	3
40. *Panageus crux major*								1			
41. *Oodes helipioides*				1	1			7	5		
42. *Brachynus crepitans*								87	36		10
43. *Aptinus bombardata*		1		3		5	27	35	20	6	30

Table 2: The presence and abundance of carabid species identified in studied forest.

Foresr districts and forests / Characteristic species	Caiuti			Trusesti		Podu Iloaiei		Raducaneni		Husi	
	Paltinata	**Heltiu**	**Cornatel**	**Dracsani**	**Guranda**	**Popesti**	**Gheorghitoaia**	**Bacalu**	**Bunesti**	**Dobrina**	**Valea Teiului**
1. *Carabus coriaceus*	24.5	7.9				7.1	18.2		7.8		
2. *Carabus cancelatus*				14.7	13						7.4
3. *Carabus excelens*									44.9	23.8	
4. *Carabus violaceus*						10.7					
5. *Calosoma inquisitor*				45	40.5	34.5	5.8	33.2	15.7	27.9	
6. *Notiophilus biguttatus*				5.1							
7. *Pterostichus oblongopunctatus*	18.2	7.2					41.6				
8. *Pterostichus madens*			13.5								
9. *Molop spiceus*		8.4	27.3	5.6	19	15.5	9.1		8.4	23.8	38.6
10. *Abax ater*	7.6							5.1	5.6	8.2	20.4
11. *Abax ovalis*					11.5						
12. *Calathus fuscipes*								6.9			
13. *Harpalus calceatus*	12.3										
14. *Harpalus griseus*				5.6	6.5						
15. *Harpalus pubescens*								5.2			
16. *Brachynus crepitans*								7.9			
17. *Aptinus bombardata*							5.2				

Over 5.1 % W4, W5 - characteristic

Table 3: Characteristic species in studied forests (Dzuba index).

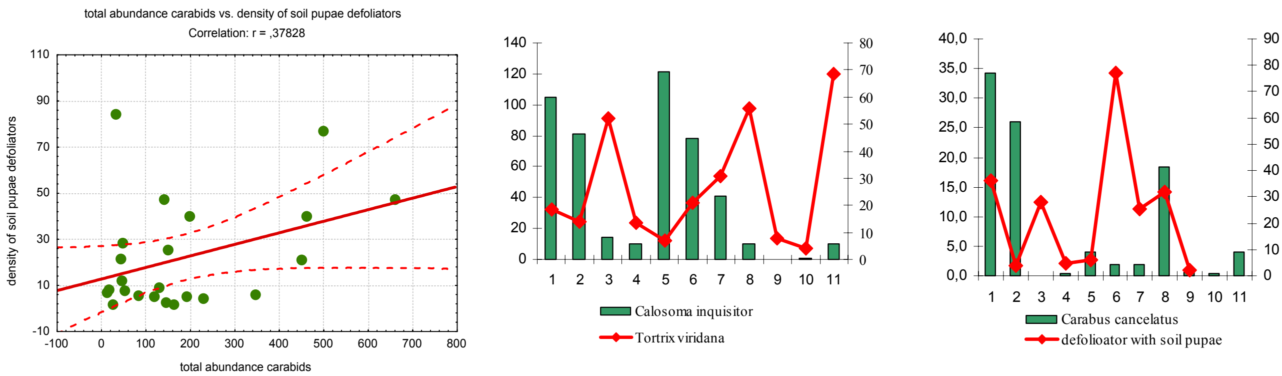

Fig. 1: Correlations between defoliator density and abundance of some carabid species.

Poster presentation

2004 - year of the gypsy moth in Hungary

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Abstract

A vast majority of the Hungarian forests is potential food plant for gypsy moth, which is the most important forest pest in Hungary. The last country-wide outbreak prior to 2004 was recorded in 1994, peaking with 34,000 hectares of damage in the country. In 2004, a record breaking area, ca. 110 thousand hectares was recorded. The most significant hotspot of the gypsy moth damage in Hungary is Veszprém county (a region North of the lake Balaton). This county is highly forested (29.2%), and the proportion of most preferred host plants (turkey oak and pedunculate oak) is very high. Primary food plants of gypsy moth represent more than 50% in this county. In 2004 beech stands and even conifers were damaged severely. A new and dramatic aspect of this gypsy moth outbreak is the interference with the human population. Larvae appeared in huge numbers in villages and towns causing serious public worry.

Keywords: gypsy moth, outbreak, Veszprém country, interference with human population,

Introduction

Ca. 75% of the Hungarian forests are located lower than 450 m a.s.l. 86.2% of the Hungarian forested area is covered by broadleaved trees (Table 1). The majority of these tree species, with a few exceptions (i.e. *Fraxinus*), are potential primary or secondary food plants for gypsy moths. Gypsy moth is both the most widespread and most significant forest pest in Hungary. Its outbreaks have been reported since the beginnings of the forestry literature. Outbreaks of different scale can occur all over the country. The yearly average of damaged areas between 1961-2003 was 5,500 hectares. The peak of the last country-wide outbreak prior to 2004 was recorded in 1994, peaking with 34,000 hectares of damage country-wide (Fig. 1). In 2004 ca. 110 thousand hectares forest were damaged by gypsy moth. This value is approximately 3-fold higher than the earlier record.

TREE SPECIES	**1,000 ha**	**%**
Oaks (including *Quercus cerris*)	568.3	32.5
Beech	108.9	6.2
Hornbeam	99.0	5.6
Black locus	379.8	21.8
Other hardwood	79.9	4.6
Hybrid poplars	118.4	6.8
Native poplars	53.5	3.1
Other softwood	97.3	5.6
Conifers	241.7	13.8
TOTAL	**1746.8**	**100.0**

Table 1: Proportion of the different tree species in the Hungarian forests.

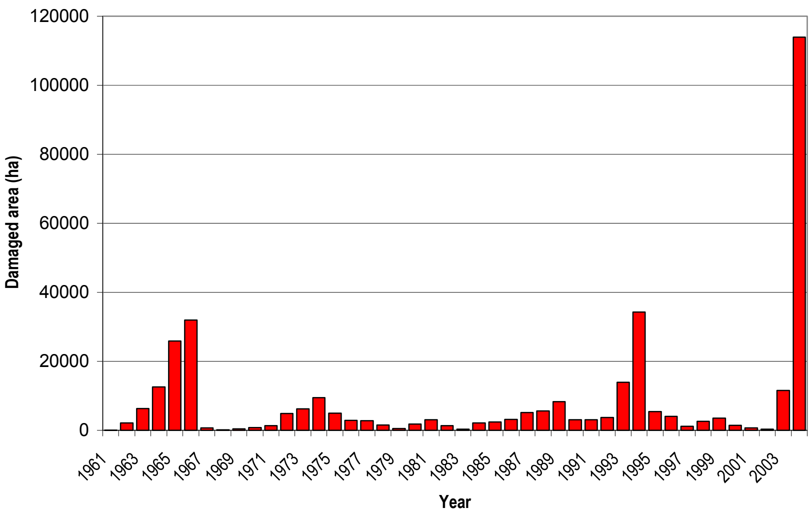

Fig. 1: Area damaged by gypsy moth in Hungary between 1961 and 2004.

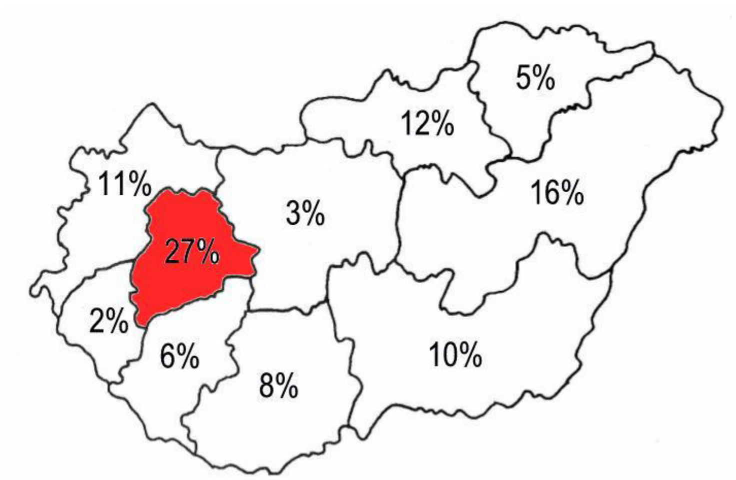

Fig. 2: Contribution of the different regions to the total gypsy moth damage in Hungary between 1990 and 2003.

The most important hotspot of *Lymantria* outbreaks is Veszprém county (North of the Lake Balaton). While this county represents less than 8% of the forest land in Hungary, 27% of all gypsy moth damage in the period of 1990-2003. was recorded here (Fig. 2). The proportion of *Quercus cerris* (the most preferred food plant of the gypsy moth in Hungary) is high (25%) in this region (Fig. 3,4). Primary hosts of gypsy moth represent more than 50% (Fig. 4).

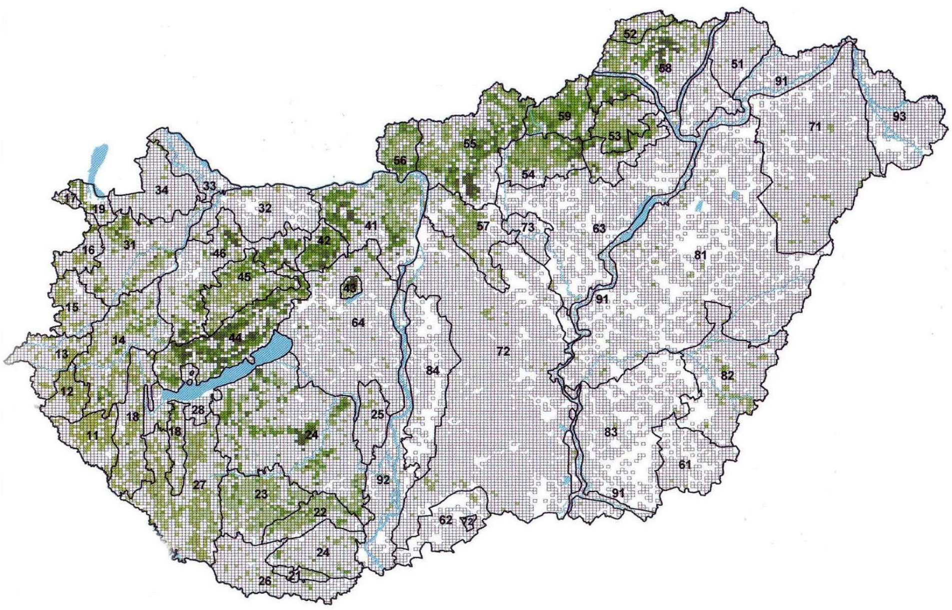

Fig. 3: Distribution of turkey oak (*Quercus cerris*) in Hungary.
(source of the map: Hungarian State Forest Service)

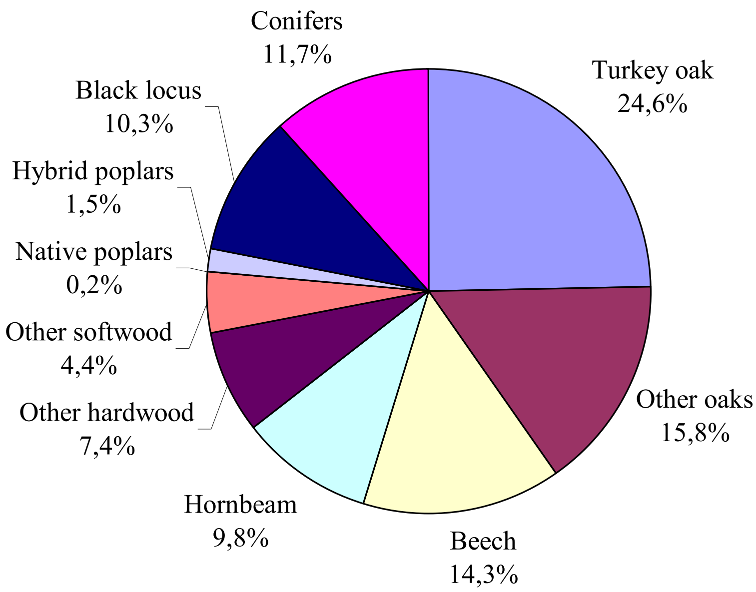

Fig. 4: Contribution of different tree species in Veszprém county.
(source of the data: Hungarian State Forest Service)

The dry and warm period peaking in 2002-2003 helped significantly to trigger an outbreak. After a very low damage value in 2002 (only 337 hectares country wide) the damage value showed a steep increase in 2003 (11,580 hectares).

The egg mass survey in winter 2003/2004 (high density of egg masses was reported from ca 35,000 hectares) already predicted record-breaking damage for 2004. In 2004, despite the cold and rainy April/May, gypsy moth damage exceeded every expectation and caused damage on 114,000 hectares of forest. Nearly 70% of the country- wide damage, including more than 26,000 hectares of total defoliation, again occurred in Veszprém county. It means that more than half of the forest area of this highly (29.2%) forested region suffered some level of gypsy moth defoliation. The sudden area expansion to North was certainly helped by frequent and strong southern winds in late April and early May. On top of well known primary food plants, beech, poplar, willow and even conifer stands suffered total defoliation (Fig. 5-6). The outbreak seems to collapse at its original centre, mainly due to lack of food, but some populations drifted away for long distances (sometimes for tens of kilometres) on the wind, and these seem to be healthy and viable. The egg masses are large and abundant on at least 30,000 hectares. This suggests that we are also facing significant damage in 2005.

Fig. 5-6: Heavy defoliation on beeches int he Bakony mountain.
(Photos: Hungarian State Forest Service, Veszprém Directorate)

Fig. 7-8: Interference with the human population.
(Photos: Hungarian State Forest Service, Veszprém Directorate)

A new and dramatic aspect of the gypsy moth outbreak is the interference with the human population. Larvae appeared in huge numbers in villages and towns causing serious public worry (Fig. 7-8.). Hardly any forestry related topic in the last decade received anywhere near as much media attention as this gypsy moth calamity did. The outbreak has become a real political issue. A serious debate (involving all possible extremes) has evolved about the necessity or vanity of control measures. It is worth mentioning that a considerable part of the area damaged is protected land. Control measures were taken on ca. 6,000 hectares, mainly at the Northern coast of the Lake Balaton.

Poster presentation

www.invasive.org: Linking images, and information of invasive and exotic species to North America

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Abstract

Proper identification of invasive species and associated organisms are important for adequate monitoring and detection activities, as well as to support proper management decisions. Invasive.org (www.invasive.org) is a web-accessible archive of high quality images driven by a fully-searchable taxonomic database based upon the ForestryImages (www.forestryimages.org) framework. Images in the system can be downloaded in the desired resolution, format and file size needed by the user and can be used with no royalties and no fees for all educational applications.

The system was developed as a portal to high resolution images with links to species-based information. Invasive.org is one of fifteen (15) websites maintained by the Bugwood Network (www.bugwood.org) on a broad range of topics, including invasive species, forestry and forest health, and entomology dealing with both natural systems and more directly managed systems. Invasive.org and the associated ForestryImages system make over 20,000 images taken by over 650 photographers on 4,000+ subjects available to users. During the period of Jan. 2002 through June 2004, over 25 million pages of information were served to more than 5 million users through these systems.

The content of the systems and the user base continues to expand. We invite you to visit, utilize and contribute to these sites. Invasive.org is a joint project between the University of Georgia, USDA Forest Service and USDA APHIS PPQ.

Keywords: invasive.org, forestryimages.org, bogwood. org, searchable database

WWW.INVASIVE.ORG

Linking Images, and Information of Invasive and Exotic Species to North America


emerald ash borer, *Agrilus planipennis* Fairmaire
Photo by David Cappaert, Michigan State University


cogongrass, *Imperata cylindrica* (L.) Beauv.
Photo by Jim Meeker, USDA Forest Service


Pterolonche inspersa Strig.
a biological control agent of knapweed
Photo from USDA APHIS PPQ Archives


tree of heaven *Ailanthus altissima* (P. Mill.) Swingle
Photo by Paul Wray, Iowa State University


tallow tree, *Triadica sebifera* (L.) Small
Photo by James H. Miller, USDA Forest Service


Asian longhorned beetle, *Anoplophora glabripennis* (Motschulsky)
Photo by Kenneth R. Law, USDA APHIS PPQ


European wood wasp, *Sirex noctilio* Fabricius
Photo by Stanislaw Kinelski


tropical soda apple, *Solanum viarum* Dunal
J. Jeffrey Mullahey, University of Florida


viburnum leaf beetle, *Pyrrhalta viburni* Paykull
Photo by Paul Weston, Cornell University

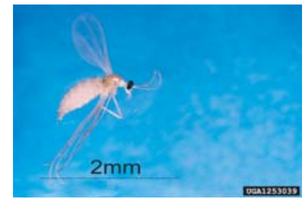

sudden oak death, *Phytophthora ramorum*
Photo by Joseph O'Brien, USDA Forest Service


Yellow starthistle, *Centaurea solstitialis* L.
Photo by Cindy Roché


leafy spurge, *Euphorbia esula* L.
Photo by William Ciesla, Forest Health Management International


Giant East African Snail, *Achatina fulica* Bowdich
Photo by Yuri Yashin, achatina.ru


purple witchweed, *Striga hermonthica* (Del.) Benth
Photo by USDA APHIS - Oxford, North Carolina Archives



Swede midge, *Contarinia nasturtii* (Kieffer)
Photo by Susan Ellis, USDA APHIS PPQ


giant hogweed, *Heracleum mantegazzianum* Sommier & Levier
Photo by Donna Ellis, University of Connecticut


gypsy moth, *Lymantria dispar* (Linnaeus)
Photo from USDA APHIS PPQ Archives


nun moth, *Lymantria monacha* Linnaeus
Photo by Petr Kapitola, Forestry and Game Management Research Institute - Czechia


kudzu, *Pueraria montana* (Lour.) Merr.
Photo by Chuck Bargeron, UGA


Japanese climbing fern, *Lygodium japonicum* (Thunb. ex Murr.) Sw.
Photo by Chris Evans, The University of Georgia


giant salvinia, *Salvinia molesta* D.S. Mitchell
Photo by Scott Robinson, Georgia Department of Natural Resources


Ralstonia solanacearum Race 3 Biovar 2 (Smith) Yabuuchi et al.
Photo by Jean L. Williams-Woodward, The University of Georgia


European spruce bark beetle, *Ips typographus* (Linnaeus)
Photo by Landesforstpräsidium Sachsen Archives


purple loosestrife, *Lythrum salicaria* L.
Photo by Bernd Blossey, Cornell University


Japanese honeysuckle, *Lonicera japonica* Thunb.
Photo by Chuck Bargeron, The University of Georgia

Featured Publications


large brown trunk beetle, *Hylobius abietis* Linnaeus
Photo by Gyorgy Csoka, Hungary Forest Research Institute


Citrus canker, symptoms on leaves, stems and fruit of grapefruit
Photo by Timothy Schubert, Florida Department of Agriculture and Consumer Services


Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann)
Photo by Scott Bauer, USDA ARS


Spanish slug, *Arion lusitanicus* Mabille
Photo by Luboš Kolouch

Proper identification of invasive species and associated organisms are important for adequate monitoring and detection activities, as well as to support proper management decisions. Invasive.org (www.invasive.org) is a web-accessible archive of high quality images driven by a fully-searchable taxonomic database based upon the ForestryImages (www.forestryimages.org) framework. Images in the system can be downloaded in the desired resolution, format and file size needed by the user and can be used with no royalties and no fees for all educational applications. The system was developed as a portal to high resolution images with links to species-based information. Invasive.org is one of fifteen (15) websites maintained by the Bugwood Network (www.bugwood.org) on a broad range of topics, including invasive species, forestry and forest health, and entomology dealing with both natural systems and more directly managed systems. Invasive.org and the associated ForestryImages system make over 20,000 images taken by over 650 photographers on 4,000+ subjects available to users. During the period of Jan. 2002 through June 2004, over 25 million pages of information were served to more than 5 million users through these systems. The content of the systems and the user base continues to expand. We invite you to visit, utilize and contribute to these sites. Invasive.org is a joint project between the University of Georgia, USDA Forest Service and USDA APHIS PPQ

The University of Georgia   USDA   USDA APHIS

Poster presentation

Crown damage by insects and diseases in Friuli Venezia Giulia (NE Italy): their impact on forest health

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Abstract

Occurrences and incidences of the main defoliating insects and foliar diseases during the last decade are reported from the Friuli Venezia Giulia (NE Italy). Damage by quite a few insects and pathogens were found both on conifers a broad-leaf trees. The most important pathogens are *Chrysomyxa rhododendri* on spruce, *Sphaeropsis sapinea* on pines, *Melanconium* sp., *Eutypella alnifraga* on alder and *Microsphaera alphitoides* on oaks. Significant defoliators are *Coleophora laricella, Zeiraphera griseana* on larch, *Thaumetopoea pityocampa* on Austrian pine, *Barbitistes oczkay* and *Miramella irena* on hop hornbeam, *Operophtera brumata* and *Erannis defoliaria* on hop hornbeam and oaks.

Keywords: crown damage, defoliators, foliage diseases

Introduction

The forests of the Friuli Venezia Giulia (FVG) district (North-eastern Italy) cover an area of about 265,000 hectares, corresponding to 34% of the district area. Forest lands show a high floristic richness of both tree and undergrowth species, due to the geographical location of the region, which presents both Mediterranean and Alpine climatic conditions. However, the forest management performed in the last centuries modified the natural composition of the stands, which today show a tree flora counting 53 tree species distributed in about 100 types of forests, pooled in 20 main groups.

Methods

In the last 10 years the occurrence and incidence of some important defoliating pests and diseases were recorded. Crown damage is usually recorded as hectares of defoliated area, whereas the intensity of the defoliation is evaluated by using the damage classification reported in the EU Council Regulation n. 1696/87. Defoliations interesting more than the 25% of the crown are considered as severe, although lower damage is recorded as well.

Discussion

The impact of defoliators deeply varies in relation to the forest roles, such as timber production, soil protection and landscape amenity. For example, although the green alder (*Alnus viridis*) has no economical value for timber production, it has a great importance for mountain landscape and soil protection against erosion. For this reason the expansion of the green alder crown wilt and dieback is monitored since 1999.

The evaluation of defoliation effects on the forest health is difficult, because of the combined action of many factors, such as the different susceptibility/tolerance of different tree species towards defoliations, as well as the incidence of variable weather conditions. So, large outbreaks of defoliating pests attacking healthy stands could cause a damage lower than slight mildew infections widespread in oak stands already affected by oak decline.

Monitoring is the first step for understanding which are the more susceptible forest types and which are the pests and diseases more commonly causing damage. In this respect, defoliators and foliage diseases seems to have a very small incidence on the health of FVG's forests, as severe defoliations are annually involving only the 0.7% of the total forest area. Nevertheless, some types of forests and some tree species are more affected by defoliations. For example, the 2.7% of the larch stands (*Larix decidua*) are annually defoliated; similar level of defoliation concerns forests of hop hornbeam (*Ostrya carpinifolia*) mixed with other broadleaf species. Finally, the oak/hornbeam mixed stands, which are relicts of ancient natural forests, are the more defoliated forests (3.6%). Defoliations caused by pests and diseases heavily affect the phytosanitary conditions especially of pedunculate oak (*Quercus robur*), which already suffer by oak decline.

