CONTROL OF THE *Hylobius abietis* L. (COLEOPTERA: CURCULIONIDAE) PEST DURING 2010-2019, WITHIN THE MIERCUREA SIBIULUI FOREST DISTRICT

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Abstract. The *Hylobius abietis* weevil (Linnaeus, 1758) is considered one of the most dangerous pests of softwood forests, attacking in particular spruce, pine, fir, larch and Douglas fir. The appearance of this pest in the perimeter of the studied surface occurred after the felling of the conifers, but the presence of the pest was especially noted in young seedlings. Within the Miercurea Sibiului Forest District, this pest was detected during the period 2010-2019 on an area of 925.93 ha, in three production units – UP III Bistra, UP IV Ciban, UP V Pod. The protection of the forest fund in the area is essential to keep the evolution of this pest under control, and the following protection methods were used in the Miercurea Sibiului Forest District: for young seedlings in the new plantations, treatments with Mospilan 20 Sp, with a consumption norm of 0.2 kg/1000 seedlings and bark traps mounted on trees in the perimeter of the facility at the end of May of each year for mass capture of adults.

Keywords: *Hylobius abietis*, conifer seedling, chemical protection.

Rezumat. Controlul dăunătorului *Hylobius abietis* L. (Coleoptera: Curculionidae) în perioada anilor 2010-2019, în cadrul Ocolului Silvic Miercurea Sibiului. Trombarul puieților de molid *Hylobius abietis* (Linnaeus, 1758) este considerat unul dintre cei mai periculoși dăunători ai pădurilor de rășinoase atacând în special molidul, pinul, bradul, laricele și bradul duglas. Apariția acestui dăunător în perimetrul suprafeței studiate a avut loc după tăierea arboretelor de rășinoase, însă prezența dăunătorului a fost semnalată mai ales în plantațiile tinere de puieți. În cadrul Ocolului Silvic Miercurea Sibiului, acest dăunător a fost depistat în intervalul cuprins între anii 2010-2019 pe o suprafață de 925.93 ha, în cele trei unități de producție – UP III Bistra, UP IV Ciban, UP V Pode. Protejarea fondului forestier din zonă este esențială pentru ținerea sub control a evoluției acestui dăunător, iar în cadrul Ocolului Silvic Miercurea Sibiului au fost folosite ca metode de protecție: pentru puieți din plantațiile noi tratamente cu Mospilan 20 Sp, cu o normă de consum de 0.2 kg/1000 puieți și capcane de scoarță montate pe arborii din perimetrul ocolului la sfârșitul lunii mai a fiecărui an pentru capturarea în masă a adulților.

Cuvinte cheie: *Hylobius abietis*, puieți de conifere, controlul chimic.

INTRODUCTION

The Miercurea Sibiului Forest District has a total area of 17,263 ha of which 15,900 ha include specific hill and mountain areas located at an altitude from 500 m to 2000 m. It contains the following production units: UP Bistra, UP IV Ciban, UP V Poda, UB I Tilișca and UB I Miercurea Sibiului). Of the total forest fund, state forests occupy an area of 14,911 ha, the difference being managed by bypass on the basis of a contract with the Tilișca and Miercurea Sibiului town hall. The basic species is spruce.

The *Hylobius abietis* (Linnaeus, 1758) (Coleoptera: Curculionidae) is popularly called large pine weevil. According to the latest 2020 data from CABI.org (https://www.cabi.org/isc/datasheet/28175#REF-DDB-109955), the distribution of this pest has been reported in the continent of Oceania (New Zeeland), 9 countries in Asia and 35 countries in Europe, including Romania. The species is polyphagous and has a trophic basis in almost all species of conifers, but also deciduous, but prefers pine (*Pinus sylvestris*), spruce (*Picea abies*), and duglas fir (*Pseudotsuga menziensii*) (LANGSTROM, 1982; KUZIEMSKA & GRZECZKA, 1985; WILSON & DAY, 1996; DAY & SALISBURY, 1999; OLENICI & OLENICI, 2003; DILLON et al., 2006, 2008).