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MAIN FOREST TYPES IN FRIULI VENEZIA GIULIA		Areas damaged by defoliating insects and foliage disease *	
	ha	ha	%
A - Hop-hornbeam / ilex bushy mixed forest *(Ostryo-Quercetum ilicis)*	116	0.00	0.0%
B - Hornbeam and Oak/Hornbeam mixed forests *(Carpinetum and Querco-Carpinetu*	2,435	86.95	3.6%
C - Sessile-pubescent oak/Chestnut mixed forests *(Quercetum petraeae)*	16,721	90.30	0.5%
D - Flowering ash/hop-hornbeam mixed forests *(Ostryetum carpinifoliae)*	32,114	835.48	2.6%
E - Ash/Sycamore maple/Lime mixed forests *(Fraxinetum)*	12,547	94.43	0.8%
F - Hazel and Birch stands	1,236	0.28	0.0%
G - Beech forests *(Fagetum sylvaticae)*	69,032	78.87	0.1%
H - Mountain dwarf pine stands *(Pinetum mughi)*	7,223	0.60	0.0%
I - Austrian and Scots pine stands *(Pinetum nigrae and Pinetum sylvestris)*	36,629	111.50	0.3%
L - Spruce/Beech mixed forests *(Fagetum)*	23,787	20.36	0.1%
M1 - Silver fir forests *(Abietetum and Fagetum)*	500	7.01	0.0%
M - Spruce/fir/beech mixed forests *(Abietetum and Piceetum)*	17,155		
N - Spruce forests *(Piceetum)*	17,790	164.33	0.7%
N1 - Secondary spruce forests *(Fagetum)*	4,833		
O - Larch stands *(Laricetum)*	3,350	89.80	2.7%
P - Alder stands *(Alnetum)*	3,464	52.29	1.5%
Q - Willow bushy stands *(Salicetum)*	736	7.56	1.0%
R - Black locust stands	5,966	1.40	0.0%
S - Plantations	6,023	74.22	1.2%
X - Others	4,096	59.83	1.5%
TOTALE	265,753	1775.21	0.7%
* Mean annual area severely defoliated/damaged (>25% loss) during the period 1994-2003			

Table 1: Main forest types in Friuli Venezia Giulia.

Foliage diseases on Conifer Trees				
Tree	total damaged area ha	disease	light damaged area (< 25% loss) ha	severe damaged area (> 25% loss) ha
SILVER FIR *Abies alba*	0.2	*Cytospora friesii*	0.2	-
NORWAY SPRUCE *Picea abies*	301.7	*Chrysomyxa rhododendri*	112.8	179.9
		Lophodermium piceae	9.0	-
LARCH *Larix decidua*	81.2	*Botrytis cinerea*	0.6	-
		Hypodermella laricis	-	1.7
		Lophodermium laricinum	6.8	-
		Mycosphaerella laricina	35.4	36.9
MOUNTAIN DWARF PINE *Pinus mugo*	3.5	*Lophodermella sp.*	-	1.5
		Lophodermium seditiosum	-	2.0
AUSTRIAN PINE *Pinus nigra*	1,085.7	*Cenangium ferruginosum*	-	8.0
		Lophodermium seditiosum	10.3	5.0
		Naemacyclus minor	103.5	44.0
		Naemacyclus s.p	10.0	-
		Sphaeropsis sapinea	743.3	161.6
SCOTS PINE *Pinus sylvestris*	31.4	*Lophodermium seditiosum*	0.5	1.5
		Lophodermium pinastri	0.3	0.5
		Sphaeropsis sapinea	-	0.5
		Naemacyclus minor	-	28.2
COMMON YEW *Taxus baccata*	0.2	*Cryptocline taxicola*	0.2	-

Foliage diseases on Broad-leaf Trees				
Tree	total damaged area ha	disease	light damaged area (< 25% loss) ha	severe damaged area (> 25% loss) ha
HEDGE MAPLE *Acer campestre*	22.0	*Rhytisma acerinum*	22.0	-
SYCAMORE MAPLE *Acer pseudoplatanus*	16.0	*Cristulariella depraedans*	1.3	7.1
		Pleuroceras pseudoplatani	-	4.4
		Rhytisma acerinum	2.5	0.7
MAZZARD CHERRY *Prunus avium*	14.0	*Blumeriella jaapii*	-	14.0
ASH *Fraxinus excelsior*	0.2	*Venturia fraxini*	-	0.2
FLOWERING ASH *Fraxinus ornus*	68.3	*Venturia fraxini*	68.3	-
SCOTCH ELM *Ulmus glabra*	0.5	*Septoria ulmi*	-	0.5
SPECKLED ALDER *Alnus incana*	9.0	*Melampsoridium* sp.	-	9.0
GREEN ALDER *Alnus viridis*	1,518.4	*Melanconium* sp. *Eutypella alnifraga* (and other not recognized species)	1,080.4	438.0
HOP HORNBEAM *Ostrya carpinifolia*	355.3	*Asteroma sp.* (and other not recognized species)	3.1	352.2
PEDUNCULATE OAK *Quercus robur*	71.1	*Apiognomonia quercina*	10.0	-
		Microsphaera alphitoides	10.8	49.3
PUBESCENT OAK *Quercus pubescens*	616.7	*Microsphaera alphitoides*	-	616.7
ROWAN *Sorbus aucuparia*	25.0	*Gymnosporangium sp.*	-	25.0

Table 2: Foliage diseases on the main conifer and broad-leaf trees.

Defoliating Insects on Conifer Trees

Tree	total damaged area ha	pest	light damaged area (< 25% loss) ha	severe damaged area (> 25% loss) ha
NORWAY SPRUCE *Picea abies*	155.6	*Epinotia tedella*	145.2	8.0
LARCH *Larix decidua*	1,216.1	*Coleophora laricella*	-	666.3
		Zeiraphera griseana	79.1	470.7
MOUNTAIN DWARF PINE *Pinus mugo*	1.5	*Thecodiplosis brachyntera*	-	1.5
AUSTRIAN PINE *Pinus nigra*	2,310.5	*Cryptocephalus pini*	1.0	-
		Diprion pini	1,717.5	-
		Neodiprion sertifer	1.0	-
		Thaumatopoea pityocampa	251.9	339.1
SCOTS PINE *Pinus sylvestris*	3.0	*Thaumatopoea pityocampa*	-	3.0

Defoliating Insects on Broad-leaf Trees

Tree	total damaged area ha	pest	light damaged area (< 25% loss) ha	severe damaged area (> 25% loss) ha
SYCAMORE MAPLE *Acer pseudoplatanus*	8.8	*Harrisomiya vitrina*	0.3	8.5
HORNBEAM *Carpinus betulus*	32.3	*Colotois pennaria*	-	3.3
		Deporaus betulae	0.3	-
		Erannis defoliaria	-	9.3
		Operophthera brumata	-	19.3
HOP HORNBEAM *Ostrya carpinifolia*	1,518.5	*Barbitistes oczkayi*	58.1	391.2
		Colotois pennaria	-	20.4
		Erannis defoliaria	8.6	177.1
		Eupsilia transversa	-	0.3
		Lymantria dispar	-	8.3
		Malacosoma neustria	-	7.6
		Melolontha melolontha	-	1.6
		Miramella irena	58.1	391.2
		Operophthera brumata	18.6	265.4
		Orthosia cruda	3.1	55.9
		Orthosia stabilis	-	7.4
		(other not recognized species)	-	45.7
TURKEY OAK *Quercus cerris*	5.2	*Neuroterus lanuginosus*	-	5.2
BEECH *Fagus sylvatica*	2,770.0	*Erannis defoliaria*	10.4	36.3
		Malacosoma neustria	40.3	65.9
		Operophthera brumata	2.7	-
		Operophthera fagata	1,196.2	84.8
		Orthosia cruda	4.5	-
		Rhynchaenus fagi	986.0	16.2
		(other not recognized species)	326.7	-
PEDUNCULATE OAK *Quercus robur*	476.4	*Tortrix viridana*	-	3.4
		Rhynchaenus quercus	141.9	-
ASH *Fraxinus excelsior*	15	*Caloptilia syringella*		15.0
NARROW-LEAF ASH *Fraxinus angustifolia*	183.1	*Stereonychus fraxini*	10.0	173.1
FLOWERING ASH *Fraxinus ornus*	10.9	*Archips xylosteana*	-	3.8
		Erannis defoliaria	-	0.2
		Operophthera brumata	-	0.1
		Orthosia cruda	0.9	-
		(other not recognized species)	-	5.0
BLACK LOCUST *Robinia pseudoacacia*	29.7	*Parectopa robiniella*	9.4	20.3
SESSILE OAK *Quercus petraea*	836	*Colotois pennaria*	-	3.2
		Erannis defoliaria	-	147.2
		Lymantria dispar	-	3.2
		Operophthera brumata	49.8	145.3
		Orthosia cruda	25.7	-
		Orthosia stabilis	-	3.2
		Tortrix viridana	61.1	90.6
		(other not recognized species)	-	306.7
PUBESCENT OAK *Quercus pubescens*	126.8	*Operophthera brumata*	-	2.0
		Barbitistes oczkayi	-	1.0
		Miramella irena	-	1.0
		Tortrix viridana	14.9	97.6
		(other not recognized species)	-	10.3

Table 3: Insects on the main conifer and broad-leaved trees.

Fig. 1: Scots pines killed by *Sphaeropsis sapinea.*

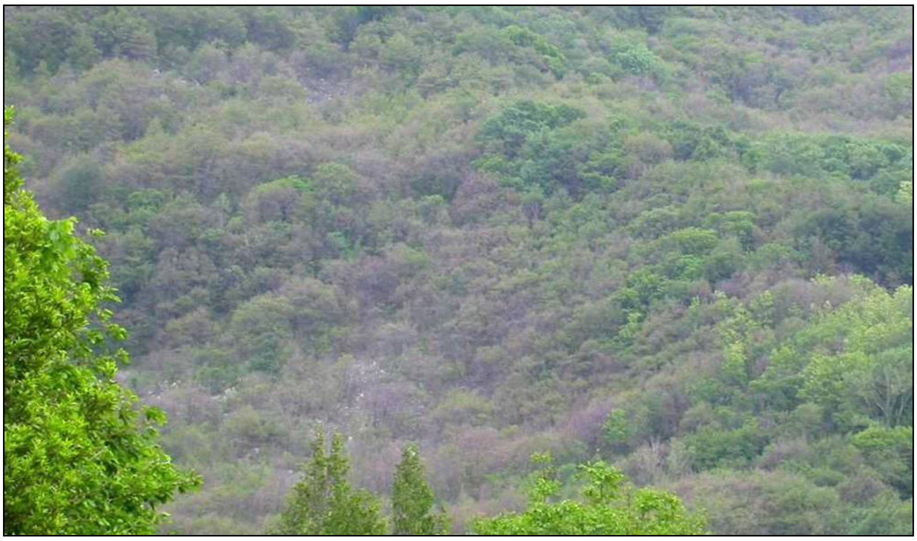

Fig. 2: Hop hornbeam mixed forest defoliated by loopers.

Poster presentation

Insects of timber residuals in clear-cuts

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Abstract

Studies on xylofauna living in felling residues were carried out in 2003-2004 in the forests of Kaunas district, Lithuania. Felling residues (branches) of oak, birch, spruce and pine trees were collected in October 2003. Xylofauna present in the branches was raised in eclectors. During studies, representatives of the following insect orders were found in felling residues (branches): *Diptera* (51%), *Psocoptera* (24%), *Coleoptera* (22%), *Hymenoptera* (2%), *Neuroptera, Hemiptera* and *Lepidoptera.* All in all, 48 species of arthropoda were detected. Most arthropoda species were detected in spruce (33 species) and pine (23 species) branches. The first to attack branches are sarcophagus *Psocoptera* sp. and microphages *Mycetophilidae* sp. Besides *Mycetophilidae* and *Psocoptera,* pine branches were dominated by *Ips typographus* – 17% and *Pissodes pini* – 14%, while those of spruce – by *Polygraphus polygraphus* – 43 % and *Pityophthorus lichtensteini* – 16%. Thin branches contained even 6 times less arthropoda than average ones and 4 times less than thick branches. Among *Coleoptera* xylophages comprise 91%, while among all arthropods detected in branches – 20%.

Key words: felling residues, branches, xylofauna, diameter

Introduction

Insects make the most abundant group of animals on the Earth. About 14000 species of insects (Žiogas *et al* 2000, Lietuvos fauna. Vabalai 1995, Lietuvos fauna. Vabalai 1997) are described in our republic. The arthropods of clear-cuts are least investigated. Harmful to forest xylofauna is studied sufficiently well, but the xylofauna living in the residues of cutting areas was observed too little.

Looking for cheaper fuel sources and with the appearance of newer and more economic possibilities (heating plants of new type) of a versatile use of fuel, the possibility to use cutting residues (branches, stumps, etc.) left in clear-cut is provided.

The problem is whether the entomofauna of cutting residues is important for the newly formed forest ecosystem and adjacent stands? Whether elimination of cutting residues won't destroy the habitats of rare and beneficial insect species?

Vorontsov maintains, that forest protection measures should be applied only after thorough studies of the processes going on in forest ecosystems (Vorontsov *et al* 1991). Thus, if succession processes in the forest are more deeply understood, then the studies of cutting sites as an anthropogenically-affected part of forest ecosystem are only episodically.

The works of Lithuanian scientists most often contain data on the biology and ecology of insects, their damage caused and protection measures. However, works on arthropods, especially those of clear-cut, their interrelations and trophical relation are not abundant (Žiogas *et al* 2001). The relationship between different groups of insects is more complicated than first thought. Therefore, it is necessary to carry out studies for a series of years, seeking to establish regularities and arrive at proper conclusions.

The studies were aimed to determine species composition and abundance of xylofauna hibernating in forest felling residues.

Methods

Forest felling operations were conducted in October 2003 in the forests of Dubrava Experimental Training Forest Enterprise, Kaunas district, Lithuania. On 6 April 2004, 5 plots were selected, where cut 40cm long pine, spruce, oak and birch branches of varying diameter were collected for the study (Fig. 1). At 3 (5 replications, totally 15 branches) thin branches (diameter 1 cm) of each tree species were taken from the plots; at 2 (5 replications, totally 10 branches) branches of average thickness (diameter 3 cm); at 1 (5 replications, totally 5 branches) thick branch (diameter 6 cm). These branches, at 1, at 2 and at 3 were placed into eclectors and observed until 12 August 2004 (Fig. 2). Xylofauna appearing in eclectors was collected and recorded every month.

Fig.1: Pine branches of varying diameter.

Fig. 2: Branches placed to eclectors.

Results and discussion

After 4 months of study, a total of more than 1000 arthropoda were detected in felling residues. They belonged to 2 classes (*Insects* and *Myriapoda*). The class of insects was represented by 7 orders: *Diptera* (51%), *Psocoptera* (24%), *Coleoptera* (22%), *Hymenoptera* (2%), *Neuroptera*, *Hemiptera* and *Lepidoptera*. All in all 48 species of arthropoda were detected. The main dominants are: *Mycetophilidae* sp., *Psocoptera* sp.

The branches of different tree species contained different dominants. Apart from *Mycetophilidae* and *Psocoptera,* pine branches were dominated by *Ips typographus* – 17% and *Pissodes pini* – 14%, while spruce branches by *Polygraphus polygraphus* – 43% and *Pityophthorus lichtensteini* – 16%. The representatives of *Psocoptera* order dominated birch and oak branches, they comprised respectively 42% and 83%.

Most arthropod species were found in spruce (33 species) and pine (23 species) branches (Fig. 3). Similar is the distribution of arthropod abundance. Spruce branches contained 1.5 times more arthropods than pine branches and 7 times more than birch branches (Fig. 4). Average branches are more preferred by xylofauna than thin ones. Thin branches contained 6 times less arthropods than average branches and 4 times less than thick branches.

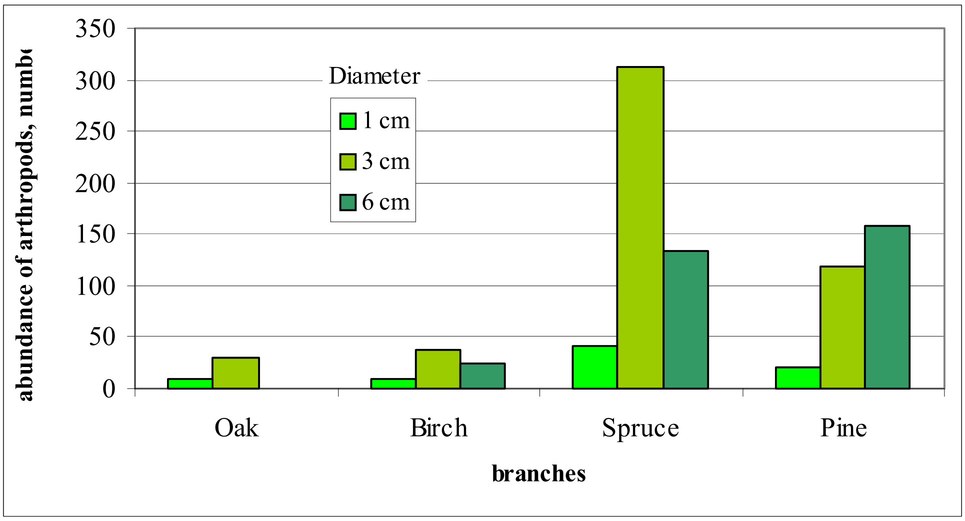

Fig. 3. Abundance of arthropods in cutting residues (branches) of different diameter.

Comparing the variety of xylofauna living in the branches of different diameter, it can be seen that most species were detected in average and thick branches, respectively 25 and 32 species. The highest number of species was collected in the second month of observations (15 species), while the highest abundance of arthropods was ascertained only after 4 months of observations (417 individuals).

Analysing the collected material, it can be seen that xylofauna composition in spruce branches changes depending on the diameter of branches. If in thin branches dominated *Psocoptera*, then in average ones they took only the 3rd place, while in thick branches they failed to fall within the most abundant seven species. Slightly different is the distribution of *Scolytidae*. These beetles start dominating only in branches of average diameter, while in thick branches *Mycetophilidae* representatives mix with them (Tables 1,2).

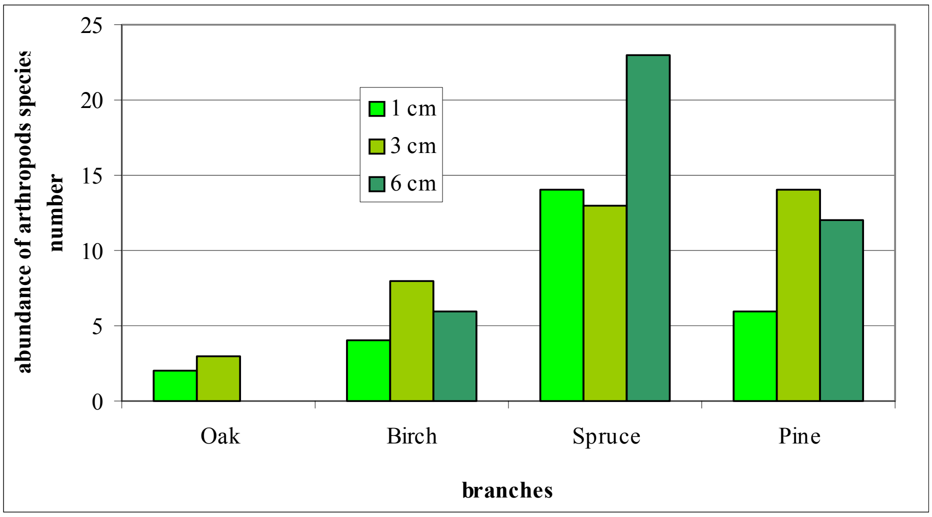

Fig. 4. Abundance of arthropod species in cutting residues (branches) of different diameter.

Order, class of xylofauna	Abundance (%) of arthropods in branches of different species trees				Total (%)
	Oak	Birch	Spruce	Pine	
Diptera	19.42	23.97	39.01	85.43	51.54
Psocoptera	80.58	66.12	24.19	2.85	24.28
Coleoptera	0.00	5.79	34.07	10.05	21.90
Hymenoptera	0.00	0.00	2.52	1.34	1.78
Hemiptera	0.00	2.48	0.00	0.00	0.16
Lepidoptera	0.00	1.65	0.10	0.00	0.16
Chilopoda	0.00	0.00	0.00	0.34	0.11
Neuroptera	0.00	0.00	0.10	0.00	0.05

Table 1. Xylofauna abundance in branches (cutting residues) of different tree species.

Order, class of xylofauna	Abundance (%) of arthropods in branches of different diameter			Total (%)
	1 cm	3 cm	6 cm	
Psocoptera	83.91	34.33	20.32	36.58
Diptera	1.74	23.18	59.54	33.58
Coleoptera	8.70	41.77	15.90	27.04
Hymenoptera	3.91	0.14	4.06	2.20
Hemiptera	0.87	0.14	0.00	0.20
Lepidoptera	0.87	0.14	0.00	0.20
Chilopoda	0.00	0.29	0.00	0.13
Neuroptera	0.00	0.00	0.18	0.07

Table 2: Xylofauna abundance in branches (cutting residues) of different diameter.

Thin branches are mostly dominated by *Scolytidae* and *Psocoptera*, while average and thick branches contained most *Mycetophilidae* adults, and in the second place dominated beetles of *Ips typographus* and *Pissodes* genera. Mainly *Mycetophilidae* and *Psocoptera* representatives dominated birch and oak branches, independently of their diameter.

Distribution by trophic group show, that xylophages among *Coleoptera* comprise even 91%, while among all-found arthropoda, they make up to 20%. Dominant xylophagous species in spruce branches were *Polygraphus polygraphus* and *Pityophthorus lichtensteini*, while in pine branches – *Ips typographus* and *Pissodes pini* (Table 3).

Species	**Abundance (number) of xylophagous beetles**				**Total (%)**
	Oak	**Birch**	**Spruce**	**Pine**	
Polygraphus polygraphus L.			185	1	50,4
Pityophthorus lichtensteini Ratz.			68	9	20,9
Hylurgops palliatus Gyll.			28		7,6
Pityogenes chalcographus L.			19	6	6,8
Ips typographus L.			6	18	6,5
Pissodes pini L.				15	4,1
Pissodes piniphilius Hbst.				7	1,9
Pogonocherus fasciculatus Deg.			2	1	0,8
Trypodendron lineatum Ol.		1			0,3
Pityophthorus micrographus L.			1		0,3
Ips duplicatus Sahlb.			1		0,3
Crypturgus cinereus Hbst.			1		0,3

Table 3: Abundance of xylophagous beetles in branches (cutting residues) of different trees.

As far as felling residues were produced in October, there was a very short period of only about one month left until frosts. Over this period only some branches of spruces and pines were infested. Some of them and almost all oak and birch branches remained completely uninfested by xylofauna. Our studies have ascertained, which are pioneer species of xylofauna in felling residues and which species hibernate in these felling residues (branches).

Conclusions

1. During the studies the following representatives of insect orders were detected in felling residues (branches): *Diptera* (51%), *Psocoptera* (24%), *Coleoptera* (22%), *Hymenoptera* (2%), *Neuroptera, Hemiptera* and *Lepidoptera.* Totally, 48 species of arthropods were found.

2. Most arthropod species were found in spruce (33 species) and pine (23 species) branches.

3. The first to infest branches are saprophagans *Psocoptera* sp. and mycophagans *Mycetophilidae* sp.

4. Beside *Mycetophilidae* and *Psocoptera,* pine branches were dominated by *Ips typographus* – 17% and *Pissodes pini* – 14 %, while spruce branches by *Polygraphus polygraphus* – 43% and *Pityophthorus lichtensteini* – 16%.