Within the Miercurea Sibiului Forest District, this pest was reported during the years 2010-2019 (Table 1) in the places with cut-offs and immediate afforestation where it has caused damage to the crops just planted, to resinous saplings, especially spruce, with age between 1-5 years. From the observations made during the ten years and the studies in the specialized literature, the period of damage was between April and September, when the adults of *H. abietis* began to feed on the bark of conifer seedlings which led to the deformation of young offspring and even to their death (LEATHER et al., 1999).

The adult of this pest feeds on bark, but also on young pine seedlings. SOLBRECK & GYLDBERG (1979) showed that the highest number of beetles (over 90%) fly in the evening when the air temperature exceeds 8.5° C and the wind speed can be lower than 3 m/s. During the migration period, beetles can also keep at distances of over 10 km. The females lay the eggs at the end of May and the beginning of July, and one female can lay up to 100 eggs (KORCZYNSKI, 1985). The egg-laying takes place in the cracks of the bark, as the females are attracted by the smell of freshly cut wood. The larvae of this pest are not important because they cause damage to the roots of the nails. For survival but also for reproduction, beetles from different generations feed throughout the growing season, producing damage through the sprouting of seedlings (DILLON et al., 2006). In the Miercurea Sibiului Forest District, the attack was produced by adults who had fed on the bark of the seedlings, and a resin leak appeared in the injured place.

In the favourable years, adults are active from March to October when the population can reach a density of 100.000 individuals/ha (OLENICI et al., 2005). The growth of the beetle population for 2-3 years can lead to an overlap of generations and thus a multiplication of the adult population (OLENICI & OLENICI, 2002a).

MATERIALS AND METHODS

Researches regarding the control of pest populations within the Miercurea Sibiului Forest District were carried out by the authors (STANCĂ-MOISE & BLAJ, 2017a; STANCĂ-MOISE et al., 2017b, 2018c; STANCĂ-MOISE, 2014, 2016), who, in addition to the methods and the means of combating harmful beetles have studied and monitored the defoliating lepidopteran species (STANCĂ-MOISE et al., 2018c)**.**

The present study is a continuation of the researches of the last years being carried out in the same production units: UP III Bistra, UP IV Ciban, UP V Pod. From the welds carried out in the field, there have been outbreaks of infection in the plots where breeds were cut to restore the trees broken down by the wind. The exploitation works took place between June and November during the years 2010-2019.

Currently, the assessment of the efficiency of the protective measures and methods applied in the resin crops against the attack of *H. abietis* was done without taking into account a standard surface, which had a subjective result on the assessment of the control of the population of this pest, because the same measures of protection had different effects in different situations. The first control measure to protect the forest from the attack of this pest was to plant the seedlings in a solution of Mospilan 20 Sp, with a consumption norm of 0.2 kg/1000 seedlings.

Methods for combating this pest have also been studied (OLENICI & OLENICI, 2002b, OLENICI & OLENICI, 2006) in other forest areas in the country, where the effect of NeemAzal-TIS insecticide on feeding, vitality, mortality and fertility of beetles was tested. The response of *H. abietis* cockroaches to the variation rates of alpha-pinene and ethanol release as well as the ratio of alpha-pinene/ethanol compounds found in the pheromone strains used to control populations of this pest was also investigated (OLENICI et al., 2007).

From these studies, the effect of pest population control was established with the help of pheromone traps. During the ten years of study, through the centralization of the annual data, we identified an infested area of 925,93 ha (Table 1), where a number of 5,383 traps were installed with pheromone nests Atratyp and Wing-type berths (barrier) in which a total of 31,289 adult specimens of *H. abietis* (Table 2) were captured.

Similar studies regarding the monitoring and control of the populations of forest pests have been carried out by the same group of authors within the Forestry Directorate of Sibiu (STANCĂ-MOISE et al., 2018a, b) but also in the Forest District Rășinari from the Sibiu County (STANCĂ-MOISE, 2019).

RESULTS AND DISCUSSIONS

The signalling of this pest within the Miercurea Sibiului Forest District required to take action to protect the forest fund and to control and limit the evolution of the population. From the analysis of the data from the years of study we observe an increase of the infested surface in 2011 compared to 2010, a decrease in 2012, again an increase between the years 2015-2017, followed by a decrease of the area under attack in 2018 and a slight increase in 2019 (Table 1).

Out of the monitored area of 1221.5 ha, the infested area was 925.93, which represents 75.81% the degree of attack. This means the attack is a strong one and additional action must be taken to protect the forest fund within the Miercurea Sibiului Forest District.

Table 1. The degree of attack of the pest *Hylobius abietis* in the period 2010-2019, within the Miercurea Sibiului Forest District.

Year	Surface (ha)	Infected surface
2010	102.60	42.0
2011	165.04	144.0
2012	133.58	84.45
2013	134.11	79.67
2014	94.11	59.88
2015	121.62	90.58
2016	119.44	103.35
2017	138.0	138.0
2018	86.0	86.0
2019	127.0	98.0
Total	**1221.5**	**925.93**

The analysis of the data from Table 2 shows that the number of pheromone traps during the years 2010-2019 ranged from a minimum of 440 traps in 2010 to a maximum of 656 in 2013. The number of captured specimens was at least 2097 in 2015 and at most 5000 in 2011; the evolution in the number of individuals can be seen from Table 2. The intensity of the attack was very strong during 2010-2013 and strong during 2014-2019.

In the nurseries Colonia and Căzile, with an area of 1.4 ha, no pests were reported during the year 2009, as the required preventive measures were taken in due time.

In 2010, 440 pheromone traps were installed with Atratyp and Atrachalc swabs, which represented 2,328 classic trap trees for combating the *H. abietis* species on an area of 102.6 ha with low to medium attack intensity.

Table 2. Catches using pheromone curves (barrier) with pheromone nets Atratyp and Atracole, between 2010-2019, within the Miercurea Sibiului Forest District.

Year	Number of pheromone traps	Number of individuals / stroke	The attack intensity
2010	440	4500	Very Strong
2011	540	5000	Very Strong
2012	598	4453	Very Strong
2013	656	3452	Very Strong
2014	573	2402	Strong
2015	534	2097	Strong
2016	520	2100	Strong
2017	496	2344	Strong
2018	506	2522	Strong
2019	520	2419	Strong
Total	**5383**	**31,289**	

Attack degree: 1500-3000 cockroaches/trap, strong, over 3000 cockroaches/trap very powerful attack

In 2011, the presence of curculionids on an area of 2,700 ha and the intensity of medium and strong attacks were reported in the trees and a number of 526 barrier traps, 14 tubular traps and 132 treated trees were located, with the pheromone nets Atratyp and Atrachalc having represented 3,052 classic racing trees, to fight *H. abietis* on a surface of 165.05 ha, with a very strong intensity of attack.

In 2012, the presence of curculionids on an area of 2,675 ha with the degree of medium to strong attack was reported in the trees; 588 barrier-type traps, 10 tubular traps, with Atratyp and Atrachalc pheromone swabs, representing 2,960 classical trap trees, were placed to combat the beetle *H. abietis* on an area of 112 ha, with a very strong intensity of attack. In 2013, the presence of curculionids on a surface of 2,489 ha with the degree of medium to strong attack was reported in the trees; 656 barrier-type traps, 10 tubular traps, with Atratyp and Atrachalc pheromone swabs representing 3,250 classic trap trees were placed for fighting *H. beetle* on a surface of 94 ha, with the intensity of the attack very strong.

In 2014, the presence of curculionids on a surface of 2,490 ha with the degree of medium to strong attack was reported in the trees; 573 barrier-type traps were placed, with Atratyp and Atrachalc pheromone swabs representing 2,865 classical trees, for the fight against the beetle *H. abietis* on an area of 90 ha, with a strong intensity of the attack.