5. Thin branches contained 6 times less arthropods than average and 4 times less than thick branches.

6. Among *Coleoptera* xylophagans comprise even 91%, while among all arthropods found in the branches – 20%.

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Poster presentation

Integrated control of bark beetles in Spanish forests of *Pinus sylvestris* using pheromones

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Abstract

In Spain Scotch pine stands host a wide range of insects including some scolytid species which are able to cause dieback and death of conifer forests. *Ips acuminatus* is able to attack even healthy pines, whereas *Ips sexdentatus* settles in weakened trees and newly felled conifers preferably. Both insects are capable to bring several generations per year from March to October, depending on the site conditions. Up to now the control method of these beetles' damage has been developed in two ways:

Preventive: Based in a strict phytosanitary control of the fellings and extraction of wood, including striping bark off. It is also important to take away or destroy all cut rests. These time periods, have to be established as well as silviculture operations will be executed out of risk periods, before insects will emerge of colonised timber.

Control: When preventive measures application is not possible, or damage threshold is over management ability; support actions have to be developed. Therefore cut and leave practices are used as tree-traps in the successive capture of emergent insect populations. All these methods are not usually successful, and that is the reason to start a pilot programme by using pheromones in the attraction and capture of these insects. Since 2002 diverse product combinations, spreading-capsules and traps are being tested.

Keywords: Scotch pine, *Pinus sylvestris*, *Ips acuminatus*, *Ips sexdentatus*, pheromone, integrated control

INTEGRATED CONTROL OF BARK BEETLES IN SPANISH FORESTS OF *PINUS SYLVESTRIS* USING PHEROMONES

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ABSTRACT

In Spain, Scots pine stands host a wide range of insects, including some scolytids species which are able to cause die back and death in conifer forests.

Ips acuminatus is able to attack even on healthy pines, whereas *Ips sexdentatus* settles in weakened trees and newly felled conifers preferably. Both insects are capable to bring several generations out each year, since March to October; depending on site conditions.

Up to now the control method of these beetles damage has been developed in two ways:

➢**Preventive:** Based in a strict phytosanitary control of the fellings and extraction of wood, including striping bark off. It is also important to take away or destroy all cut rests. These time periods, have to be established as well as silviculture operations will be executed out of risk periods, before insects will emerge of colonised timber.

➢**Control:** When preventive measures application is not possible, or damage threshold is over management ability; support actions have to be developed. Therefore cut and leave practices are used as tree-traps in the successive capture of emergent insect populations.

All these methods are not usually successful, and that is the reason to start a pilot programme by using pheromones in the attraction and capture of these insects. Since 2002 diverse product combinations, spreading-capsules and traps are being tested.

Tree-traps *cut and leave* practices.

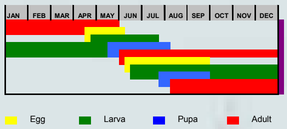
VALSAÍN (SEGOVIA)		
Species trapped		Amount
Ips acuminatus	%	35.010
Ips acuminatus	&	79.456
Ips sexdentatus	%	5.112
Ips sexdentatus	&	12.571
Orthotomicus erosus	%	89
Orthotomicus erosus	&	72
Orthotomicus longicollis	%	29
Orthotomicus longicollis	&	20
Pityogenes bidentatus	%	14
Pityogenes bidentatus	&	40
Hylaster ater		71
Hylaster attenatus		1.482
Hylurgus ligniperda		76
Thanasimus formicarius		502
Other Coleoptera		961
Total amount		**135.505**

"Valsaín" test: Total amount of captures by Species in 10 Theysohn© traps from April 2 to October 20, 2003

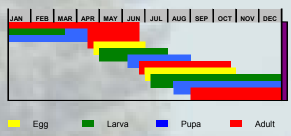
MORA DE RUBIELOS (TERUEL)			
Number of essays		16	
Types of traps tested		1	
Amount of traps with pheromone		70	
Amount of products tested		14	
Amount of captures in traps with synthetic pheromone attractive	*Ips acuminatus*	416.151	93,30%
	Ips sexdentatus	25.947	5,80%
	Other Scolytidae	3.848	0,90%
Barrier Traps (natural attractive)		7	
Barrier Traps (natural attractive) with Ø Ips		1	
Amount of captures in barrier with natural attractive	*Ips acuminatus*	13.533	77,80%
	Ips sexdentatus	57	0,30%
	Other Scolytidae	3.814	21,90%
Total amount of *Ips acuminatus* trapped		429.684	

Summary Table of the "Teruel" *Ips acuminatus* experience testing pheromones (Theysohn© trap).

Ips acuminatus (Gyllenhal, 1827)



Ips sexdentatus (Börner, 1776)



PROJECT GOALS:

Field works and laboratory trials started in 2002. These tests are directed towards:

➢Defining scolytid's life cycle within studio areas.
➢Studying effectiveness of the different capture and comparative test methods.
➢Studying of diverse scolytids and predators populations, and also interactions between them.

MATERIAL AND METHODS:

Life cycle of both scolytids has been determined by striping the bark off some controlled wood; as support to flying graphics obtained with traps. This timber was placed into the forest, and the bark was stripped off, with an axe, each week.

Different types of traps have been tested in the capture of adults. Without pheromone: natural traps, which consist on a pine pile just freshly cut, cut off or window traps ("V"), a square of glass with a capture disposal in the lower part sited over a pine pile just freshly cut. Also have been tested some pheromone traps: Theysohn® and funnel trap.

Theysohn® was selected as the most effective one. It was settled on a metal frame, 1,5 m. over the ground, to make the checking easy. Spreading-capsules and pheromones are located into the trap.

During the study, traps were checked at least 3 times per week. Beetles were kept in special containers and later, in the laboratory, all captures were counted and identified, while sexual ratio was determined.

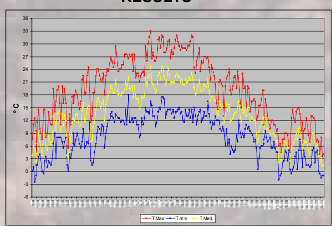
The experimental design is based in lines of traps with a distance of 100 meters among them. They were located in open forest areas and forest edges. Testing and rotation of the products have been done, in addition to the variation on the amount and location of the capsule inside the trap (Theysohn® essay). Pheromones were replaced or added at the latest in two months, all along the insect activity period.

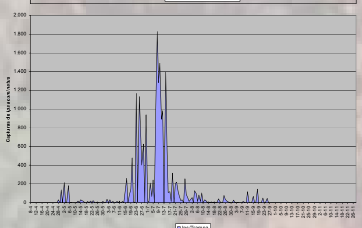
Theysohn© trap and capture disposal detail.

Funnel trap.

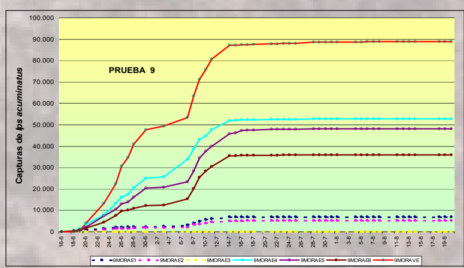
Cut off or window trap ("V").

RESULTS





Temperatures in the "Teruel" test area (highest, lowest and average), and captures of *Ips acuminatus* obtained in each checking, during 2003.



Results of essay number 9, performed during 2003. Each line corresponds to a specific compound and/or cpasule type. Duration and pheromone´s position were also tested. As a result, it was observed *a correspondence* between dose and captures, and *non relation* between dose and attractive power persistence.

CONCLUSIONS:

The capture level reached up to now, shows that control of scolytids outbreaks, by using pheromonal compounds, could be an useful tool in forest management.

In all products tested, there have been identified at least two combinations with high effectiveness, but it is still to the way to get a longer persistence for pheromonal components at forest.

According to the results obtained, Theysohn® trap with pheromonal components is the most effective control method, replacing or adding pheromones at the latest in two months.

It turns out that this technique is much more economical, easy to apply and successful than tree-traps, cut and leave practices, used up to date.

In addition, it must be pointed up that a strict control of the moment in time when cutting down and extraction, or striping bark off wood is done, is necessary to minimise damages in our forest areas. It is also important to take away or destroy all thick branches, to avoid the risk of turning them into a pest focus.

In any case it remains essential to avoid outbreaks of scolytids, for maintaining an adequate forest condition in pine forest ecosystems.

FUTURE SUGGESTIONS:

The main goal is to improve the results obtained during the test. Therefore new chemical combinations are being tested, to get a longer persistence and a stabler pheromone spreading, and different trap models are being used to increase the total amount of captures.

Final test will be developed between 2004 and 2006, by monitoring different forest ecosystems containing Scots pine. Also diverse ecological locations, where there are some other pine species liable to be attacked by *Ips sexdentatus*, will be closely observed.

Acknowledgements: Jesús Dieste, Belén Torres, Miguel Ros, Marisa Vivas, Antonio Peiro, J. M. Gil and Julio Martínez-Saavedra collaborated during several parts of the process. Jaume Castella and Jaume Palencia (SEDEQ, jcastella@sedeq.es) have been the coordinators of the chemical part (design and mixture of synthetic pheromonal compounds). Thanks a lot to all of them.

Poster presentation

Firs report of *Hypoxylon* wilt of red oak (*Quercus rubra*) in Hungary

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Abstract

A new fungal disease appeared in two red oak (*Quercus rubra*) stands of the north-east part of Hungary causing wilt and death of the trees. First results of investigation of declining read oaks show the *Hypoxylon punctulatum* (Berk. & Raw.) as the presumable cause of the disease. This fungus -like red oak itself- is native to North America.

Key words: red oak, *Quercus rubra*, wilt, *Hypoxylon*

Introduction

Quercus rubra is native to North America and was introduced to Europe in 1721. In Hungary the first red oak plantations were established about a hundred years ago (Gencsi and Vancsura 1992). Due to a lot of advantageous features (fast growth, favourable stem form, frequent seed crop, wide ecological tolerance, valuable wood, good volume of the stands) until now this is the most singinificant non-indigenius deciduous tree species in the hungarian forests besides the *Robinia pseudoacacia*, occupying roughly 14,000 ha (Állami Erdészeti Szolgálat 2002). Besides the above-mentioned advantages *Quercus rubra* has much less pests and pathogens compared to the native oak species (*Q. robur, Q. petrea, Q. pubescens, Q. cerris*) of Hungary. Only the *Loranthus europeus*, two *Melolontha* species, and some caterpillar (*Lymantria dispar, Thaumatopoea processionea*) could cause damage affecting adversely the growth of stands.

In the recent years a new fungal disease appeared in some red oak stands of Nyírség. This area situated in the north-east part of the country with lot of acidic sandy sites giving the main home of read oak plantings in Hungary.

The symptoms

The most characteristic symptoms of the disease are the followings: On the stem of some of the living trees dark exudations with a strong tannin odour appear, probably as the first symptom of the disease. The foliage of the infected tree turns yellow and dries. This dieback continues from branch to branch through the stem until eventually the tree dies. This may require 1 or more years. The trees often die in small groups. After the death of the tree the bark sloughs off, exposing fungal stroma along the dead branches and stem. The stroma may appear brown, silver, finally shiny black depending on it's age as it progresses from it's asexual to sexual stage. By the time the hard carbonaceous fungal stromata are revealed, the fungus has decayed much of the phloem and outer sapwood interweaved with the white mycelia of the fungus. The decay of the wood are often accompanied by black zone lines in the sapwood.

In 2003 and 2004, a survey was carried out at the Forest Management Unit of Baktalórántháza and Nyíregyháza in order to determine the causes and the degree of this damage. The disease was detected only in two forest subcompartments (Nyírgyulaj 3/A, Máriapócs 1/A). Both stands are 52 years old. In Máriapócs 1/A only one diseased tree was observed, but in Nyírgyulaj 3/A several significant gaps developed in the stand due to the dieback of some 40 trees. In many cases the dominant trees fall victim to the disease. On several infected trees the symptoms of the attacks of *Scolytus intricatus* and *Agrillus biguttatus* were observed as well. The disease was not found on *Quercus cerris* and *Quercus robur* in the area of the two above-mentioned forestry unit.

The results of the first investigations of fruit bodies and spores showed *Hypoxylon punctulatum* (Berk. & Raw.) as the presumable cause of the disease. The black sexual stromata are very flat (3-4 mm), discoid (2-5 x 2-5 cm), but mostly effused, elongated (2-20 x 1-5 cm). The papillate ostioles of the oblong perithecia are not conspicuous on the surface of the sexual stroma. The ascospores are brown, ellipsoid, one-celled, 17-18 x 7-8 µm. The conidia measure 4-5 x 1 µm. The correct indentification needs further investigations.

Significance of the disease:

Hypoxylon canker occurs on many oak species (*Q. marilandica, Q. virginiana, Q. stellata, Q. falcata, Q. alba, Q. rubra*) and on other hardwoods (*Platanus, Tilia, Carya, Acer, Fagus, Cornus, Carpinus, Fraxinus, Salix, Populus*) in forested areas of North America, mainly in the southern and eastern United States. In this area the most frequent isolated species in connection with the disease are the *Hypoxylon atropunctatum*, *H. thourarsianum*, *H. mediterraneum*, and *H. punctulatum*. In the Southern Europe and North Africa the *H. mediterraneum* is the dominant causing 'charcoal disease' of *Q. suber, Q. ilex, Q. cerris* (Hawksworth 1972).

Hypoxylon spp. are not considered aggressive killers. Instead, they are usually secondary pathogens attacking trees suffering from drought, heat, root disease, insect attack, frost, soil compaction, logging injury, root injury, sudden exposure to intense sunlight, lightning strikes or other, related injuries. Trees growing on clay, sandy, rocky, or other poor soils are highly susceptible to this disease, particularly during extended drought. The one-celled conidia play a limited role in initiating new infections. The infective ascospores spread via wind and splashing rain and presumably by certain insects, birds, and rodents in the summer or fall. *Hypoxylon* canker is latent, or dormant in many Oaks. In Italy, *H. mediterraneum* can be considered the most frequent endophyte of *Q. cerris*. This fungus can be detected in healthy vigorous oaks, as early as the seedling stage, living asymptomatically in bark tissues at hundreds of colonization points. It can also be isolated from most other above-ground tissues, including leaves and acorns. When the tree or part of it is subjected to severe water stress, the fungus develops rapidly within the woody tissues, preferentially spreading through the large air-embolized xylem vessels and apparently killing the adjacent parenchyma. The entire host may soon die, probably owing to synergistic colonization of tissues from several infection points where the fungus was latently present. It is known that *Quercus* species differ in their susceptibility to damage by this fungus, depending on their resistance to water stress.

In this case the drought weather of last years was probably the predisposing factor of the disease. Since the disease was detected only in two red oak stands being at the same age, it is just possible that the pathogen came to this area via the same batch of acorns or seedlings 52 years ago.

Fig. 1: One of the groups of dead and wilting read oaks in Nyírgyulaj 3/A.

Fig. 2-4: The typical symptoms of *Hypoxylon* disease: dark exudations on the living stem; sloughing of the bark; appearance of black, flat fungal stromata.

Fig 5-6: Discoid and elongated stromata on the stems of read oaks.

Fig. 7-8: The surface of the sexual stromata with the ostioles of perithecia.

Fig. 9-10. Horizontal and vertical cuts of the sexual stromata.

Fig. 11: The decayed wood are often accompanied with black zone lines in the sapwood.

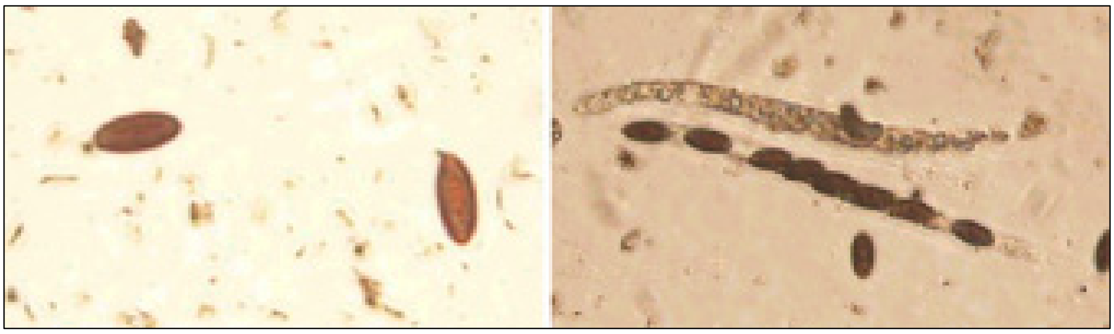

Fig. 12-13: The conidia, ascus and ascospores of *Hypoxylon punctulatum.*

Fig. 14-15: The diseased trees were often attacked by *Agrilus biguttatus* and *Scolytus intricatus.*

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Poster presentation

Two gall wasps (*Neuroterus saliens* and *Callirhytis glandium*) causing major acorn mortality on turkey oak (*Quercus cerris*) in Hungary

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Abstract

Two gall wasps (*Neuroterus saliens* Kollar 1857 and *Callirhytis glandium* Giraud 1859) galling acorns of turkey oak (*Quercus cerris*) were studied in Mátrafüred, Hungary in 2001 and 2002. In 2001 46% of the total acorn crop (888 acorns/m^2 fell on the ground) was infested by some carpophagous insects . Only 3% (26.6 acorns/m^2) of the total acorn crop was healthy and fully developed. Acorn weevils (*Curculio* sp.) and acorn moths (*Cydia* sp.) played a minor role in this year. *Neuroterus* damaged 13% and *Callirhytis* damaged 29% of the total acorn crop. The majority of the infested acorns fallen were far too small to be able to germinate. In average 749 acorns/m^2 fell on the ground surface in 2002. Presence of carpophagous insects was found in 38%. Only 5% of the total acorn crop was healthy and fully developed (37.5 acorn/m^2). The *Neuroterus* damaged 2%, *Callirhytis* 11% of the acorns.

Keywords: *Quercus cerris*, acorn mortality, carpophagous insects, gall wasps

Introduction

9 species of gall wasp (Hymenoptera: Cynipidae) have been recorded as developing in/on acorns of oaks in Hungary. Two of them (*Neuroterus saliens* Kollar 1857 and *Callirhytis glandium* Giraud 1859) live in acorns of turkey oak (*Quercus cerris*). Our earlier knowledge concerning these two species is very restricted. The aim of our investigations was to gain some basic data about the importance and life history of them.

Methods and investigation

In 2001 and 2002 the falling acorns were collected from early June to October with 3, 1x1m collecting baskets placed under a large turkey oak in Mátrafüred. The baskets were emptied weekly. The acorns were cut up and investigated individually in the lab in order to determine the factors damaging them. The acorns damaged by different carpophagous insects could easily be distinguished from each other, because they belonged to significantly different size groups (Fig. 1).

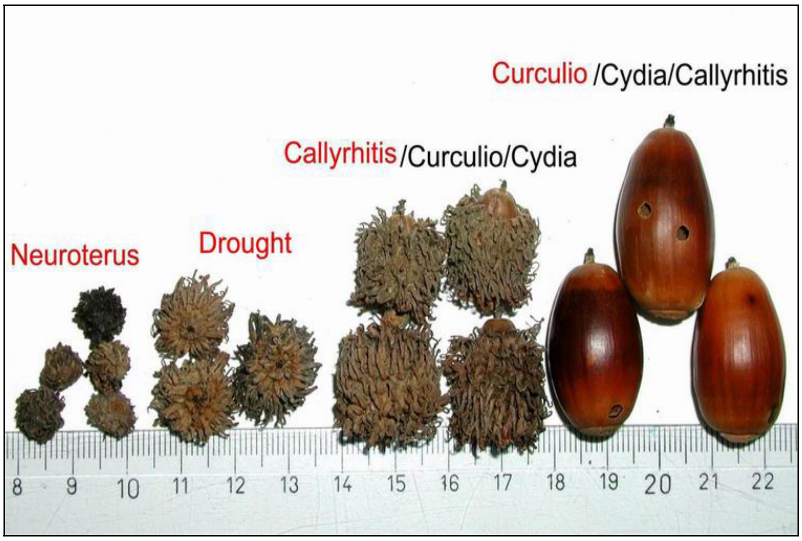

Fig. 1: Size categories of the fallen acorns according to the damaging factors.

Results and discussion

Brief life history of Neuroterus saliens

The species has two alternating generations, both developing on turkey oak. The literature mentions other oaks as host. The spring bisexual generation develops inside the 2nd year young acorns in up to 20 separated chambers (Fig. 2) stopping the development of the acorn and causing early acorn abscission. The autumn asexual generation develops in 3-4 mms long elongated galls on the mid veins on the underside of the leaves (Fig. 3). The bisexual gall was earlier called *Neuroterus glandiformis* but later the two "species" were paired as alternating generations of each other.

Fig. 2: Bisexual galls of *Neuroterus saliens* inside the young acorn of *Quercus cerris.*

Fig 3: Asexual galls of *Neuroterus saliens* on the underside veins of *Quercus cerris* leaf.

Brief life history of Callirhytis glandium

Main host is turkey oak, seldom found on *Quercus robur*. The bisexual generation develops in thin shoots and twigs. Their presence is indicated only by minor swellings and small emergence holes. The asexual generation develops inside acorns in groups (up to 40-50 in an acorn) of 2-3 mm long chambers located regularly close to the hylum of the acorn (side within the cup) (Fig. 4). The galls in smaller acorns often fill up the whole acorn (Fig. 5). The wasps emerge from these galls after 2-4 years diapause.

Fig. 4: Asexual galls of *Callirhytis glandium* in fully developed acorn of *Quercus cerris.*

Fig 5: Asexual galls of *Callirhytis glandium* in undeveloped acorn of *Quercus cerris.*

Damaging factors and process of acorn fall in 2001

In average 888 acorns/m^2 fell on the ground surface in 2001. 46% of them were infested by some carpophagous insects (Fig. 6). Only 3% (26.6 acorns/m^2) of the total acorn crop was healthy and fully developed. Acorn weevils (*Curculio* sp.) and acorn moths (*Cydia* sp.) played a minor role in this year. *Neuroterus* damaged 13% and *Callirhytis* damaged 29% of the total acorn crop. The majority of the infested acorns that fell were far too small to be able to germinate. The temporal pattern of acorn abscission can be seen on Fig. 7. The acorns with *Neuroterus* fell earliest, from mid June to late July. Falling of acorns damaged by the *Callirhytis* has two peaks. The infested smaller acorn fell in largest numbers in August/September. Fully grown but damaged acorns fell in late September and October.

Damaging factors and process of acorn fall in 2002

In average 749 acorns/m^2 fell onto the ground surface in 2002. Presence of carpophagous insects was found in 38% (Fig. 8). 5% of the total acorn crop was healthy and fully developed (37.5 acorn/m^2). The *Neuroterus* damaged 2%, *Callirhytis* 11% of the acorns. The temporal pattern of the falling process for *Neuroterus* was similar to 2001 (Fig. 9). In case of *Callirhytis* the falling process was different from 2001. From late June to early August, infested acorns (9%), from the previous year, fell. These ca. half size acorns (Fig. 10) had remained on the tree for a whole year. The gallwasp larvae in them were heavily attacked by birds. The current-year damaged acorns (2%) fell from mid September to mid October.

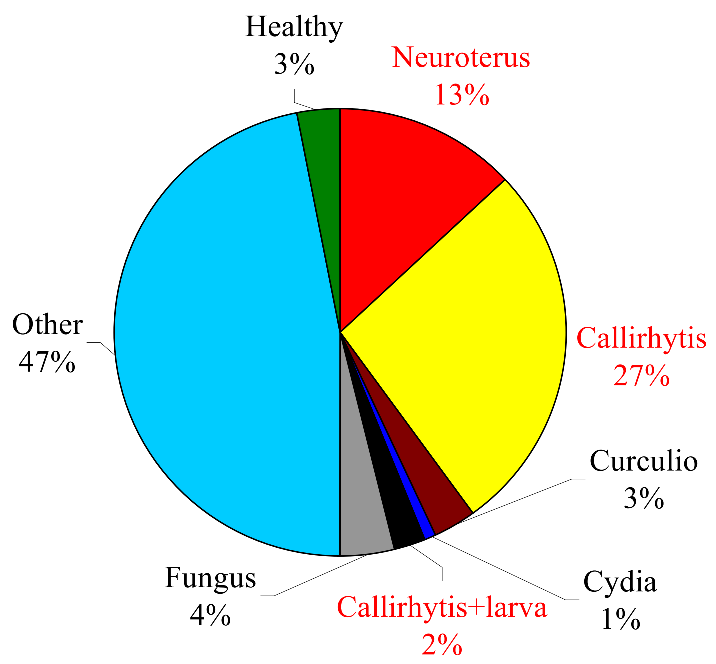

Fig. 6: Distribution of the total acorn crop (888 acorn/m^2) by damaging factors (Mátrafüred, 2001).

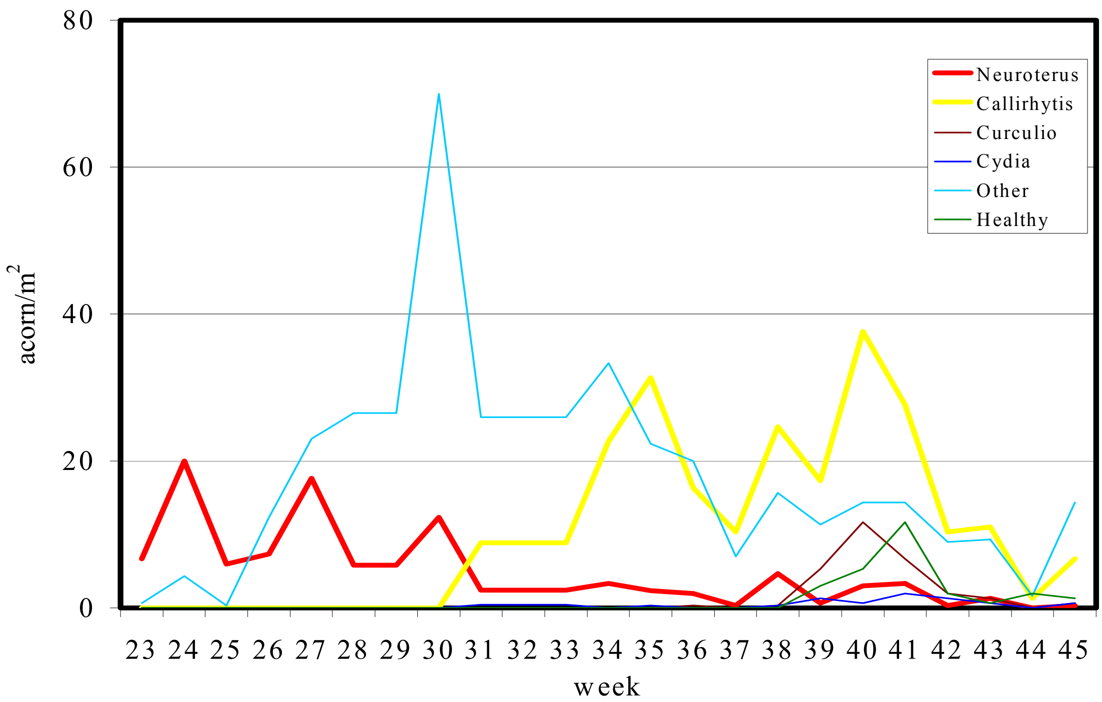

Fig. 7: Temporal patterns of acorn abscission caused by different damaging factors (Mátrafüred, 2001).

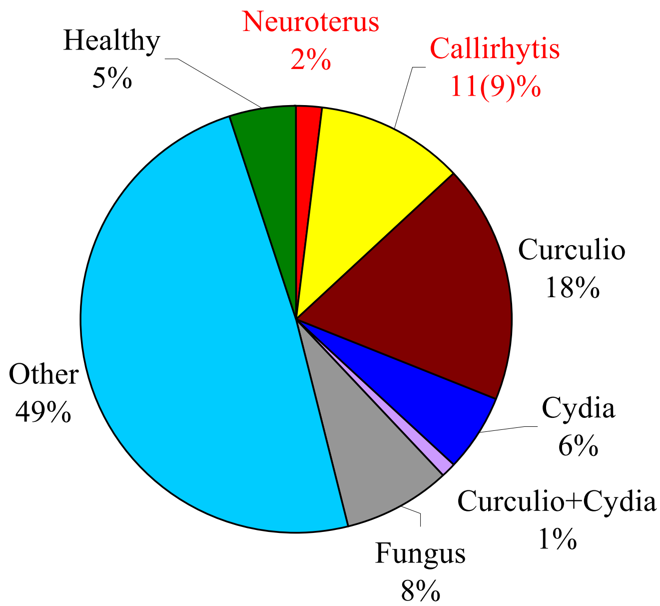

Fig. 8: Distribution of the total acorn crop (749 acorn/m^2) by damaging factors (Mátrafüred, 2002).

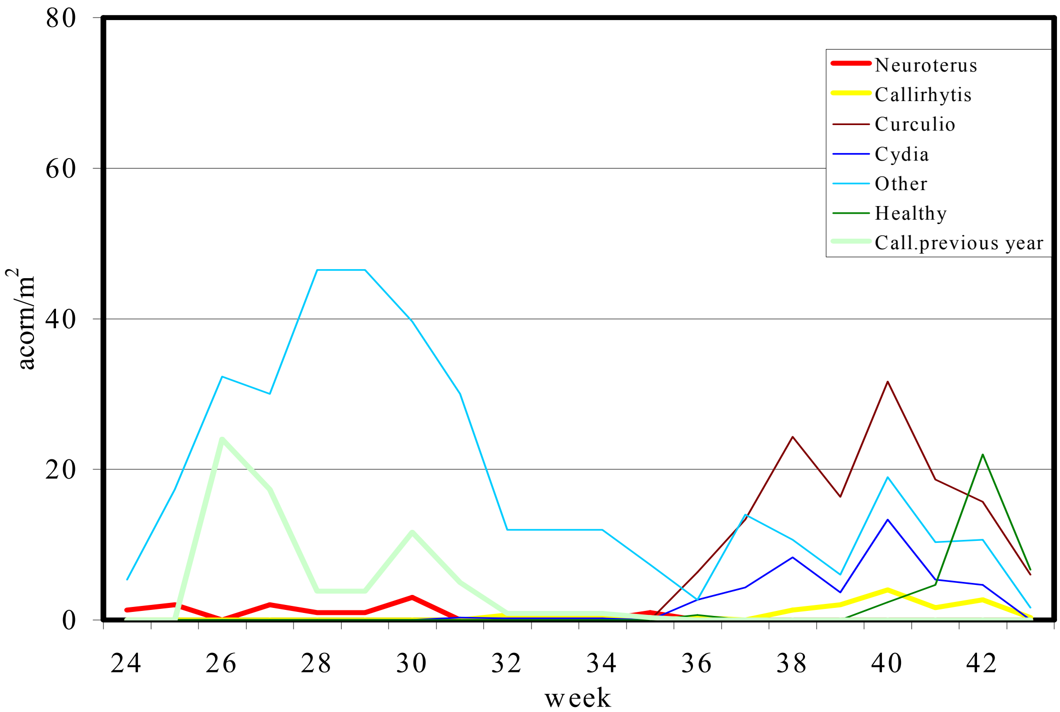

Fig. 9: Temporal patterns of acorn abscission caused by different damaging factors (Mátrafüred, 2002).

Fig. 10: *Callirhytis* - infested acorn remaining on tree for a year and attacked by birds.

Acknowledgement

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Poster presentation

Influence of parasitoids on the spruce-related web-spinning sawflies (*Cephalcia* spp.) larvae populations in the inter-outbreaks period

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Abstract

The main aim of the study was to investigate the structure of the complex of larval parasites in the web-spinning sawflies from the genus *Cephalcia* Pz.: *C. abietis* (L.), *C. arvensis* PANZ., *C. alpina* (Klug) (=*fallenii* Dalm.). The investigations were done in Silesian Beskid (Poland) during an inter-outbreak period (1999-2001). Seven species of larval parasites (6 of *Ichneumonidae* and 1 of *Tachinidae*): *Homaspis narrator* Grav., *H. rufinus* Grav., *Xenoschesis fulvipes* Grav., *Olesicampe monticola* (Hdwg.), *Sinophorus crassifemur* (Th.), *Notopygus nigricornis* Kriechb., *Myxexoristops bicolor* (Vill.) were found in 4 altitudinal zones (700-800; 800-900; 900-1,000; 1,000-1,250) a.s.l.. The total level of parasitism by larval parasites in the host population was 2.5%. The highest general importance had *O. monticola* (27.1%) and *X. fulvipes* (19.9%). The highest impact in *C. abietis* had *X. fulvipes* (0.7%) and *O. monticola* (0.5%); in *C. alpina* – *M. bicolor* (4.1%) and *N. nigricornis* (1.1%), and in *C. arvensis* – *H. rufinus* (2.4%) and *O. monticola* (1.0%). In Silesian Beskid *C. masuttii* as a new species was discovered.

Keywords: *Cephalcia* spp., parasitoids

Aim and scope of studies

The objective of the study was to examine the structure of parasitoid complex in *Cephalcia* (*C. abietis*, *C. alpina*, *C. arvensis*) larvae, which influence the level of homeostasis in forest biocoenoses during an inter-outbreak period.

The work undertaken to attain this objective covered:

- determination of the area and natural distribution limits of web-spinning sawflies in the studied region (Silesian and Żywiecki Beskids) ,
- analysis of the development of web-spinning sawflies on study plots,

- identification of species, larval developmental stages and health status of collected larvae,
- determination of the survival level and causes of the mortality of C*ephalcia* larvae,
- determination of the species composition of reared parasitoids,
- determination of the structure of parasitoid communities depending on the host abundance, altitude and slope exposition,
- determination of the mortality of *Cephalcia* larvae caused by parasitoids.

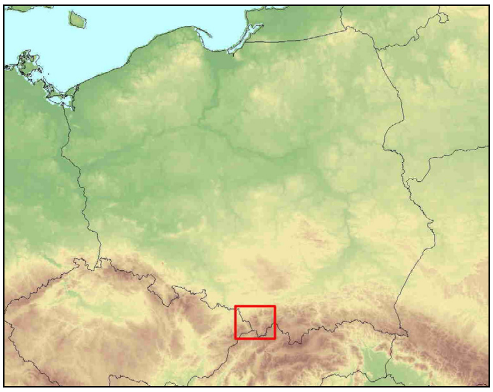

Fig. 1: Location of the study area

Description of *Cephalcia* populations

The studies were carried out in the stands of Silesian and Żywiecki Beskids (southern Poland) (Fig.1). The stands are there composed of spruce (74.4%), beech (10.4%), pine (3.7%) and oak (3.1%). The mass occurrence of web-spinning sawflies in this area dates back to 1976 (Fig. 2) (Kosibowicz, and Jachym 1998). The year 1998 faced the last pronounced mating of insects from the genus *Cephalcia*. Results of the autumn sampling carried out in 2000 indicated a three-year decline in the level of threat posed by web-spinning sawflies to spruce stands. The dominant species in the studied area was all the time *C. abietis*, however its population abundance was declining. In recent years, an increase in abundance of *C. alpina*, *C. arvensis* larvae has been recorded. In 2002, the area of stands with ascertained warning level in the Polish Carpathians showed a tenfold decrease as compared with 2001. In 2001 and 2002, no pronounced mating of web-spinning sawflies was encountered.

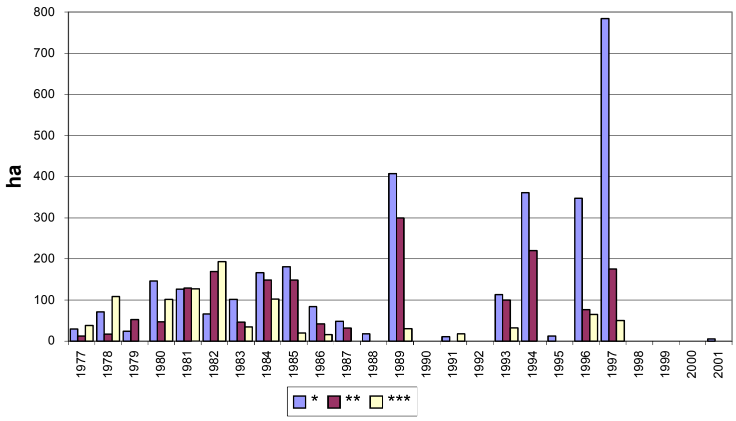

Fig. 2. The area of stands threatened by *Cephalcia* spp.. Results of the autumn sampling.
Threat degree: * - low, ** - medium, *** - high

Material and methods

The studies were conducted on 14 plots established at four altitudes: 700-799 m a.s.l., 800-899 m a.s.l., 900-999 m a.s.l. and above 1,000 m a.s.l. Detailed observations and collection of insects were carried out in 1999-2000. A total of 9,716 larvae were sampled for rearing. The Sørensen's similarity coefficient was used to compare parasitoid communities on each plot and for each *Cephalcia* species. Differences in host infestation by parasitoid species on each plot were tested with a multiple comparison method using a χ^2 test for the 2 x 2 contingent tables. It was tried to test the hypothesis about the lack of relationship between the parasitism level of web-spinning sawfly larvae by different parasitoid species and altitude.

Results

The reared parasitized eonymphs, pronymphs and pupae of three *Cephalcia sp*. (*C. abietis*, *C. alpina, C. arvensis*) produced six parasitoid species belonging to the family *Ichneumonidae*: *Homaspis narrator* GRAV., *Homaspis rufinus* GRAV., *Xenoschesis fulvipes* GRAV., *Notopygus nigricornis* KRIECHB., *Olesicampe monticola* (HDWG.), *Sinophorus crassifemur* (TH.) and one belonging to *Tachinidae*: *Myxexoristops bicolor* (VILL.).

The parasitism of the web-spinning sawfly larvae by parasitoids in the years of 1999-2000, expressed as the ratio of obtained parasitoids to the number of live larvae lied for rearing was at the level of 2.5% (Fig. 3).

The highest number of specimens were obtained from *O. monticola* - 44, *X. fulvipes* - 32, *M. bicolor* - 30 and *H. rufinus* - 29, while the lowest – from *H. narrator* - 17, *S. crassifemur* - 5 and *N. nigricornis* -4.

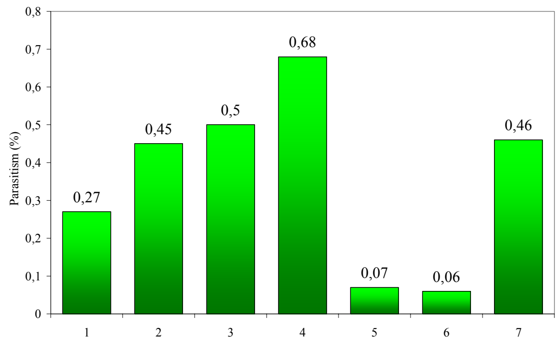

Fig. 3: The total parasitism in the host population by larval parasites.
1. *H. narrator*, 2. *H. rufinus*, 3. *X.* fulvipes, 4. *O. monticola*, 5. *S. crassifemur*, 6. *N. nigricornis*, 7. *M. bicolor*

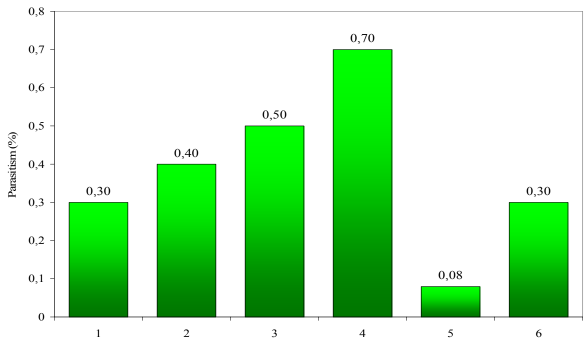

Fig. 4: Parasitoids of the *C. abietis* larvae.
1. *H. narrator*, 2. *H. rufinus*, 3. *X. fulvipes*, 4. *O. monticola*, 5. *S. crassifemur*, 6. *M. bicolor*

The results above demonstrated that *O. monticola*, *X. fulvipes*, *X. bicolor*, *H. rufinus* and *H. narrator* were the most effective parasites for web-spinning sawflies. Differences in parasitism level of web-spinning sawflies between the first three specified parasitoid species were not statistically significant.

X. fulvipes and *O. monticola* were the major parasitoids of *C. abietis*. *H. narrator*, *H. rufinus* and *M. bicolor* were of lower significance. In *C. abietis* the statistically significant (χ^2 = 9.81**, p = 0.002; χ^2= 3.95*, p = 0.047) differences in parasitism level were found between *H. narrator*, *H.*

rufinus and *O. monticola,* while such differences were not found between these parasitoids and *X. fulvipes*.

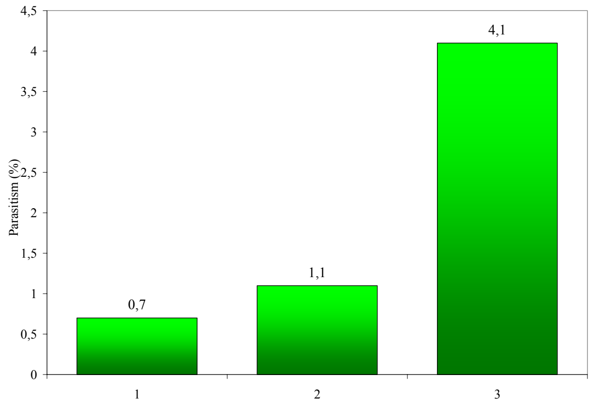

Fig. 5: Parasitoids of the *C. alpine* larvae.
1. *H. rufinus*, 2. *N. nigricornis*, 3. *M. bicolor*

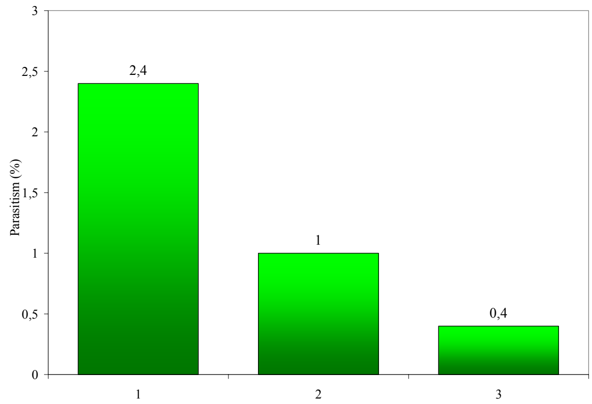

Fig. 4: Parasitoids of the *C. arvensis* larvae.
1. *H. rufinus*, 2. *O. monticola*, 3. *N. nigricornis*

Parasites	Elevation (m a. s. l.)			
	700-799	800-899	900-1,000	>1,000
	Frequency (%)			
H. narrator	9	17	10	27
H. rufinus	11	51	15	13
X. fulvipes	26	13	13	20
N. nigricornis	3	10	2	13
O. monticola		4	42	27
S. crassifemur			4	
M. bicolor	51	4	14	

Table 1: Characteristics of parasitoids of the web-spinning sawfly larvae at various altitudes.

The main parasitoids of *C. alpina* were *M. bicolor* and the ichneumonids: *H. rufinus* and *N. nigricornis* (fig. 5), while those of *C. arvensis* were *H. rufinus*, *O. monticola* and *S. Crassifemur* (Fig. 6).

The similarity analysis of parasitoid species infesting web-spinning sawflies at different altitudes demonstrated that the coefficient of similarity for individual species at all altitudes ranged from 50% to 100%. The parasitoid species whose distribution limits extends from the lowest to the highest altitudes occurred in the largest numbers at 800 - 1,000 m a.s.l., where the prevalent number of *C. alpina* was observed. Among the three examined *Cephalcia* species, *C. alpina* was infested by the largest number of parasitoids occurring below 800 m a.s.l. and between the lowest and the highest altitudes.

Similar analysis was done for individual *Cephalcia* species and their entire parasitoid communities regardless the elevation zone. The coefficients of similarity slightly differed and oscillated between 44% and 67%. The examined three *Cephalcia* species had a few common parasitoids and were infested by a number of other parasitoid species. However, the coefficients of similarity indicated that parasitoid communities of *C. alpina* and *C. abietis* were the least similar. *M. bicolor* was the most frequent parasitoid of *C. alpina*, hence the lack of larger numbers of parasitoids common for the other two *Cephalcia* species. In turn, *C. arvensis* was a species associated with *C. alpina.*

Obtained results indicate that the level of infestation of larvae by the majority of observed parasitoids depended on two factors: host species and their population size. *C. abietis* was parasitized by all the above-specified parasitoid species, while *C. alpina* - only by a few ones (e.g. *M. bicolor*).

To recapitulate, it can be concluded that the inter-outbreak period of web-spinning sawflies is also specific for the reproduction of parasitoids. It is thought that intrapopulation mechanisms, biology and factors unconnected with the population density are among the variety of factors regulating the low population level of web-spinning sawflies.

The analysis of counts of web-spinning sawflies captured using GEOLAS Polish collar traps in the Wisła Forest Inspectorates allowed to identify *C. masuttii*, a species new for the Silesian and Żywiecki Beskids, and for Poland (Fig. 8).

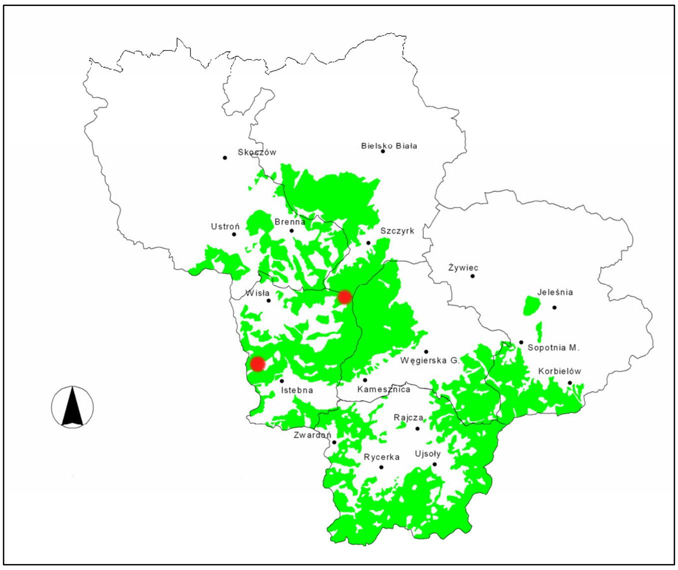

Fig. 8. Location of *Cephalcia masuttii* captures in Silesian Beskid.
N 49° 35' 34", E 18° 51' 36" and N 49° 39' 13", E 18° 59' 28"

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Poster presentation

Afforestation in the friulian plain (north-eastern Italy): remarks on entomofauna

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Abstract

Since 1994 about 2400 ha of deciduous trees for wood production were planted in Friuli Venezia Giulia because of the implementation of European Regulations. This survey has concerned the insects and the mites living on the epigeal parts of the trees, and their role in these new woodlands. In Spring-Summer 2002 and 2003 field observations were carried out in 50 plantations. The results were integrated with further data (concerning some harmful species in the plantations) obtained from the BAUSINVE forest phytopathological inventory of Friuli Venezia Giulia. It was possible to point out the pests responsible for injuries in the last seven years, some of their antagonists, and some insect species interesting from a naturalistic point of view. Some remarks on these kinds of entomofauna are given in the text.