In 2015, the presence of curculionids on an area of 2,490 ha with a strong intensity of attack was reported in the trees, 534 barrier-type traps were located, with Atratyp and Atrachalc pheromone swabs representing 2,670 classic trees trap, for fighting *H. abietis* on a area of 120 ha, with a strong intensity of the attack.

In 2016, the presence of curculionids with a high intensity of attack was noted in the trees, 520 barrier-type traps were located, with Atratyp and Atrachalc pheromone swabs for combating *H. abietis* cockroach.

In 2017, the presence of curculionids on a surface of 2,480 ha with a strong intensity of attack was reported in the arboretum, 496 barrier-type traps were placed, with Atratyp and Atrachalc pheromone swabs being used to fight the *H. abietis* cockroach.

Table 3. *Hylobius abietis* pest control and prevention and control measures for 2020.

No.	Forestry district	Surface attacked by *Hylobius abietis*	
		On which treatment was applied on 2019 (ha)	Treated during the year 2020 (ha)
1	**UP III Bistra**	22	23
2	**UP IV Ciban**	27	29
3	**UP V Pode**	39	46
TOTAL		**88**	**98**

In 2018, an area of 86 ha was infested. The infestations ranged from very weak to moderate, covering between 50 and 150 barks/ha, treated with Mospilan 20 Sp, with a consumption norm of 0.2 kg/1000 seedlings; 506 barrier traps were placed on the bark, with Atratyp and Atrachalc pheromone swabs. In the areas already treated in the previous years, the toxic bark was placed at the end of May, the results were good with a maximum percentage of 10% attacked seedlings.

At the plantations that were carried out in the spring of 2018, depending on the estimation of the risk of attack of each surface, toxic seedlings and bark were placed with the planting. Also, to protect the seedlings, they were bathed before planting in a Mospilan 20 Sp 0.5% emulsion using 50 g per 1000 seedlings. This treatment ensured the protection of the seedlings for a period of approximately one month, with very good results in the plantations carried out after two years after the operation of the tree.

In 2019, in the three production units within the Miercurea Sibiului Forest District, on 88 ha of forest, treatments were applied to combat this pest. At the plantations that were carried out in the spring of 2019, depending on the estimation of the degree of attack of each surface, they were placed with the planting of the seedlings and barks that were subjected to toxic treatment according to the intensity of the attack. Also, in order to protect the 320 resin

seedlings (spruce, larch), they were bathed before planting in a solution of Mospilan 20 Sp 0.5% using 50 g/1000 seedlings. In order to ensure the population control of this pest, prevention and control measures were taken for the year 2020, when 98 ha are planned for treatment. An estimated 15 kg of insecticide will be used to treat the 296 seedlings that will be planted in the spring of 2020, respectively 3 kg for treating toxic bark. The work is to be performed by the contracting service company.

CONCLUSIONS

From the studies carried out in the field and the research undertaken by the different groups of researchers regarding the biological, ecological and ethological particularities of the species *Hylobius abietis* (OLENICI & OLENICI, 1994a, b) we can conclude that the protection measures within the Miercurea Sibiului forest fund against weeds of this pest must include three directions: the treatments should apply from the first year of the cut; they must extend over the entire duration of the development of at least one generation; they must be effective throughout the entire vegetation season, especially in the first year and especially in the year of the appearance of young cockroaches. Last but not least, the control measures applied within the Miercurea Sibiului Forest District must be economically efficient and should not generate ecologically negative effects. This last objective is the most important and it must be awarded special attention, because, due to the lack of a method of forecasting the degree of attack, most of the forest protection measures being undertaken must be applied preventively.

In our country, according to the regulations in force regarding the use of insecticides in pest control treatments, the instructions provided on the products must be observed.

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Received: March 12, 2020
Accepted: July 22, 2020