Keywords: afforestation, friulian plain, entomofauna

Introduction

As a result of the implementation of the ECC Regulation 2080/92 and the later EC Regulation 1257/99, new woodlands with slow-growing deciduous species of trees have been planted in Friuli Venezia Giulia (north-eastern Italy) in the last 10 years. Nowadays these plantations cover about 2,400 ha of land, representing about the 1% of the woods of the region. Among the tree species grown for wood production in friulian mixed plantations, Common ash (*Fraxinus excelsior* L.), Pedunculate oak (*Quercus robur* L.), Wild cherry (*Prunus avium* L.) and European walnut (*Juglans regia* L.) are the most common (Mossenta and Zandigiacomo 2004).

The aim of the research was to study the arthropod fauna (insects and mites) living on the epigeal parts of the trees, and the role it may play in plantations.

Materials and methods

In Spring-Summer 2002 and 2003 field observations were carried out in 50 plantations. The survey was based on visual inspections and on sampling of some insect specimens using insect net and entomological umbrella. The study has concerned all kinds of arthropod fauna, harmful or beneficial, widespread or rare.
Further data concerning the harmfulness of some arthropod species in the plantations were obtained from the BAUSINVE forest phytopathological inventory of Friuli Venezia Giulia that, since 1994, has studied damage caused by insects, pathogenic fungi, meteorological events and other agents in the forests of the region (Frigimelica *et al* 2001).

Results and Discussion

Integration of the results of our observations with those from the BAUSINVE forest phytopathological inventory, has made it possible to point out the pests that have shown harmful outbreaks in the last seven years, some of their antagonists, and some entomological species interesting from a naturalistic point of view.

Remarks on harmful arthropods

Generally, attacks of phytophagous insects on broadleaf trees have been, until now, not so serious as to compromise the expected outcome of the plantations.

The largest infestations are those of homopterous and heteropterous insects, such aphids and the Flatid *Metcalfa pruinosa* (Say). Damage consisted mainly of leaf-discoloration and distortion, and in honeydew production, responsible for the proliferation of the black fungus called "sooty mould". Attacks of the Cherry black aphid *Myzus cerasi* (F.) on shoots of *Prunus avium* are frequent. Similar injuries on flowering shoots are caused by the Eriophyd *Eriophyes fraxinivorus* Nalepa. This mite has been frequently observed during the last years on Common ash and Manna Ash (*Fraxinus ornus* L.) in several plantations. Young trees are slightly damaged by this pest, which inhibits vegetative growth, making it difficult for the trees to reach the normal size.

Defoliator activity has remained at an acceptable level for the vegetation. In the last years the damage of the most harmful caterpillar, *Hyphantria cunea* Drury, has been scarce and localised on single plants. More dangerous seems to be the Tenthredinid *Tomostethus nigritus* Fabricius. This sawfly appeared in the central area of the friulian plain in 1999. Since it pupates in a cocoon in the soil, near the roots of affected trees, it probably reached the area with young plants used for afforestation. The only tree species affected is *Fraxinus excelsior*, on which the damage is caused by the larval stages that feed on leaves, leaving only the midribs intact. Since its arrival, this pest has defoliated, every year, the ashes of the plantations in which it is present. Luckily the infestation area is limited to a few hectares, but the phenomenon is slowly spreading.

The only insects threatening plant survival are the xylophagous beetles. They may represent a serious problem for the productivity of the plantation; *Xylosandrus germanus* (Blandford) caused the almost total loss of investment in some walnut plantations. This ambrosia beetle was found for the first time in Italy in 1998 in some friulian plantations of European walnut. Lately it was observed on other broadleaved species, since it can feed on a wide range of both living plants and timber of deciduous and coniferous species. Walnut trees affected by the beetle showed wilting, crown dieback, stem cankers and production of sprouts near the ground. The reason why is that the female may introduce spores of pathogenic fungi (i.e. genus F*usarium*) in the wood during the gallery excavation (Frigimelica *et al* 1999). For the injuries it can cause both on physiology of living plants and on timber, and for the possibility of affecting a large number of wood species, this beetle is considered very dangerous, although its presence seems to be bounded. Another Scolytid beetle which in friulian plantations was found only on *Prunus avium* (but it may also affect other broadleaf trees) is *Scolytus* *rugulosus* Müller. Since 1999, the year it was first found in a plantation, the beetle seems to have spread. Its attacks affect several hundred Wild Cherry trees each year, mostly plants in not optimal condition due to other pests or environmental stresses, such as glazes and summer drought. Affected trees suffer an irreversible withering, which usually results in death. A more efficient biological control of *S. rugulosus* may be possible considering the high parasitization rate observed in 2003 in some plantations, due to Braconid (*Ecphylus silesiacus* Ratzeburg) and Calcidoid (subfam. *Pteromalinae*) wasps.

Remarks on naturalistic and ecological aspects of entomofauna

The first organisms that colonize the new woods are the flying ones (i.e. aphids, white flies, gall wasps, leaf-miners), which find their specific host plants in the plantations. Their good capability of diffusion is proved by the findings of a new species for the friulian plantations: *Crypturaphis grassii* Silvestri. This Callaphidid aphid is a monophagous pest of *Alnus* spp. Its aspect is characteristic: the flatted body of the females makes them very similar to a scale. It was observed for the first time in 2002 on *Alnus cordata* (Italian alder) in a mixed plantation and it was the first finding of the species in northern Italy. The presence of this pest, known until then only from the warmer southern regions, is due to the use of Italian alder, whose original distribution area was the Mediterranean area, in the wood plantations.

Polyphagous insects are well represented: both elements of autochthonous fauna, normally present on trees and shrubs at the border of the cultivated fields (i.e. the moth *Orgyia antiqua* (L.) and the beetle *Anomala vitis* (Fabricius)), and imported insects. Of the latter, *M. pruinosa* and *H. cunea* have reduced their impact in the last years. This is due to the progressive adaptation of the native beneficial insects to these pests, but also to the diffusion of the Dryinid wasp *Neodryinus typhlocybae* (Ashmead), a natural enemy of *M. pruinosa,* introduced a few years ago in Italy (Girolami & Camporese, 1994) and observed in a great number of plantations where this Flatid planthopper is present.

Being of recent introduction, these plantations in monocultural rural areas are still unstable with regard to the ecological balance. Beneficial insects colonize a new territory usually later than their prey. This may account for the presence of species, like saw-flies *Croesus* spp. and *T. nigritus*, rare or absent in natural friulian forests, where biological control works efficiently.

Plantations, breaking the uniformity of rural landscape, link shrubs, rows of trees and plain woods isolated among the cultivated fields. An example of a species that has moved from natural sites to plantations is *Bradybatus creutzeri* Germar. This little Curculionid beetle (about 4 mm) is tied to *Acer campestre*, where larvae feed on samaras. Adults live on the blossoms from April to June. The species is not common in Italy. Recently found in a friulian plantation, it is normally present in the few natural woods of the plain.

These migration corridors allow the settlement of phytophagous insects but also the migration of their predators and parasites. The most common beneficial insects observed in the plantations are natural enemies of aphids, such as green lacewings (i.e. *Chrysoperla carnea* (Stephens)), hover-flies (mainly of genus *Syrphus* and *Episyrphus*) and ladybirds (a lot of specimens of *Coccinella septempunctata* L., *Oenopia conglobata* (L.), *Psyllobora vigintiduopunctata* L. and *Adalia* spp. were observed). There are also predators of soft-skinned insects and larvae, like snake-flies (Raphidiidae), and parasitic wasps, like Ichneumons, whose larvae live as parasites on or in arthropods, mostly in insects and their larvae. In these artificial woods these beneficial antagonists can find optimal sites for wintering and reproduction, from which they can move to the adjoining crops, where the simplification of the agro-ecosystem has caused the loss of a lot of natural antagonists of pests.

The occurrence in the plantations of wild bee predators (Chrysid wasps and the Meloid beetle *Lytta vesicatoria* L.) has an important naturalistic meaning. Since 2002 intense outbreaks of *L. vesicatoria* have been observed in different spots of the plain, where the adults completely destroyed the ash leaves. Since its larval stages are predators of broods of wild bees, the presence of this "Spanish-fly" means that it can find pollinators' nests to feed in. Consequently, plantations represent an uncontaminated ecological niche among the cultivated areas, where wild bees like bumblebees (*Bombus* sp.), mining bees (*Andrena* sp., *Halictus* sp.), and mason bees (O*smia* sp.) take advantage of the scalar-booming of the hard wood trees, and the absence of chemical treatment permits their survival and nest-building.

Since the components of entomofauna in these young woods are still in evolution, further studies will be carried out in the future, especially to evaluate the development of pest natural control.

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Poster presentation

Predators and parasitoids of *Ips typographus* (L.) in Estonia

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Abstract

61 natural-enemy insect species *I.typographus* were identified in Estonia. Predator fauna was more species-rich than parasitoid fauna. Of the predators, specimens of genera *Placusa, Thanasimus, Epuraea, Rhizophagus* and *Medetera* were more numerously present. Larvae of *Medetera signaticornis* Lw. were observed to be the most numerous larvae under the bark of Norway spruce inhabited by *I. typographus.*

Key words: *Ips typographus*, predators, parasitoids, *Medetera signaticornis*

Introduction

Ips typographus is the most important insect pest of Norway spruce (*Picea abies* L. (Karst.)) in Estonia, which had several large outbreaks in the last century (Rõigas, 1971; Voolma, Õunap, 2000). The last great outbreak of *I. typographus* started after the droughty summer of 1992. The area of spruce stands damaged by the bark beetles reached more than 1600 ha in 1994 (Aastaraamat Mets, 2002). Natural enemies can significantly reduce bark beetle populations (Girits, 1975; Linit & Stephens, 1983; Weslien, 1992, 1994; Weslien & Regnander, 1992; Mihajlović et al., 1994; Nicolai, 1995; Õunap, 2001). For understanding population dynamics of *I. typographus* it is important to know the composition and abundance of its natural-enemy species. Study of predators and parasitoids of *I. typographus* was carried out during 1972-2003 in forests of all 15 counties of Estonia.

Material and methods

During the study period, predatory and parasitoid insects were collected from the galleries of *I. typographus* and from the surface of the bark of trunks. For obtaining adults of predators and parasitoids, larvae and pupae were collected and reared in laboratory conditions. The larvae and pupae were kept in vials with pieces of bark beetle galleries or on infested logs and exposed in rearing cages.

The dynamics of the population density of predators and parasitoids under the bark was investigated in three small outbreak areas of Norway spruce stands in Taagepera (Southern Estonia) on ten trees in 1983-1985. The trees were felled at the end of March or at the beginning of April. At the end of April they were pruned, and logs with a length of 4–5 m and a diameter of 15–20 cm were cut from the lower part of the trunks and mounted on props about half a metre above the ground. The dates of colonization of the logs by *I. typographus* were recorded. From May through August, bark samples with a width of 15 cm were taken from the logs after every 1–2 weeks. In the bark beetle galleries, all insects were counted.

Results and discussion

In spruce bark beetle galleries, 61 natural-enemy insect species of *I. typographus* were identified (Table 1). Predator fauna was more species-rich than parasitoid fauna. Of the predators, specimens of genera *Placusa, Thanasimus, Epuraea, Rhizophagus* and *Medetera* were more numerously present.

Estimation of the highest densities of predators and parasitoids in galleries of *I. typographus* on Norway spruce showed that larvae of *Medetera spp* were the most numerous predators in these galleries (Table 2).

Larvae of *Medetera signaticornis* Lw. were observed to be the most numerous larvae under the bark of Norway spruce inhabited by *I. typographus* (Table 3). The individual efficiency of *M. signaticornis* can be high: one larva of this species is able to eat up to 18–20 bark beetle larvae during its feeding period (Haritonova 1972). According to the estimated population density of different predatory insects and parasitoids in galleries of *I. typographus,* as well as published data (Õunap 2001) of their individual efficiencies, *M. signaticornis* appears to be the most important insect predator of this bark beetle in Estonia.

Comparison of the population density of different species and different groups of natural enemies in galleries of bark beetles is complicated. Different species of natural enemies inhabit bark beetle galleries at different times and remain there for different periods.

While some species live under the bark only during the larval stage, others also pupate there; also, adults of many species live in bark beetle galleries. The population density of different groups of natural enemies depends on the species composition and abundance of species in different localities as well as on the occurrence of other bark beetle species because most of them are polyphagous. Our field experiments showed that, depending on the population density of *I. typographus* and the species composition and population density of natural enemies, the number of emerged bark beetle adults was reduced by natural enemies 1.3–6.9 times on different trees.

Predators and parasitoids	A	Predators and parasitoids	A
HETEROPTERA Anthocoridae *Scoloposcelis pulchella* (Zett.)	2	**HYMENOPTERA**	
Xylocoris cursitans Reut.	1	**Pteromalidae**	
COLEOPTERA		*Tomicobia seitneri* (Ruschka)	3
Carabidae		*Roptrocerus mirus* (Walk.)	3
Tachyta nana (Gyll.)	1	*Roptrocerus xylophagorum* Ratz.	3
Staphylinidae		*Roptrocerus brevicornis* Thoms.	1
Quedius plagiatus (Mnnh.)	1	*Dinotiscus eupterus* (Walk.)	2
Nudobius lentus (Grav.)	3	*Rhopalicus tutela* (Walk.)	4
Phloeopora corticalis (Grav.)	**2**	**Eurytomidae**	
Placusa complanata Er.	**3**	*Eurytoma blastophagi* Hedqv.	2
Placusa depressa Mäkl.	**4**	**Braconidae**	
Placusa incompleta Sjöb.	**2**	*Dendrosoter middendorffi* Ratz.	2
Histeridae		*Coeloides abdominalis* (Zett.)	1
Plegaderus saucius Er.	1	*Coeloides bostrychorum* Giraud	3
Plegaderus vulneratus (Pz.)	2	*Ropalophorus clavicornis* (Wesm.)	2
Paromalus parallelepipedus (Hbst.)	1	*Cosmophorus regius* Niez.	1
Platysoma deplanatum (Gyll.)	1	*Cosmophorus klugii* Ratz.	**1**
Platysoma angustatum (Hoffm.)	1	**DIPTERA**	
Platysoma lineare Er.	1	**Xylophagidae**	
Trogossitidae		*Xylophagus cinctus* (Deg.)	2
Nemozoma elongatum (L.)	1	**Dolichopodidae**	
Cleridae		*Medetera ambigua* (Zett.)	1
Thanasimus formicarius (L.)	3	*Medetera breviseta* Parent	**1**
Thanasimus femoralis (Zett.)	3	*Medetera dichrocera* Kow.	1
Nitidulidae		*Medetera excellens* Frey	1
Epuraea laeviuscula (Gyll.)	**2**	*Medetera fumida* Negrobov	1
Epuraea thoracica Tourn.	3	*Medetera impigra* Coll.	1
Epuraea angustula Sturm	3	*Medetera nitida* (Macq.)	1
Epuraea marseuli Reitt.	2	*Medetera piceae* Õunap	2
Epuraea pygmaea (Gyll.)	1	*Medetera prjachinae* Negrobov	2
Epuraea terminalis (Mnnh.)	**1**	*Medetera setiventris* Thuneb.	1
Epuraea muehli Reitt.	**2**	*Medetera signaticornis* Lw.	4
Glischrochilus quadripunctatus (L.)	1	*Medetera zinovjevi* Negrobov	1
Rhizophagidae		**Pallopteridae**	
Rhizophagus depressus (F.)	3	*Palloptera usta* Meig.	2
Rhizophagus dispar (Pk.)	3	**Lonchaeidae**	
Pythidae		*Lonchaea bruggeri* Morge	3
Pytho depressus (L.)	2	**Muscidae**	
Tenebrionidae		*Phaonia gobertii* Mik	**1**
Corticeus fraxini (Kug.)	1		
Corticeus suturalis (Pk.)	1		
Corticeus linearis (F.)	1		

Table 1: Insect predators and parasitoids of *Ips typographus* (L.) and their abundance (A) in the galleries of *Ips typographus* (L.) collected in Estonia in 1972-2003.
(Abundance: 1 – rare, 2 – low abundance, 3 – medium abundance, 4 – abundant)

Predators and parasitoids	The highest density (specimens/dm^2)		Days after colonization of tree by *I. typographus*	
	Per tree	Average	By trees	Average
All species together	7.3–22.5	14.2	33–53	45
Placusa spp.	0.9–4.4	2.4	29–57	44
Thanasimus spp.	0.3–1.2	0.5	33–53	45
Epuraea spp.	0.3–2.9	1.4	28–48	36
Rhizophagus spp.	0.1–2.4	0.9	45–57	50
Medetera spp.	2.6–14.7	7.6	46–69	53
Hymenoptera	0.8–7.9	3.5	38–50	48

Table 2: The highest densities of predators and parasitoids in galleries of *Ips typographus* (L.) and the time that had passed from the colonization of trees according to observations on ten Norway spruce in Southern Estonia in 1983–1985.

Natural enemies	Number	%
H y m e n o p t e r a		
Tomicobia seitneri (Ruschka)	97	5.4
Roptrocerus mirus (Walk.)	74	4.2
Roptrocerus xylophagorum Ratz.	42	2.4
Dinotiscus eupterus (Walk.)	10	0.6
Rhopalicus tutela (Walk.)	69	3.9
Eurytoma blastophagi Hedqv.	1	0.1
Dendrosoter middendorffi Ratz.	10	0.6
Coeloides bostrychorum Giraud	37	2.1
Ropalophorus clavicornis (Wesm.)	36	2.0
Cosmophorus klugii Ratz.	14	0.8
D i p t e r a		
Medetera ambigua (Zett.)	9	0.5
Medetera breviseta Parent	9	0.5
Medetera dichrocera Kow.	5	0.3
Medetera excellens Frey	11	0.6
Medetera fumida Negrobov	1	0.1
Medetera piceae Õunap	51	2.9
Medetera prjachinae Negrobov	14	0.8
Medetera setiventris Thuneb.	4	0.2
***Medetera signaticornis* Lw.**	**1050**	**58.9**
Palloptera usta Meig.	23	1.3
Lonchaea bruggeri Morge	214	12.0
Phaonia gobertii Mik	1	0.1
Total	1782	100,0

Table 3: Number of natural enemies (Hymenoptera and Diptera) reared from the bark of Norway spruce inhabited by *Ips typographus* (L.).

Acknowledgements

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Poster presentation

Research regarding birds communities from Romanian oak forests infested by defoliators

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Abstract

14 forests from the eastern part of Romania were studied. In 1997 the forests with ages ranging from 40 to 120 years old were infested in percentage of 8-62 % by defoliators. The diversity of nesting birds varied from 14 to 41 species. The majority of the nesting birds fed their offspring with soft body invertebrates, especially insect larvae. The usage of artificial nests was related to the evolution of defoliator outbreaks.

Keywords: oak, defoliating insects, bird communities

Research area

The research were undertaken in oak stands mixed with other deciduous species (European hornbeam, ash, linden, bird cherry tree, and so on) from the following counties: Bacau [A,B,C], Neamt [D, E, F], Iasi [G, H, I], Vaslui [J, K] and Botosani [L, M, N] (Fig. 1).

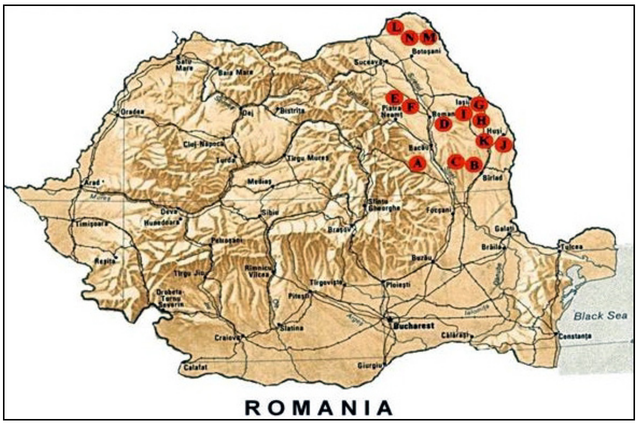

Fig. 1: Location of the research plots

Methods

1) The evaluation of species diversity of nesting birds communities from the stand with oak in composition using the singing manifestation.

2) The determination of the forests infestation degree with defoliators.

3) The evaluation of the occupied artificial nests percentage out of the total number installed in forests and the identification of the occupying species considering the material used for nest building.

Results

The observation regarding the birds communities were undertaken in forests placed at low and medium altitude hill region from the Siret river basin. The stands are mostly sessile oak or mixed hard wood forests with ages ranging from 40 to 120 years.

The level of infestation with defoliating insects

In the spring of the year 1997 the infestation with defoliating insects ranged from very weak intensity (1-10%) in some forests - Gadinti (Roman), Dobrina and Valea Teilui (Husi) - to very high (51-75%) in Sohodol - Glavanesti (Zeletin).The main pest recorded was *Tortrix viridana* L., which caused defoliation ranging from 4 to 55%. In the studied stands were identified with high frequency caterpillars from Geometridae family belonging to the following species: *Operophtera brumata* L. and *Erannis defoliaria* Cl., and rarely *Erannis aurantiaria* L.*,* *Erannis marginaria* L. and *Colotois pennaria* L. (Table 1).

In some forests, especially in Heltiu forest from the Forests District Caiuti placed on Trotus river valley, were identified *Apethymus filiformis* larvae - new pest for oak stands registered in 1994 in Romanian fauna.

Bird communities.

There were identified 52 birds species (Table 3). The lowest diversity (14 nesting species) in Buhaceni forest (Botosani) [N]. The highest diversity (41 nesting species) - in Dobrina and Valea Teiului forests (Vaslui) [J, K]. In Buhaceni forest was applied a treatment for defoliators control with Dipel (1.5 l/ha) obtaining 98% efficiency. Regarding the food diet there were identified: 44% insectivorous species, 24% granivorous, and 21.3% frugivorous. All these species feed their offspring with invertebrates, especially different larval stages.

Forest direction	Forest district	Forest	Forest type	Age - years -	Mean infestation with defoliators (%)							
							Geometridae					
					Tortrix viridana	*Apethymus filiformis*	*Operophtera brumata*	*Erannis defoliaria*	*Erannis aurantiaria*	*Erannis marginaria*	*Colotois pennaria*	TOTAL
0	1	2	3	4	5	6	7	8	9	10	11	12
Bacau	Caiuti	Heltiu	s.o.f.	80-120	10,0	16,0	1,5	0,5	-	-	-	28,0
	Zeletin	Icoana	m.f.s.o.	60	25,0	0,5	0,5	1,0	2,0	-	1,0	29,0
		Sohodol Glavanesti	m.f.s.o.	60	55,0	0,5	3,5	1,5	-	1,5	-	62,0
Neamt	Roman	Gadinti	m.f.s.o.	60-80	4,0	-	2,0	1,0	-	-	-	7,0
	Targu Neamt	Fagetel	m.f.s.o.	60-80	12,0	-	1,5	1,5	-	-	1,0	16,0
		Coverca	s.o.f.	120	10,0	-	0,5	1,5	-	-	-	12,0
Iasi	Iasi	Ciric	m.f.s.o.	60-80	5,0	-	2,5	2,0	1,0	0,5	-	11,0
	Ciurea	Poieni	m.f.s.o.	100-120	27,0	-	3,5	1,5	-	-	-	32,0
	Podu Iloaiei	Cenusa	m.f.s.o.	60-80	9,0	-	1,5	4,0	-	-	-	14,0
Vaslui	Husi	Dobrina	s.o.f.	60-100	7,0	0,5	0,5	-	-	-	1,0	8,5
		Valea Teiului	m.f.s.o.	60-80	6,0	-	1,5	1,0	-	-	-	8,0
Botosani	Darabani	Codreni	m.f.s.o.	40-60	10,0	-	1,5	0,5	0,5	-	-	13,0
	Trusesti	Zgarieta	m.f.s.o.	40-60	12,0	0,5	2,0	2,5	-	-	1,5	19,0
		Buhaceni	m.f.s.o.	40-60	35,0	0,5	3,5	1,5	-	0,5	-	42,0

Abreviations: s.o.f. – sessile oak forests; m.f.s.o. – mixed forests with sessile oak.

Table 1: The level of defoliator insects infestation in oak forests from the eastern part of Romania in 1997 (spring time).

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No.	Forest District	P.U. m.u.	Composition	Stands age	Number of artifi-cial nests/hec.	High of artificial nests emplace.	Defoliators (%)	The use of artificial nests by species																
									Species															
								Total (%)	PAR sp.	PAR MAJ.	PAR. CAE.	PAR. PAL.	SIT. EUR.	PAS. MON.	PHO. PHO.	FIC. sp.	MUS. STR.	Unidentified species	MUS. AVE.	GLIS GLIS	ELI. QUE.	APO. SYL.	VESPA sp.	CHIROPT.
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Bacau - Caiuti	VI 59	sessile oak	60-80	4	4-5	-	**62**		25						37	38							
2	Bacau - Zeletin	I 53-55	mixed forest	50	4	3-5	Tv,G 25-50	**80**									50							50
3	Bacau - Zeletin	I 76,77	mixed forest	50	4	3-5	Tv,Ld 5-10	**92**	10		20		4	20		7	30	9	20		30			
4	Vaslui - Husi	III 96	mixed forest	50	2	4-6	Tv 5	**90**						50	20	10	20							
5	Vaslui - Husi	IV 10	mixed forest	100	2	3-6	Tv 3-5	**92**						40	15	10	20	15						
6	Neamt - Tg. Neamt	V 62	mixed forest	40	2-3	2-6	G 10	**100**	12					28	17	20	15	8	25	5				
7	Neamt - Tg. Neamt	V 64	oak	160	1-2 (10)	2-6	Tv 2-3	**100**	16					25	2	15	35	7	25	5				
8	Neamt - Roman	V 11,59	mixed forest	40-60	2-4 (10)	3-4	Tv 2-3	**100**	10					30	15	2	35	8	15	30				
9	Iasi - Podu Iloaiei	V, VI	mixed forest	100	4	4-5	Tv 10	**80**	5							35	60		25			10	20	
10	Iasi - Ciurea	I 45	oak + diff. (beech)	120	2	4-6	Tv 5	**78**	22			14					57	7				7		
11	Iasi - Iasi	I 45,46 51,52	oak, ash, black locust	50	12-27	3-5	Tv,G 5-10	**66-93**	6-49					7-43	10-15		5-25							
12	Botosani - Trusesti	IV	mixed forest	50-80	4	3-4	Op,Er 18	**72**	28						15	12	40	5	15					

Table 2: The percentage of the artificial nests used by birds in different forests from Moldavia during the year 1997.

No.	Species	Food type	Research area													
			A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	*Acanthis cannabina* (L.)	C					■	■				■	■			
2	*Accipiter gentilis* (L.)	I, F	■	■			■	■	■	■	■	■	■			
3	*Anthus trivialis* (L.)	C	■			■				■	■	■			■	■
4	*Buteo buteo* (L.)	G			■		■									
5	*Carduelis carduelis* (L.)	G	■	■	■	■		■	■	■	■	■	■	■	■	
6	*Carduelis chloris* L.	G	■							■	■	■	■			
7	*Certhia familiaris* L.	I	■					■	■	■	■	■	■			
8	*Coccothraustes coccoth*. (L.)	G	■			■	■	■	■	■	■	■	■	■	■	
9	*Columba oenas* L.	G								■	■	■		■		
10	*Columba palumbus* L.	G			■			■					■			
11	*Corvus cornix* (L.)	O	■			■	■	■				■	■	■		
12	*Corvus frugilegus* (L.)	O			■				■							
13	*Corvus monedula* (L.)	O				■		■		■	■					
14	*Cuculus canorus* L.	I	■		■		■	■	■	■	■	■	■	■	■	■
15	*Dendrocopos major* (L.)	I, G	■	■	■		■	■	■	■	■	■	■		■	
16	*Dendrocopos medius* (L.)	I, G				■	■	■			■	■	■			
17	*Dendrocopos minor* (L.)	I, G		■												
18	*Emberiza citrinella* L.	G	■	■			■	■	■	■	■	■	■	■	■	
19	*Erithacus rubecula* (L.)	I, F	■	■	■	■	■	■	■	■	■	■	■	■	■	
20	*Falco tinnunculus* (L.)	C, I				■			■			■				
21	*Ficedula albicollis* (Temm.)	I, F	■							■	■	■	■			
22	*Ficedula hypoleuca* (Pall.)	I, F		■				■	■							
23	*Fringilla coelebs* L.	G	■	■		■	■	■	■	■	■	■	■	■	■	■
24	*Garrulus glandarius* (L.)	O	■	■	■	■	■	■	■	■	■	■	■	■	■	■
25	*Hirundo rustica* L.	I	■	■	■		■		■	■	■	■	■	■		
26	*Jynx torquilla* L.	I						■		■	■		■			
27	*Lanius collurio* L.	I	■	■	■		■	■	■	■	■	■	■	■		■
28	*Luscinia megarhinchos* Brehm	I, F	■	■				■	■	■	■	■	■	■	■	■
29	*Merops apiaster* L.	I		■						■	■	■		■		
30	*Motacilla alba* L.	I			■	■			■		■	■	■		■	
31	*Muscicapa striata* (Pall.)	I	■			■	■	■	■	■	■	■	■	■	■	
32	*Oriolus oriolus* (L.)	I, F	■	■	■		■	■	■	■	■	■	■	■	■	■
33	*Parus caeruleus* L.	I, F	■	■		■		■		■	■	■	■		■	
34	*Parus major* L.	I, F	■	■	■	■	■	■	■	■	■	■	■		■	■
35	*Parus palustris* L.	I, F			■	■		■		■	■	■	■			
36	*Passer domesticus* (L.)	G					■		■	■			■	■	■	■
37	*Passer montanus* (L.)	G		■	■	■	■	■	■	■	■	■	■	■	■	■
38	*Phylloscopus collybita* (Vieill.)	I, F	■				■	■	■	■	■	■	■	■		■
39	*Phylloscopus sibilatrix* (Bechstein)	I, F	■					■			■	■	■		■	
40	*Pica pica* L.	O		■	■	■	■		■			■	■	■		
41	*Picus canus* Gmel.	I, G			■		■	■			■	■				
42	*Picus viridis* L.	I, G		■	■					■						
43	*Sitta europaea* Wolf.	I, G	■	■		■		■	■	■	■	■	■		■	
44	*Streptopelia decaocto* (Frivoldsky)	G			■				■				■			
45	*Streptopelia turtur* L.	G	■	■				■			■	■	■	■	■	■
46	*Sturnus vulgaris* L.	I, F	■	■	■	■	■	■	■	■	■	■	■	■		
47	*Sylvia atricapilla* (L.)	I, F	■				■	■	■	■	■	■	■	■	■	
48	*Sylvia curruca* (L.)	I, F		■					■				■	■	■	
49	*Troglodytes troglodytes* (L.)	I	■			■	■	■			■	■	■	■		■
50	*Turdus merula* L.	I, F	■			■	■	■	■	■	■	■	■		■	
51	*Turdus philomelos* Brehm	I, F	■	■	■	■	■	■	■	■	■	■	■		■	
52	*Upupa epops* L.	I	■					■		■	■	■	■	■		■
Total species:			**31**	**24**	**21**	**22**	**27**	**36**	**31**	**35**	**39**	**41**	**41**	**27**	**24**	**14**

Abbreviations: C – carnivorous; I - insectivorous; F – frugivorous; G – granivorous; O - omnivorous

Table 3: Nesting bird species in different forests from Moldavia.

The following species used the artificial nests: *Ficedula sp., Muscicapa striata* (Pall), *Parus major* L., *Parus caeruleus* L., *Parus palustris* L., *Passer montanus* (L.), *Phoenicurus phoenicurus* (L.), *Sitta europaea* Wolf (table no.2). The following mammal species occupy the same kind of artificial nests: *Muscardinus avellanarius* (L.), *Glis glis* (L.) and *Elyomis quercinus* (L.), they also damage the bird communities by eating their eggs and offspring. At a mean density of 4 artificial nests per hectare and during the outbreak of different defoliators in the conditions of the Moldavian hill region, the percent of used artificial nests ranged from 62% to 100%. In Icoana forest (Bacau) the percentage of birds occupied artificial nests (at a density of 10 artificial nests/ha) was proportional with the outbreak evolution of the pest *Tortrix viridana* L.

Conclusions

In the fourteen researched forests with ages ranging from 40 to 120 years were registered infestations with defoliators varying between 8 to 62%. During the nesting period were identified a number of 52 bird species. The highest species diversity, over 30 birds species, was observed in older stands (80-120 years) [A, F, G, H, I, J, K]. The lowest species diversity (14 species) was observed in a forest with trees age ranging between 40 to 60 years [N] and which was treated against the defoliators.

At a mean density of 4 artificial nests per hectare the occupying percentage is high - over 60%. The percentage of the artificial nests occupied by birds is directly correlated with the degree of stands infestation with defoliators. There were identified some small mammals species which damage birds communities by eating the eggs and offspring and using their nesting space.

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Poster presentation

Mountain pine beetle: modelling landscape disturbance under different management scenarios

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Abstract

A stochastic simulation was developed to explore the impacts and effects of mountain pine beetle (*Dendroctonus ponderosae* Hopk. Coleoptera: Scolytidae) at the landscape scale. A stand level mountain pine beetle population dynamics model (MPBSIM) was scaled and integrated into a spatially explicit landscape simulation using SELES (Spatially Explicit Landscape Event Simulator). In addition, timber harvest, beetle management (targeted block and single tree harvest) and beetle dispersal submodels were built in SELES, and interact on the landscape. The simulation can be used to explore and compare the effects of different management strategies and tactics in the presence of a beetle outbreak. A large range of output indicators are generated from the simulation, including projections of beetle impacts, timber supply, residual stand structure and the status of the beetle population. This model has been successfully implemented in several forest districts in British Columbia.

Keywords: mountain pine beetle, model, simulation, landscape, disturbance, Scolytidae, *Dendroctonus ponderosae*

Poster presentation

Health conditions of poplar stands on different site conditions

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Abstract

Is it a good idea to use a single clone ('Pannónia') on the biggest part of poplar area (a practice in Hungary)? From this there are some questions: Are there any significant comparisons between the health conditions of the most important hybrid poplar varieties and the different site conditions; Is it true that the clonal susceptibility to diseases depends on site conditions? We would like to find the answers using the investigation of the different poplar clones on different site conditions. We investigated different symptoms – discolouration, defoliation, bud and shoot damages, trunk, stump and root damages. We tried to decide if there are any clonal susceptibility between different site conditions. Finally we can say, that the used method is suitable for the investigation of several poplar varieties and to make comparisons. Different clonal susceptibility occurred on different site conditions. It's very important to find the connection between clonal susceptibility to diseases and the most important ecological factors.

Keywords: poplar clones, *Populus*, health status, site conditions

Poster presentation

Identification of entomopathogenic nematodes by molecular biological approach

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Abstract

Entomopathogenic nematodes (EPN; Rhabditida: Steinernematidae and Heterorhabditidae) have been used as effective biological control agents against a wide spectrum of insect pests for over a decade. In the central part of Europe have been found more than 10 species of *Steinernema* and 3 species of *Heterorhabditis.* In Hungary a new EPN strain isolation work was initiated to investigate the Hungarian EPN fauna and to establish and maintain an EPN and EPB collection, which can be a basis of research works on biological control techniques against grubs of *Melolontha melolontha* (Coleoptera, Scarabeidae) and other insect pests. EPN species are hard to identify by morphological way, therefore a fast and simply identification method was needed. The aim of this study was to identify the newly isolated *Heterorhabditis* strains by PCR-RFLP method. Easily evaluable and reliable RFLP pattern can be generated using *Msp*I restriction endonuclease to digest ITS region of DNA, thus PCR-RFLP analysis offer fast, reliable and relatively low-cost solution. This method suitable to identify all of the three European Heterorhabditis species.

Keywords: entomopathogenic nematodes, cockchafers, *Melolontha*

Introduction

One of the first and most important needs in biocontrol programmes, is the accurate identification of the pest and any beneficial organisms with biocontrol potential. This aspect has a direct impact not only in determining the geographical range of a pest but also in the acquisition of permits necessary for release of control agents. Moreover, this basic but indispensable information eventually impacts directly on their success as biocontrol agents.

Entomopathogenic nematodes (EPN) are important biological control agents against insect pests. In Hungary a new EPN strain isolation work was initiated in the framework of the project aimed at elaborating biological control technique of grubs of *Melolontha melolontha*, one of the most serious insect pest in the Hungarian horticulture and forestry. EPN species are hard to identify by morphological way, therefore a fast and simply identification method was needed. The aim of this study was to identify the newly isolated *Heterorhabditis* strains by molecular biological method.

Material and methods

In 2003 sixty EPN strains were isolated from different deciduous forests or orchards in NE Hungary. 7 of them belong to the genus *Heterorhabditis* (Table 1), the others were *Steinernema*. In this presentation *Heterorhabditis* were studied. The molecular biological identification of EPNs is based on the analysis of the internal transcripted spacer (ITS) region. After a heat-shock DNA isolation PCR RFLP analysis was performed using six restriction endonucleases (Hominick et al., 1997). Size of fragments were analysed on 3 % MetaPhor agarose gel or on 5 % polyacrylamide gel. Observed fragment sizes were compared to the expected fragments determined from nucleotide sequences of known *Heterorhabditis* species. Reference sequences were originated from the GenBank nucleotide sequence database (Table 2). The complete DNA sequence of ITS region of six strains were determined.

Isolates	**Date of isolation**	**Place of isolation**	**Habitat**
111	27.05.2003	Nyírcsaholy	poplar forest
121	27.05.2003	Mátészalka	apple orchard
267	16.06.2003	Nyíribrony 2/D	red oak forest
269	16.06.2003	Nyíribrony 2/D	red oak forest
295	16.06.2003	Levelek 10/A	robinia forest
297	16.06.2003	Levelek 7/A	poplar-robinia forest
uft28	23.07.2003	Újfehértó	apple orchard

Table 1: Origins of newly isolated EPN strains used to the present study.

Species	**Strain**	**GenBank accession No.**
Heterorhabditis bacteriophora	G2	AY321477
Heterorhabditis baujardi		AF548768
Heterorhabditis downesi	K122	AY321482
Heterorhabditis indicus	D1	AY170329
Heterorhabditis marelatus	OH10	AY321479
Heterorhabditis megidis	AGC	AY321480
Heterorhabditis zealandica	X1	AY170330
Steinernema feltiae	T92	AY230185

Table 2: Nematode strains and the GenBank accession number of ITS sequence used to phylogenetic analysis

Results

All of restriction endonucleases used in this study produced evaluable RFLP pattern, so well detectable (minimum 100 bp length) fragments were issued from ITS region of DNA (Table 3). At least 2, but maximum 4 RFLP patterns could be identified for all the six restriction enzymes (Table 4) and these patterns were suitable for distinguish isolates from each other. Moreover, comparing observed fragment size patterns to expected patterns of type sequences of GenBank, species identification was possible. Isolates 111, 121, 295 and 297 proved to be *Heterorhabditis megidis*, isolates 267 and 269 belong to the species *H. downesi*, while isolate uft28 is a *H. bacteriophora.* But, similarities between isolates calculated from RFLP patterns (Table 5) were not proportional to similarities calculated from phylogenetic tree based on DNA sequences of the whole ITS region (Fig. 2). Among the studied restriction endonucleases, *Msp*I proved to be the most suitable for the species identification in the case of the three European *Heterorhabditis* species (Fig. 1).

Isolates	***Alu*I**	***Bsu*RI**	***Hin*6I**	***Hinf*I**	***Msp*I**	***Rsa*I**
111	298, 263, 123	556, 185	504, 303	385, 154, 82	480, 255, 79	313, 219, 128, 115
121	312, 269, 205, 122	585, 185	503, 305, 199	367, 254, 151, 82	454, 255, 83	319, 226, 130, 100
267	312, 275, 128	643, 202	533, 319	414, 238, 93, 78	515, 369	633, 146
269	327, 284, 135	622, 200	523, 313	414, 238	507, 357	575, 139
295	337, 294, 132	662, 202	540, 319	396, 165, 86	493, 273, 84	343, 240, 138, 125
297	291, 258, 207, 123	616, 172	483, 275, 190	356, 248, 151, 80	430, 234, 76	310, 212, 123
uft28	313, 174, 120, 106	764	483, 298	393, 287, 87	779	537, 189, 78
dow.	325, 283, 126	626, 192	516, 302	388, 220, 81, 75	482, 336	561, 131, 123
meg.	331, 291, 129	638, 196	526, 308	394, 158, 82, 78, 68	488, 267, 79	575, 137, 122
bact.	341, 192, 128, 109, 49, 23	842	536, 308	392, 292, 83, 75	478, 364	389, 287, 180, 74, 12

Table 3: Fragment sizes (bps) produced by digesting ITS region of different EPN isolates with six restriction endonucleases and expected fragment sizes of *H. downesi* strain K122 (labelled as dow. in the table), *H. megidis* strain AGC (meg.) and *H. bacteriophora* strain G2 (bact.) using GenBank sequences (see Table 2) to the calculations.

Isolates	*Alu*I	*Bsu*RI	*Hin*6I	*Hinf*I	*Msp*I	*Rsa*I
111	A1	B1	H1	Hn1	M1	R1
121	A2	B1	H2	Hn2	M1	R1
267	A1	B1	H1	Hn3	M2	R2
269	A1	B1	H1	Hn3	M2	R2
295	A1	B1	H1	Hn1	M1	R1
297	A2	B1	H2	Hn2	M1	R1
uft28	A3	B2	H1	Hn4	M3	R3
dow.	A1	B1	H1	Hn3	M2	R2
meg.	A1	B1	H1	Hn1	M1	R2
bact.	A3	B2	H1	Hn4	M3	R4

Table 4: RFLP patterns generated by digestion of the ITS region of DNA for Heterorhabditis isolates with six restriction endonucleases. (see Table 3 for labels)

	111	121	267	269	295	297	uft28	dow.	meg.	bact.
111	6									
121	3	6								
267	3	1	6							
269	3	1	6	6						
295	6	3	3	3	6					
297	3	6	1	1	3	6				
uft28	1	0	1	1	1	0	6			
dow.	3	1	6	6	3	1	1	6		
meg.	5	2	4	4	5	2	1	4	6	
bact.	1	0	1	1	1	0	5	1	1	6

Note: highest (6) the value of similarity, when RFLP pattern is the same for all the studied estriction endonucleases in a given isolate-pair.

Table 5: Similarity matrix of the 7 new isolates, *H. downesi* (labelled as dow. in the table) *H. megidis* strain AGC (meg.) and *H. bacteriophora* G2 calculated from types of RFLP patterns.

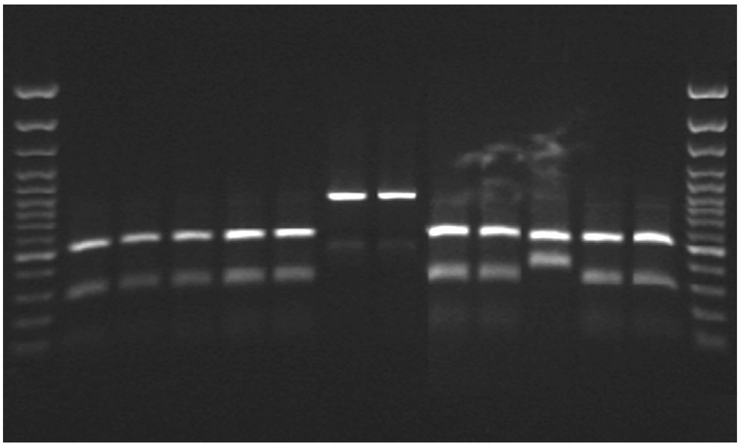

Fig. 1: Observed DNA fragments of ITS region after digesting by *Msp*I restriction endonuclease. Lane 1 and 14: molecular weight marker, lane 2-6, 9-10 and 12-13: *Heterorhabditis megidis*, lane 7-8: *H. bacteriophora*, lane 9: *H. downesi*.

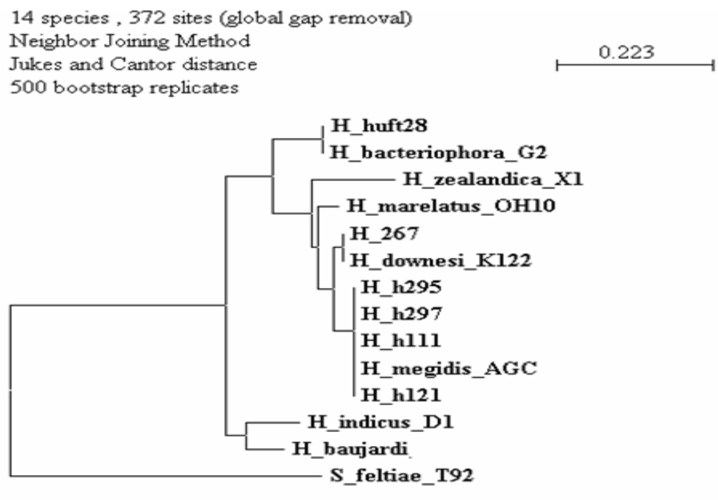

Fig. 2: Phylogenetic tree of genus *Heterorhabditis* with *Steinernema feltiae* as outgroup.

Discussion

Interest towards entomopathogenic nematodes as biocontrol agents is increasing dramatically worldwide (Kaya *et al* 2006). Developing a biocontrol technique needs lot of basic information about the sensitivity of pest organisms to potential biocontrol agents, the geographical distribution of pest and biocontrol organisms or non-target effects of biocontrol agents on natural elements of the fauna. Sorry to say, there are only few data about EPNs from this point of view in Hungary. There were only two funistic study to this time (Mracek and Jenser 1988; Griffin *et al* 1999), and we have incomplete knowledge about the Hungarian EPN fauna. In the framework of a new research project intensive EPN strain isolation work was initiated. Identification of EPNs by morphologically is a labour intensive and slow method, because more life stages are needed to the exact measurements (Adams and Nguyen 2002). Molecular biological methods, such as PCR-RFLP analysis offer fast, reliable and relatively low-cost solution. Easily evaluable and reliable RFLP pattern can be generated using *Msp*I restriction endonuclease to digest ITS region of DNA. This method suitable to identify all of the three European *Heterorhabditis* species.

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Poster presentation

Land-use intensity and diversity parameters: Collembola (Insecta) communities in Csévharaszt (Hungary)

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Abstract

Collembola communities were investigated in 2001 and 2002 on dry calcareous sandy soil in Central-Hungary (continental climate). A set of simple parameters were used to characterize the Collembola diversity along a land-use gradient (=LUUs) from an old-growth forest to arable land. The complete Collembola collection contained 6637 specimens belonging to 85 species and 39 genera. Collembola abundance per LUUs ranks from 186 to 1241 specimens. In both years, the lowest value of Collembola abundance per LUU was found in LUU4 (= mixed-use landscape, not dominated by a single land-use), however the abundance in the investigation plot LUU1 (= old grown forest) was also very low. The highest abundance was exposed in the LUU6 (= mixed-use landscape, dominated by arable crops). Conclusions demonstrate that the profusion and the species richness increase towards less-wooded arable fields. A similar investigation in the Atlantic, Mediterranean climate zone (Western-Europe) (SOUSA et al., 2004) has revealed an opposite tendency, while, at the same study sites in Csévharaszt, the influences of land-use intensity on Collembola and on ground beetle assemblages has shown a parallelism (Szél and Kutasi 2004).

Key words: *Collembola, diversity, land-use intensity, Hungary*

Introduction

Hungary belongs to an area with deciduous forest ecosystems. Ultimately, an old-growth forest succession is conditioned only by a few factors, such as temperature, moisture, soil chemistry and the geomorphology of the sites. However, the final stage of the forest succession is determined by the proximate factor of the intensity of human activities. Since hundreds of years, preferring arable fields to forest areas, destroying it and changing resident main tree species on the managed forest areas are the most common types of damage in Hungary as well as in other European forests.

Soil Collembola are one of the most important, ever present components of the soil meso-fauna, both in terms of abundance and in terms of species richness. Many faunal and ecological studies mention Collembola communities as bio-indicators of human-induced disturbance in agriculture and forest ecosystems, as well as indicators of forest management practices. (Deharveng 1989, 1995; Dunger 1974; Fjellberg 1985; Slawska 2002; Sousa *et al* 2000, 2004.)

According to the European project, entitled "BioAssess" (Biodiversity Assessment Tools) (Sousa *et al* 2004), the present work deals with the structure and diversity of the Collembola communities in sites alongside land-use gradients, which were selected to reflect the impact of land-use changes on biodiversity, especially on the Collembola diversity.

Material and Methods

Site description and sampling

Going from the Hungarian capital – Budapest – to the Southeast, we find the small village, Csévharaszt at the border of the Great Hungarian Plain. On the outskirts of the village, six study sites, situated quite close to one other (each of the study sites /Land-Use Units or LUU-s/ is of 1x1 km territory /quadrates), had been delimited in a 5x7 km area. These represent the degree of different land-use intensity and the proportion of coverage by tree-vegetation.

- LUU1: an old-growth forest dominated by endemic White Poplar (*Populus alba*) and Common Juniper (*Juniperus communis*) shrubs, as well as by typical natural vegetation fragments of oak woods (*Convallario-Ligustro-Quercetum*) on dry calcareous sandy soil. Here, the most characteristic treeless vegetation is the *Festucetum vaginatae danubiale* association. This LUU has not been cultivated.
- LUU2: managed forest on 80% of the site with planted, cultivated woodland of *Quercus robur, Robinia pseudacacia, Pinus silvestris* and with Poplar hybrids.
- LUU3: mixed-use landscape dominated by managed forest with a proportion of treeless agricultural patches about 30 %.
- LUU4: mixed-use landscape, not dominated by a single land-use. Here, the treeless open habitats are either fallow lands or cornfields.
- LUU5: mixed-use landscape, dominated by a moderately saline pasture, humid in spring and dry in summer, mowed twice in a year. Complementary to the dominant pasture, there are strips of trees and managed poplar plantations.
- LUU6: mixed-use landscape, dominated by arable crops, with an abandoned orchard and a garbage dump.

Climatic data of the sites are lacking, however the average data of the region can be informative, so the following conclusions can be drawn: The annual rainfall is normally 550 – 600 mm/year, the evaporate transpiration is 660 – 700 mm/year. The solar radiation is 2,000 – 2,100 hour/year. The rainiest months are June – July and November, and the annual average temperature is 10,5˚C. The coldest month is January, with an average temperature of - 1.5˚C, while the warmest one is July, with its average temperature of + 21 – 22˚C. The summer is moderately hot and dry. The soil here is sandy calcareous; the area is flat, without large elevations.

The sampling was taken
in **2001** between **29. 05**. and **19. 06**. (a very dry period)
in **2002** between **26** – **27. 03.** (a moderately humid period)

In accordance with the BioAssess project (Sousa *et al* 2004), the Collembola sampling took part on a territory of 16 quadrats (4x4, each of 200m width), at each LUU a grid of 5x5 quadrats was defined and the intersection points were marked (16 points in total). Each intersection point served as the reference point for sampling. Collembola were sampled at each sampling point, (= 16 in each $1km^2$ quadrat) taking a sample core with $100\ cm^3$ soil from the surface to 5 cm depth. The soil was put in plastic bags and was transported to the laboratory on the same day. In the laboratory, Collembola were extracted by placing samples on a modified Tullgren extractor (Balogh 1957) for a 10-day exposition. Animals were preserved in 80% ethyl alcohol, were sorted and identified, mainly by the keys of Gisin (1960), Bretfeld (1999), Jordana *et al* (1997), Babenko *et al* (1994), Fjellberg (1980, 1998), Massoud (1967), Pomorski (1998), Zimdars and Dunger (1994) and Stach (1960, 1963).

Data analysis

A set of parameters was established in advance and at each LUU, data were simply compared. Parameters for the characterisation of diversity (Deharveng 1986) are as follows:
* = sample size dependant parameter

- Species richness

*N: total number of individuals, N_j= individuals in site "j"
*N_{max} : number of individuals of the most abundant species
*S : number of species
*Sj : number of species in site "j"
*Sg : global specific richness for the complete set of samples
*RSR : relative species richness % $RSR_j = 100 \cdot \frac{S_j}{N_j}$ in the „j" study area

$RSR = 100 \cdot \frac{S_g}{N}$ in the total study area

*$D_{(Mg)}$: Margalef's relative species richness $D_{(Mg)_j} = \frac{S_j - 1}{\ln N_j}$

*$D_{(Mn)}$: Menhinick's relative species richness $D_{(Mn)_j} = \frac{S_j}{\sqrt{N_j}}$

- Inter – sample diversity

*S_β : β diversity of Whittaker, 1972 $S_\beta = \frac{S_g}{S_\alpha}$

- Dominance

d : Berger – Parker's index $d = N_{max}/N$ with N_{max} = number of individuals in the most abundant species.
*S_{50} : number of species providing 50% of the number of individuals
*D : Simpson's index (overall dominance) $D = \sum p_i^2$; $p_i = n_i/N$

- Rarity

S_r : number of species present in less than 5% of the set of samples
*$R_{5\%}$: Relative number of rare (infrequent) species $R_{5\%} = 100\frac{S_r}{S_g}$

*$R_{1\%}$: Relative number of low-abundance species $R_{1\%} = 100\frac{S_{r'}}{S}$

$S_{r'}$ = number of species which have under 1% of the total number of individuals

- Community organization

H' : Shannon's index $H' = -\sum_{i=1}^{s} p_i \ln p_i$; $p_i = \frac{n_i}{N}$

E : Evenness $E = H'/\ln S$

Results and conclusions

The complete Collembola collection contained 6637 specimens belonging to 85 species and 39 genera. (Table 1) Abundance ranks from 186 to 779 in 2001 and from 373 to 1241 specimens per LUU in 2002. In both years, the lowest value of Collembola abundance per LUU was found in the LUU4, however the highest was in the LUU6. It is interesting to see that in both years tendencies of the LUU's abundance values were the same, though the abundance itself has changed strongly from 2001 to 2002. (Table 2)

	Csévharaszt, 2001 - 2002	SUMMA	SUMMA
	COLLEMBOLA	2001	2002
	Onychiuridae Börner, 1901		
1	*Protaphorura armata* (Tullberg, 1869)	3	89
2	*Protaphorura gisini* (Haybach, 1960)	15	16
3	*Protaphorura serbica* (Loksa & Bugojevic, 1967)	116	117
4	*Protaphorura* sp. juv.	7	
5	*Protaphorura* sp. 1	25	
	Tullbergiidae Bagnall, 1935		
6	*Doutnacia mols* Fjellberg, 1998	8	
7	*Doutnacia xerophila* Rusek, 1974	86	59
8	*Mesaphorura critica* Ellis, 1976	104	251
9	Mesaphorura hylophila Rusek, 1982	2	
10	*Mesaphorura krausbaueri* Börner, 1901	144	609
11	*Mesaphorura macrochaeta* Rusek, 1976	72	755
12	*Metaphorura affinis* (Börner, 1902)	7	104
	Hypogastruridae Cassagnau, 1955, sensu Massoud, 1967		
13	*Ceratophysella armata* (Nicolet, 1841)	6	
14	*Ceratophysella denticulata* (Bagnall. 1941)+A53		4
15	*Hypogastrura vernalis* Carl, 1901	70	110
16	*Hypogastrura* sp.	1	
17	*Choreutinula inermis* (Tullberg, 1871)	1	14
18	*Willemia anophthalma* Börner, 1901	2	2
19	*Willemia denisi* Mills, 1932	1	
20	*Willemia intermedia* Mills, 1934	1	8
21	*Willemia scandinavica* Stach, 1949	6	5
22	*Willemia virae* Kaprus, 1997		10
23	*Xenylla corticalis* Börner, 1901	1	3
24	*Xenylla maritima* Tullberg, 1869	30	98

25	*Xenyllogastrura octoculata* (Steiner, 1955)	82	
	Neanuridae Cassagnau, 1955 sensu Massoud, 1967		
26	*Neanura muscorum* (Templeton, 1835)	9	37
27	*Deutonura conjuncta* Stach, 1926		2
28	*Deutonura phlegraea* (Caroli, 1912)	1	16
29	*Friesea afurcata* (Denis, 1927)		2
30	*Friesea truncata* Cassagnau, 1958	12	59
31	*Micranurida pygmaea* Börner, 1901	1	31
32	*Pratanurida cassagnaui* Rusek, 1973	11	8
33	*Pseudachorutes pratensis* Rusek,	27	50
	Odontellidae Massoud, 1967		
34	*Pseudostachia populosa* (Selga, 1963)	1	
	Brachystomellidae Stach, 1949		
35	*Brachystomella curvula* Gisin, 1948	242	58
36	*Brachystomella parvula* (Schaeffer, 1896)	5	1
	Isotomidae Börner, 1902		
37	*Appendisotoma juliannae* Traser,Thibaud & Najt, 1993		2
38	*Cryptopygus bipunctatus* (Axelson, 1903)	167	386
39	*Cryptopygus cf. orientalis* (Stach, 1947)	2	
40	*Cryptopygus thermophilus* (Axelson, 1900)	25	
41	*Folsomia fimetaria* (L., 1758)		63
42	*Folsomia manolachei* Bagnal,1939 s. Deharveng,1982	58	94
43	*Folsomia quadrioculata* Tullberg, 1871)	1	5
44	*Folsomides portucalensis* da Gama, 1961		102
45	*Isotomodes productus* (Axelson, 1906)	23	57
46	*Isotomodes sexsetosus* da Gama, 1963	1	
47	*Isotoma anglicana* Lubbock, 1862	3	25
48	*Isotoma propinqua* Axelson, 1902		1
49	*Isotoma viridis* Bourlet, 1839	7	3
50	*Isotomiella minor* (Schaeffer, 1896)	42	57
51	*Micranurophorus cf. schalleri* Christian, 1986	18	21
52	*Parisotoma notabilis* (Schaeffer, 1896)	194	427
53	*Proisotoma franzi* Haybach, 1962	2	21
54	*Proisotoma minima* (Absolon, 1901)		24
55	*Proisotoma minuta* (Tullberg, 1871)	19	74
	Entomobryidae Schött, 1891		
56	*Entomobrya* sp. juv.		26
57	*Entomobrya lanuginosa* (Nicolet, 1841)	23	4
58	*Entomobrya nivalis* (L. 1758)		1
59	*Entomobrya multifasciata* (Tullberg, 1871)	392	17
60	*Entomobrya nigriventris* Stach, 1929	2	8
61	*Entomobrya violaceolineata* Stach, 1963		6
62	*Orchesella albofasciata* Stach, 1960	8	8
63	*Orchesella cincta* (Linné, 1758)	71	6
64	*Orchesella flavescens* (Bourlet, 1839)		1
65	*Orchesella multifasciata* Stscherbakow, 1898	8	1
66	*Seira* sp.		1
67	*Lepidocyrtus arrabonicus* Traser, 2000	9	
68	*Lepidocyrtus nigrescens* Szteptycki, 1967		6
69	*Lepidocyrtus cyaneus* Tullberg, 1871	18	48

70	*Lepidocyrtus lanuginosus* (Gmelin, 1790)	103	61
71	*Lepidocyrtus cf. tellacheae* Arbea & Jordana, 1990	82	7
72	*Lepidocyrtus paradoxus* Uzel, 1891	6	2
73	*Pseudosinella* sp.	2	16
74	*Pseudosinella alba* Packard, 1873	3	10
75	*Pseudosinella sexoculata* Schött, 1902	1	
76	*Willowsia buski* (Lubbock, 1869)	1	
	Cyphoderidae Börner, 1913		
77	*Cyphoderus albinus* Nicolet, 1841	11	6
78	*Cyphoderus bidenticulatus* (Parona, 1888)	1	
	Arrhopalitidae Richards, 1968		
79	*Arrhopalites* sp. juv.		6
	Sminthurididae Börner, 1906		
80	*Sphaeridia pumilis* (Krausbauer, 1898)	7	53
	Katiannidae Börner, sensu Stach, 1956		
81	*Sminthurinus* sp. juv		4
82	*Sminthurinus aureus* (Lubbock, 1862)	5	17
	Bourletiellidae Börner, 1913		
83	*Fasciosminthurus strigatus* (Stach, 1922)	1	
	Sminthuridae Lubbock, 1862		
84	*Sminthurus maculatus* Tömösvary, 1883	3	11
	Neelidae Folsom, 1896		
85	*Megalothorax minimus* (Willem, 1900)	1	13
	SUMMA:	2419	4218

Table 1: Global Collembola species spectrum and abundance value.

	abundance		species richness	
	2001	2002	2001	2002
LUU1	275	459	19	22
LUU2	320	551	15	32
LUU3	341	900	23	28
LUU4	186	373	20	21
LUU5	518	695	36	34
LUU6	779	1241	33	35
∑	2419	4218	∑ 68	∑ 67

Table 2: Abundance and species richness per LUU-s in 2001–2002.

Tendencies of Collembola abundance in the LUU-s:

Year **2001**: LUU**4** < LUU**1** < LUU**2** < LUU**3** < LUU**5** < LUU**6**
Year **2002**: LUU**4** < LUU**1** < LUU**2** < LUU**3** < LUU**5** < LUU**6**

Species richness per sample ranks between 15 – 36 in 2001 (main value: 24,3), however it ranges between 21 – 35 species (main value: 28,6) in the year 2002. The tendency here is nearly the same as for the abundance values and the increase of species richness in the LUU5 and LUU6.

Tendencies of species richness per LUU-s:

Year **2001**: LUU**2** < LUU**1** < LUU**4** < LUU**3** < LUU**6** < LUU**5**
Year **2002**: LUU**4** < LUU**1** < LUU**3** < LUU**2** < LUU**5** < LUU**6**

An opposite tendency to this the relative species richness is shown towards the low abundance LUU-s. In 2001, the relative richness in both the Margalef and the Menchinick has shown the highest values in the LUU5, while the lowest one was observed in the LUU2. The tendency has not been the same in 2002 (Tables 4 and 5)

Dominance:

According to the Berger-Parker's Index, the mean value was 0,33 in 2001 and 0,26 in 2002. These parameters per LUU-s rank from 0,198 to 0,76 in 2001 and between 0,18 and 0,347 in 2002. This corresponds to the number of species providing 50% of the total number of Collembola per LUU-s, which ranks from 1 to 4 species in 2001 and from 2 to 6 in year 2002 (Tables 4 and 5).
The so-called Simpson's Index (overall dominance) ranks from 0,09 (LUU5) to 0,584 (LUU1) in 2001 and stretches between 0,085 (LUU5) and 0,209 (LUU4) in 2002.

The number of those species, which has less than 1% of the total number of individuals ($R_{1\%}$) is relatively high. In both years of the investigation, the highest values with 20 and 19 species were found in the LUU6. The relative number of low-abundant species is extremely high in nearly all LUUs. The $R_{1\%}$ ranks from 20% to 60 % and it is high in LUU1 as well as in the LUU6.

In terms of LUU-s and years, the maximal values of the individual dominance per Collembola families show a high percentage of many families in the investigation plots LUU5 and LUU6:

Maximal dominance % in the LUUs			
Collembola families	LUU	2001	2002
Onychiuridae	LUU5	62%	33%
Tullbergiidae	LUU6	50%	31%
Hypogastruridae	LUU6	45%	41%
Neanuridae	LUU5	41%	41%
Odontellidae	LUU5	100%	---
Brachistomellidae	LUU6	88%	76%
Isotomidae	LUU6	33%	28%
Entomobriidae	LUU1	31%	LUU2 35%
Cyphoderidae	LUU6	58%	100%
Arrhopalitidae	LUU2	---	66%
Katiannidae	LUU3	40%	LUU5 38%
Sminthuridae	LUU5	33%	90%
Neelidae	LUU2	100%	100%

Table 3: Family dominance per LUU-s in 2001–2002.

Organization and evenness

The so-called Shannon's Index has a mean value of 2,165 in 2001 and of 2,421 in 2002, while the evenness has the value of 0,68 and 0,72. The diversity is the highest in plots LUU5 and LUU6, however differences in organization and evenness of these latter LUU-s and the most forested plots (LUU1 and LUU2) are not as significant as we have seen for the abundance and species richness.

PARAMETERS		2001.	2002.
N		2419	4218
S_g		68	67
S_e		142	142
Species richness	$RSR = 100 \cdot \frac{S_g}{N}$	2,811079	1,588431
	$D_{(Mg)} = \frac{S_g - 1}{\ln N}$	8,599545	7,906922
	$D_{(Mn)} = \frac{S_g}{\sqrt{N}}$	1,3825823	1,0316242
$S_\alpha = \frac{\sum_{j=1}^{M} S_j}{M}$		24,33333	28,66667
$S_\beta = \frac{S_g}{S_\alpha}$		2,794524	2,337207
Dominance	$d = \frac{N_{max}}{N}$	0,16205	0,178995
	S_{50}	6	4
	$D = \sum_{i=1}^{L} p_i^2$	0,065078	0,081722
S_r		63	62
$R_{5\%} = 100 \cdot \frac{S_r}{S_g}$		92,64706	92,53731
Organization	$H' = -\sum_{i=1}^{L} p_i \cdot \ln p_i$	3,172424	3,07298
	$E = \frac{H'}{\ln S_g}$	0,751847	0,730845
The dominant species		59.	11.

59. *Entomobrya multifasciata* (Tullberg, 1871), 11. *Mesaphorura macrochaeta* Rusek, 1976

Table 4: Global diversity parameters of Csévharaszt Collembola. (Definition of parameters by the "Methods")

PARAMETERS of **2001**		LUU1	LUU2	LUU3	LUU4	LUU5	LUU6	mean
N_j		275	319	339	186	518	779	402,67
$N_{j\,max}$		209	77	74	53	103	217	122,17
S_j		19	15	23	20	36	33	24,33
Species richness	$RSR_j = 100 \cdot \frac{S_j}{N_j}$	6,91	4,70	6,78	10,75	6,95	4,24	6,72
	$D_{(Mg)_j} = \frac{S_j - 1}{\ln N_j}$	3,20	2,43	3,78	3,64	5,60	4,81	3,91
	$D_{(Mn)_j} = \frac{S_j}{\sqrt{N_j}}$	1,15	0,84	1,25	1,47	1,58	1,18	1,24
Dominance	$d_j = \frac{N_{j\max}}{N_j}$	0,76	0,24	0,22	0,28	0,20	0,28	0,33
	S_{50_j}	1	3	3	3	4	3	2,83
	$D_j = \sum_{i=1}^{L} p_{ij}^2$	0,58	0,16	0,14	0,13	0,09	0,14	0,21
S'_r		10	7	12	4	19	20	12
$R_{1\%} = 100 \cdot \frac{S'_r}{S_j}$		52,63	46,67	52,17	20	52,78	60,61	47,48
Organization	$H'_j = -\sum_{i=1}^{L} p_{ij} \cdot \ln p_{ij}$	1,13	2,00	2,29	2,40	2,80	2,38	2,16
	$E_j = \frac{H'_j}{\ln S_j}$	0,38	0,74	0,73	0,80	0,78	0,68	0,68
The dominant species		59	71	74	59	3	35	

59. *Entomobrya multifasciata* (Tullberg, 1871), 71. *Lepidocyrtus cf. tellacheae* Arbea & Jordana, 1990, 74. *Pseudosinella alba* Packard, 1873, 3. *Protaphorura serbica* (Loksa & Bugojevic, 1967), 35. *Brachystomella curvula* Gisin, 1948,

Table 5: Diversity parameters of LUU's in 2001.

PARAMETERS of **2002**		LUU1	LUU2	LUU3	LUU4	LUU5	LUU6	mean
N_j		418	542	872	373	683	1241	688,16
$N_{j\,max}$		102	157	303	122	123	252	176,5
S_j		22	32	28	21	34	35	28,666
Species richness	$RSR_j = 100 \cdot \frac{S_j}{N_j}$	5,26	5,90	3,21	5,63	4,98	2,82	4,63
	$D_{(Mg)_j} = \frac{S_j - 1}{\ln N_j}$	3,48	4,92	3,99	3,38	5,06	4,77	4,27
	$D_{(Mn)_j} = \frac{S_j}{\sqrt{N_j}}$	1,08	1,37	0,95	1,09	1,30	0,99	1,13
Dominance	$d_j = \frac{N_{jmax}}{N_j}$	0,24	0,29	0,35	0,33	0,18	0,20	0,26
	S_{50_j}	4	3	2	2	6	4	3,5
	$D_j = \sum_{i=1}^{L} p_{ij}^2$	0,11	0,13	0,20	0,21	0,08	0,11	0,14
$S_r^{'}$		9	15	14	9	17	19	13,833
$R_{1\%} = 100 \cdot \frac{S_r^{'}}{S_j}$		40,90	46,87	50	42,85	50	54,28	47,48
Organization	$H_j^{'} = -\sum_{i=1}^{L} p_{ij} \cdot \ln p_{ij}$	2,43	2,57	2,09	2,00	2,77	2,67	2,42
	$E_j = \frac{H_j^{'}}{\ln S_j}$	0,79	0,74	0,63	0,66	0,79	0,75	0,72
The dominant species		44	52	11	11	11	38	

44. *Folsomides portucalensis* da Gama, 1961, 52. *Isotoma viridis* Bourlet, 1839, 11. *Mesaphorura critica* Ellis, 1976, 38. *Cryptopygus bipunctatus* (Axelson, 1903)

Table 6: Diversity parameters of LUU's in 2002.

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Poster presentation

Insect damage in Lithuania: Experience from the recent outbreaks

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Abstract

Examples of recent defoliating-insect control (outbreak-suppression) in Lithuanian forests is presented, and reasons for success or failure are discussed. The suppression of *Panolis flammea* Schif. outbreaks lasted three years (2000-2002), and over 26,000 ha were treated at the cost of 1.47 million LTL, mainly due to shy decision-making and initially deficient (low budget) control measures. Successful suppression of *Lymantria monacha* L. (1,300 ha in 2002) and *Dendrolimus pini* L. (250 ha in 2004) populations at the start of pest outbreak with minimal costs present advantageous strategy in pest management.

Key words: forest, defoliator, insect, pest, outbreak, suppression.

Introduction

Only a few species of defoliating insect pests have been threatening Lithuanian forests in recent decades, building population densities to outbreak levels with different intervals (Fig. 1). Therefore effective forest insect pest control has been of interest and of tremendous importance for a long time. However, different pest management tactics have been used, ranging from non-intervention to area-wide suppression by conventional or biological insecticides. Although it is generally agreed that suppression of insect gradations is real, cases of unsuccessful campaigns are not exceptional. Records of forest pest management in Lithuania show various experiences in defoliating insect control.

Material and methods

Records of pest damage and reports from pest management campaigns, most of which were not published in scientific literature, along with personal experience, have been used to analyse course and outcome of recent defoliating insect outbreak suppression in Lithuanian forests.

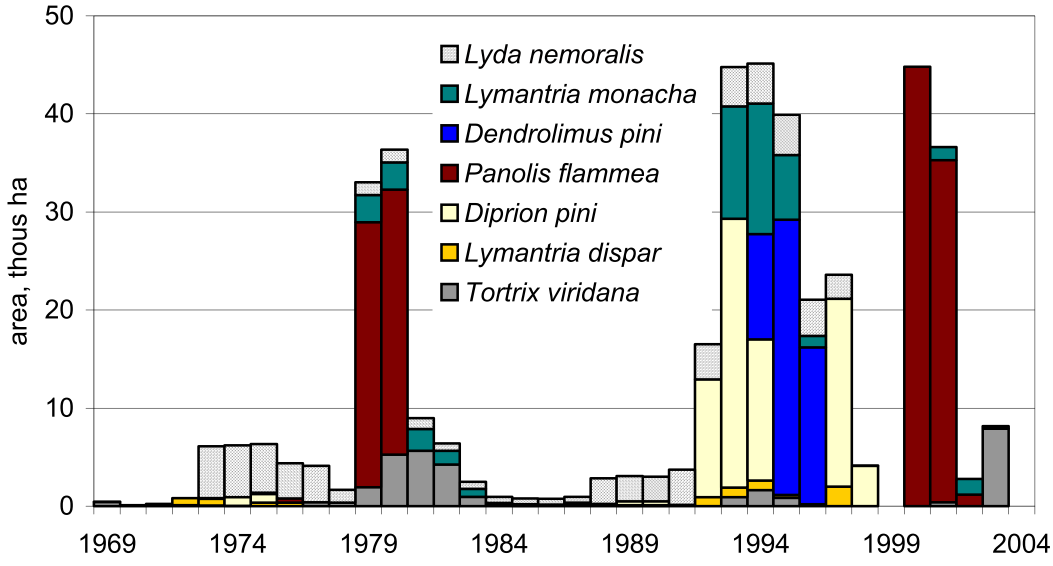

Fig. 1. History of defoliating insect damage in Lithuania 1969-2003.

Results and discussion

An example of doubtful success in defoliating insect management could be the recent outbreak of the pine beauty moth (*Panolis flammea* Schif.) in Lithuania. A population increase was noticed in 1998 (Annual report … 1998), but no apparent damage was forecasted, and no control measures were commenced. Later surveys revealed a further rise of the pest population (Annual report 1999) in pine forests of all ages, and all signs showed progradation phase of the outbreak.

Forecast for year 2000 predicted significant damage (30-50% defoliation) in 980 ha, high (50-70%) – in 4,360 ha, and severe (70-100%) – in 1400 ha of pine forests. Area-wide measures were recommended in the areas of ca 13,000 ha (Annual report 1999). Due to the lack of funding, only part of the forests at risk (6,450 ha, ~50%) were treated, and no apparent defoliation was recorded in these areas. However, these limited control measures could not stop the increase of the pest. The outbreak expanded and damage of various levels was recorded at the 44,800 ha area of untreated forests, 4000 ha of which were totally defoliated (Annual report 2000). Year 2000 was a time of mass damage and expansion – the culmination of an outbreak.

The forecast for 2001, based on the number of over-wintering female pupae, tree age, current defoliation and abundance of natural enemies, predicted significant damage in the area of 8500 ha, high – of 10,300 ha, and severe – of 19,100 ha of pine forests. Area wide suppression was recommended at least to the area of over 30,000 ha, primarily to the stands that have already experienced severe damage to avoid defoliation in two consecutive years.

Some environmentalists, employing public awareness on use of pesticides, launched a heated discussion about the need for area-wide suppression measures. Arguments against suppression were that natural enemies can and should terminate the outbreak (60% of over wintering pupae were parasitized, mainly by the tachinid fly *Ernestia rudis* Fall. and ichneumonid *Rictichneumon pachymerus* Ratz.) and that there is no money available in the current budget for these expenses. Arguments for treatment were based on evidence that entire forest ecosystem is at risk, because repeated 80-100% defoliation can be fatal for pines, and parasites will not prevent tree damage as they kill *P. flammea* during final stages of development. As a result of these deliberations, suppression was authorized to 18,620 ha of forests (~ 60% of required) and conventional pyrethroids were used. Desperate efforts in 2001 were not as successful as desired, however the forests most at risk were protected against further defoliation and dieback. Natural enemies impact was not as sound as anticipated. Meteorological conditions have not favored the pest, cold and rainy weather predominated in May and suspended development of second instar larvae for three weeks, but later pine beauty moth larvae recovered and continued development. This oppose the widely spread opinion that unfavourable weather conditions during early stages cause starvation and collapse of pest population (Надзор, учет 1965). However, all negative factors could not stop outbreak and pest expansion to new territories, and damage of various degrees was recorded on an area of 11,243 ha, 8,530 ha of which were in new territories (Annual report 2001).

Defoliation forecast for 2002 predicted severe defoliation in the area of 5,320 ha, high – 4,310 ha, significant – 4,485 ha. It was recommended to apply area-wide control measures in 12,900 ha of forests, predominantly using biological methods (Foray 48B and/or Dimilin), as most of forests under the risk had protective status (watershed protection, recreation areas, reserves, etc.) restricting use of conventional chemicals. With no discussion requested funds were allocated. Pine beauty moth pupae overwintered and emerged successfully, but females laid very few eggs (67% of the eggs have not maturated). The reason could be the lack of food in the previous year because of the high pest densities (Annual report 2002). Obviously, outbreak entered retrogradation phase, therefore only the most damaged forests were treated (1,900 ha) to prevent any further and/or repetitive defoliation, and 0.3 mln Lt (25% of requested) was expended. Next year outbreak terminated.

Suppression of *Panolis flammea* Schif. outbreak lasted three years (2000-2002) and over 26,000 ha were treated. Some important lessons were learned: first, parasites were not important in outbreak development; second, pest management activities effectively preserved forests from fatal defoliation.

Nun moth *Lymantria monacha* Z. is another serious forest insect pest in Lithuania, and its outbreaks in recent past have been recorded in 1979-1983 and 1993-1996. However, area-wide suppression has been applied few consecutive years in a row (1980-83, Table 1), indicating the same pest management strategy and insufficient effect of control measures. Different approach was employed to control nun moth in 2002: though forecast predicted only modest defoliation in some former outbreak areas, but 1,300 ha was treated with insecticides to hold back increasing pest population (Annual report… 2003). This proved to be successful decision, as next year population did not rise above perceptible levels (fig. 2A), while outbreaks of nun moth were reported in northeastern part of Poland, regions close to Lithuanian border, and year 2003 was entitled as year of continuing outbreak (The Polish 2003).

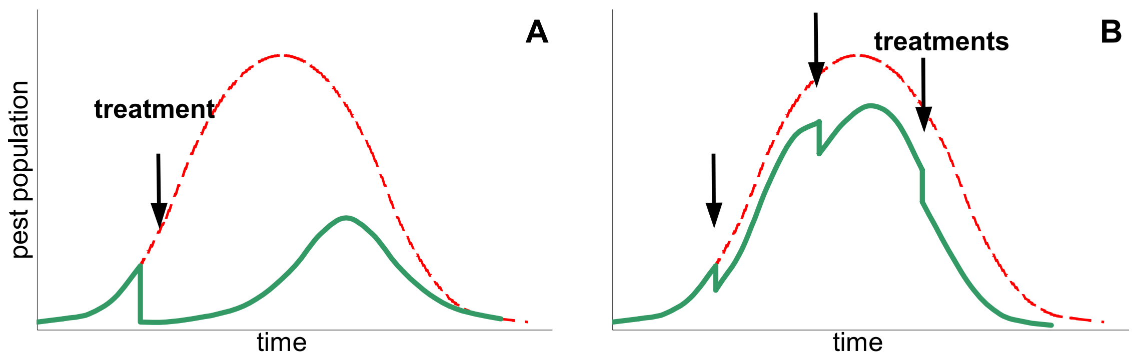

Fig. 2. Unsuccessful (A) and effective (B) outbreak suppression

Year	Pest		Area (ha)
1972	gypsy moth	*Lymantria dispar*	350
1974	pine sawfly	*Diprion pini*	80
1974	webspinning sawfly	*Lyda nemoralis*	620
1975	pine sawfly	*Diprion pini*	80
1976	gypsy moth	*Lymantria dispar*	70
1977	webspinning sawfly	*Lyda nemoralis*	1350
1980	nun moth	*Lymantria monacha*	624
1980	oak leafroller moth	*Tortrix viridana*	102
1981	nun moth	*Lymantria monacha*	1606
1981	webspinning sawfly	*Lyda nemoralis*	750
1982	nun moth	*Lymantria monacha*	1390
1983	nun moth	*Lymantria monacha*	300
1994	nun moth	*Lymantria monacha*	3100
1995	pine lappet	*Dendrolimus pini*	1006
1997	gypsy moth	*Lymantria dispar*	1500
2000	pine beauty moth	*Panolis flammea*	6450
2001	pine beauty moth	*Panolis flammea*	18620
2002	pine beauty moth	*Panolis flammea*	1176
2002	nun moth	*Lymantria monacha*	1600
2004	pine lappet	*Dendrolimus pini*	250

Table 1: Aerial spray campaigns against defoliating insects.

The same strategy was applied to the manage population of *Dendrolimus pini* L. in 2004. Although results of pest population assessment in 2003 forecasted minor to average defoliation next year, trend of population increase was seriously encountered and microbial insecticide Foray 48B was applied at the area of 250 ha. Costliness of biological control was not a serious load to a budget and all areas under the risk were treated. No obvious damage was recorded, and afterward counts do not show further increase of population.

Successful suppression of relatively small *Lymantria monacha* Z. (1,300 ha in 2002) and *Dendrolimus pini* L. (250 ha in 2004) populations at early progradation stages of pest outbreak (Fig. 2A) and with minimal costs proves advantage of this pest management strategy. Having these examples, it is evident that late funding for pine beauty moth control was more expensive – 1.47 million Lt was spent over three years (2000-2002) instead of 0.5 million Lt that was needed in the first year of the outbreak (Table 2). Shy decision-making and deficient (low budget) control measures in the beginning could not stop or limit development of the gradation (Fig. 2B). Furthermore, the adequate initial expenditure would have prevented damage (defoliation) in ca 50,000 ha of forests with total less loads of insecticides (conventional or microbial) upon the forest environment.

Year	Funds, Lt	
	requested	allocated/used
2000	0.50 million	0.22 million
2001	2.30 million	0.95 million
2002	1.20 million	0.30 million
Total		**1.47 million**

Table 2: Expenses of *P.flammea* suppression.

History of aerial spray campaigns shows few more examples of onetime application of insecticides (Table 1), suggesting that in these cases pest populations were effectively knocked down below outbreak levels (*Lyda nemoralis* in 1974, 1977, 1981; *Lymantria dispar* in 1972, 1976, 1997; *Tortrix viridana* in 1980). So prompt and firm control measures in the beginning of population rise towards outbreak should be the priority strategy in pest management of forest defoliating insects.

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Poster presentation

Most injurious factors in Slovak forest stands at the beginning of new millennium

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Abstract

Damages due to pest agents were influenced mostly by climatic factors at the beginning of new millennium. There were severe droughts in growing seasons in 2000 and 2003 and wind thrown in November 2004. Consequently, forest stands are less resistant to fungal root infections and bark beetle infestations in following years. Moreover, there has been a Gypsy moth outbreak in broadleaved trees of southern Slovakia since 2003 and we expect it to finish in 2006. Large aerial spraying of biopreparations and biotechnical preparations were realized against Gypsy moth larvae in 2004 and 2005.

Key words: Sanitary felling, *Armillaria*, bark beetle, Gypsy moth, control methods

Sanitary felling

Sanitary felling represents volume of timber that was cut due to pest agents. The worst situation occurred in the middle of 90s (Fig. 1), when forests were returned to former owners prior to communistic regime. Many small forest owners did not apply proper management of their forest against pest agents and that resulted in outbreaks of biotic pest agents, mostly of bark beetles. At the end of 2004 there was a biggest wind thrown in Slovakia. The most effected areas were High and Low Tatras, Orava and Gemer region (Kunca *et al* 2005).

Sanitary felling occurs mostly in mountains where coniferous trees dominate (Fig. 2). Kysuce, Orava, Tatras, Spiš and Gemer have been regions with the worst situation for several years. The typical symptoms of Norway spruce dieback include needle yellowing and their shortage, shorter sprout length increment, top dieback. Trees like this are most likely infected by *Armillaria* sp. or infested with bark beetle (*Ips typographus*, *Pityogenes chalcographus*). Generally, both pest agents occur together.

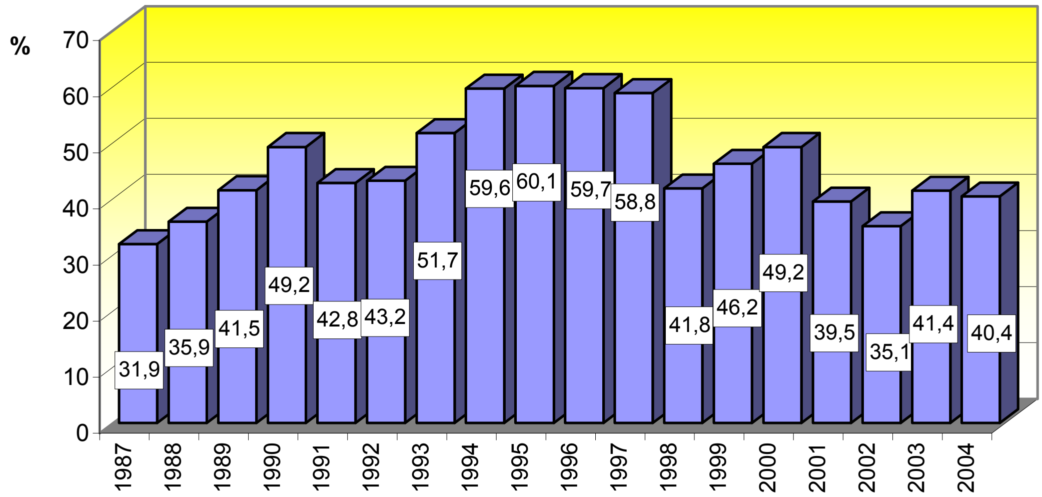

Fig. 1: Proportion of sanitary felling in total volume of felling (%) (Kunca *et al* 2005).

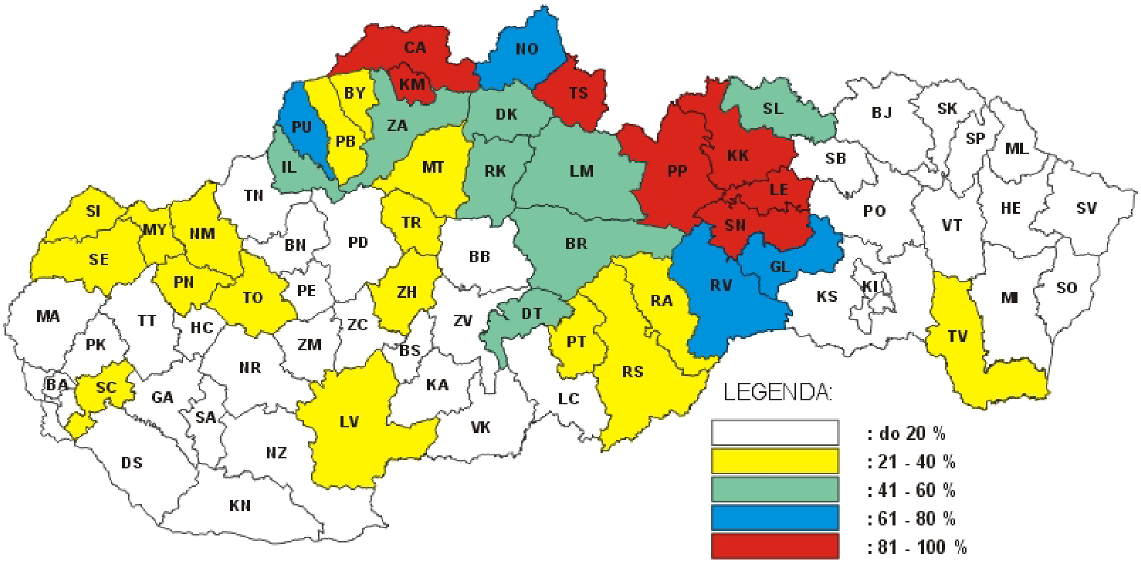

Fig. 2: Distribution of sanitary felling in 2004.

Gypsy moth

As the proceeding is getting ready in early 2006, there is a possibility to update the date about Gypsy moth outbreak up through 2005. In 2004 and 2005 the gypsy moth *Lymatria dispar* outbreak has culminated (infested annually 20,000 ha). The outbreak in 2004 was extremely strong (Fig. 3), in 2005 even worse. The number of the gypsy moth eggs per ha was often very high and larvae occurred in elevations even up to 700-800 m. As strong outbreak as this one has not been recorded at least since the half of the 20th century.

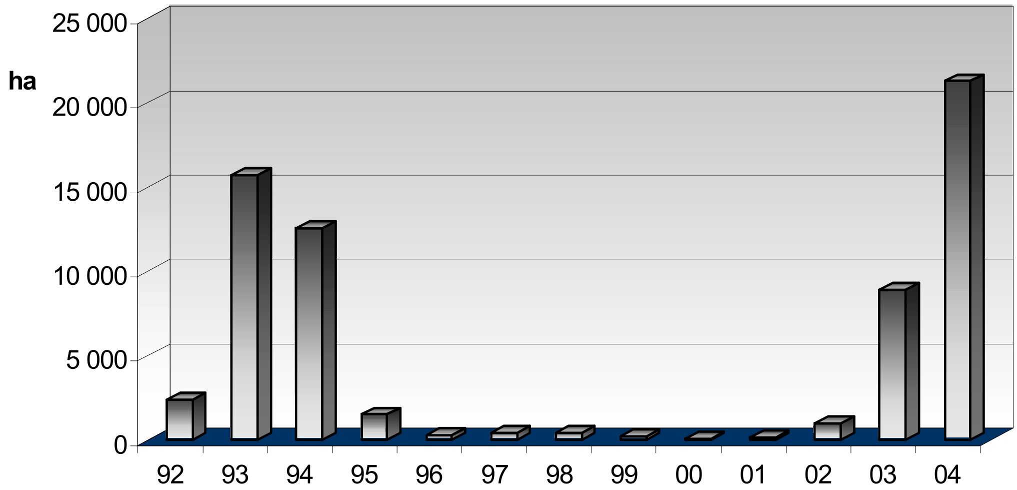

Figure 3: Area of forest damaged by Gypsy moth from 1992 to 2004.

The oak forests in the southern and southwester part of Slovakia were the most attacked forest stands (Fig. 4). There were 24,294 ha treated by insecticides in order to prevent the damages due to defoliation in 2004 and 2005 together (Table 1). The *Bacillus thuringiensis* var. *kurstaki* of the preparation Biobit XL was applied in those areas, where the natural conservation organisations attracted the highest attention. In the rest part of stands Dimilin 48 SC (diflubenzuron) or Nomolt 15 SC (teflubenzuron) in dose 0.15 l/ha resp 0.3 l/ha were applied besides Biobit XL.

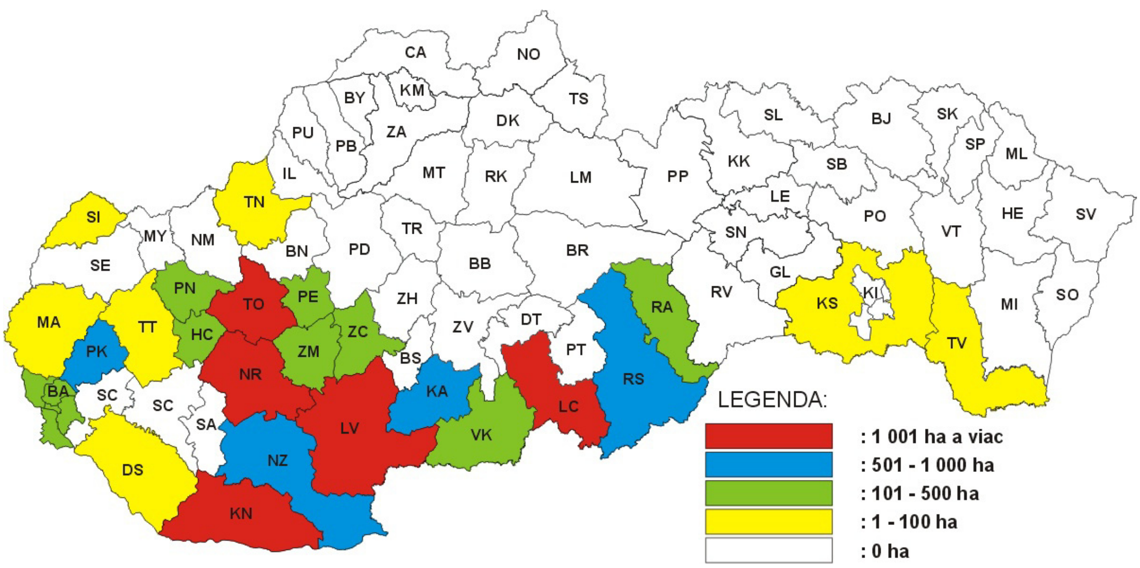

Fig. 4: Distribution of Gypsy moth in 2004.

Year	Ownership			Products			
	State land	Private land	Total	Biobit XL	Dimilin 48 SC	Nomolt 15 SC	Total
2004	7 668	630	8 298	3 815	1 340	3 143	8 298
2005	12 698	3 297	15 995	2 302	-	13 693	15 995
TOTAL	20 366	3 927	24 293	6 117	1 340	16 836	24 293

Table 1: The areas treated by insecticides against the gypsy moth in 2004 and 2005 – ownership and proportion of pesticides.

Two different types of application technologies – ultra low volume (ULV, 3-4 l per ha) and high volume (HV, 100 l water suspension per ha) were used for aerial treatments. Micronair 4 000 atomisers were used in the ULV applications. Efficiency of treatments was checked 6 – 8 weeks after treatment. The results showed very high mortality of the larvae (nearly 100 %). Applications were timed in order to influence the young larvae of the pest (second instar) in the first and the second decade of May depending on the weather condition and development of the foliage. Stands that were sprayed in 2005 showed no egg masses checked during winter months.

As for other leaf eating pest the Tortricids and Geometrids occur on oaks, *Dreyfusia nordmannianae* in young silver fir stands and *Melolontha* sp. in southern oak-pine stands.

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