Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 17, Issue 4, 2017
PRINT ISSN 2284-7995, E-ISSN 2285-3952

THE CONTROL OF THE DEFOLIATOR *LYMANTRA MONACHA* L. POPULATIONS (LEPIDOPTERA: LYMANTRIIDAE) BY MAKING USE OF PHEROMONE TRAPS IN THE FOREST RANGE MIERCUREA SIBIULUI (ROMANIA) IN THE PERIOD 2011-2015

Cristina STANCĂ-MOISE[1], Tom BRERETON[2], Robert BLAJ[1]

[1]"Lucian Blaga" University of Sibiu, Faculty of Agricultural Sciences, Food Industry and Environmental Protection, Sibiu, Romania, Phone: 0040269234111, Fax: 0040269234111, E-mails: cristinamoise1@yahoo.com, robert_blaj@yahoo.com
[2]Butterfly Conservation, Manor Yard, East Lulworth, Wareham, Dorset, BH20 5QP, UK

***Corresponding author*:** cristinamoise1@yahoo.com

Abstract

The studies which were effected by different authors enabled to be published some articles which include scientific results related to the most important defoliator of coniferae - the nun moth Lymantria monacha L., 1758. In this work the researches had an applicative character, with the view to using the results in drawing up a plan for monitoring and control the populations of Lymantria monacha L., 1758, by making use of pheromone bait traps. At the same time, the researches had in view to get new scientific information in order to improve the methods of controlling the pest, existent at the moment and of tracing the focuses of this pest, prejudicial to the forest domain of Sibiu county (Romania). The studies enabled also to be tracked the dynamics of the population of Lymantria monacha L., 1758 and to notice that the male moths can be attracted by using pheromone bait to open areas, 200-250 m distance from the border of the forest. The studies were effected in the spruce and fir arboretum which cover 70 percent of the forest, aged between 50 and 125 years.The researches effected in the last 5 years (2011-2015) aimed at the monitoring of this month, the dynamics of its population, the efficiency of capturing the male moths and the way of installing the pheromone traps in the domain of the state Forest Range Miercurea Sibiului and the private Forest Range Tilişca, totalizing 14,932.37 hectares forest.

***Key words*:** *Lymantria monacha* L., 1758, *monitoring, pheromone, trap*

INTRODUCTION

Lymantria monacha L., 1758 is a major pest of coniferous trees in Europe and Asia. For example, in Poland from 1978-1984 3.7 million ha of coniferous woodland was infested. In parts of Europe [15,26], the frequency of occurrence of outbreaks has increased in recent decades. Monitoring and control of populations are vital activities including across Romania where woodland covers 29% of the land surface and forestry is an important economic activity. Direct control with insecticides is an effective method of control over large areas, whilst pheromone trapping can be used as a means of disrupting mating [6]. Conventional monitoring methods include winter egg counts, larval counts, larval frass estimates, pupal counts, counts of adults resting on tree trunks and defoliation assessments [1-5,7,14,25]. However, these methods are labour-intensive and not good at detecting population increases over short time scales. Pheromone-based monitoring is an alternative method of detecting population change in pest moth species over short time frames, though research on the technique is at a relatively early stage and more is required. This study contributes to this knowledge gap, looking at effectiveness and applicability of various types of pheromone trap (panels, funnels, tetratraps) baited with Atralymon, a synthetic pheromone specific to this defoliator. Specific objectives of the study related to

monitoring and control of L*ymantria monacha* populations using Atralymon pheromone traps included: the efficiency of traps used, position of traps (placed on the tree trunks), the dynamics of the captures, the variation in the number of populations and evolution trend of the defoliator populations in four production units.

MATERIALS AND METHODS

A total of 85 Atralymon pheromonal traps (Fig. 2) were installed in the Forest Range Miercurea Sibiului (Sibiu, Romania) over the period 2011-2015 on plastic panels with glue for capturing the males of *Lymantria monacha* L., 1758. Among them, 81 panels with Atralymon pheromone traps were dissipated in the state Forest Range Miercurea Sibiului and four panels with traps in the private Forest Range of Tilişca village, Sibiu County.

Pheromone traps were placed in all woodlands with spruce and fir trees [13], and in mixed spruce-fir-beech forests, where spruce and the fir trees represented more than 30 %, of tree composition. The traps were placed before the emergence of adults, with the flight period varying according to the altitude and the latitude of the monitored forests [16,18,23,24]. To representatively sample forest areas (Fig.1), a grid (1:20.000 scale, as used in local forest planning) was placed over wooded areas, with traps set at evenly-spaced intervals in each grid cell and with each trap having an independent capturing surface of 200ha of forest.

These panel type traps (Fig. 3), manufactured by the Chemistry Institute "Raluca Ripan" in Cluj-Napoca were tested. Each of the 85 traps was an experimental variant, with a view to establishing the optimal position on the tree trunk of the panels with glue and Atralymon.

The largest number of moths *Lymantria monacha* were captured in 2012 in the lookout point UP III Bistra, u 162B (50 insect copies); the composition of the arboretum was 10 Mo, the altitude 1200 m, the NorthEast exposure, arboretum age 95 years, the defoliator being still in the latent period.

According to this distribution, the panels were numbered from the trap no. 1 to 81, downstream located, on the line of highest slope and going on clockwise in the three plantations of the Miercurea Sibiului Forest [24] Range and the traps 82 to 85 in the Tilişca Forest Range.

Fig.1. Region Map (orig.)

The data obtained between 2011-2015, related to the captures in the panel type pheromone traps utilized in the two forest ranges mentioned above, have allowed to establish the duration and the flight dynamics of the moths (males) and to ascertain differing proportions of captured moths.

In the three areas in Miercurea Sibiului Range Forest and in the area in Tilisca Range Forest, analysis was undertaken on correlations between the number of moths captured annually in traps and climatic factors. The climate data of the last five years was obtained from Sibiu Meteorological Station [17,19-22], located within the studied area.

In the cases with significant ties we established also the respective regressions.

Fig. 2. Pheromone traps installed in stand (orig.)

RESULTS AND DISCUSSIONS

The captures obtained in traps used in the area of Miercurea Sibiului and Tilisca Forest Ranges helped to be established the dynamics of the *Lymantria monacha* populations; they took place in the arboreta: III Bistra, IV Ciban, V Fode and UBI Tilişca where 70% of tree composition consists of spruce and fir trees, their age ranging between 50-125 years.

The number of moths captured varied annually, most likely due to variations in annual weather and the dynamics of the defoliator population, especially in the studied area of spruce and fir trees, in the Forest Range of Miercurea Sibiului. In 2012 it was recorded the highest number of insect copies captured: 2,567, followed by 2013 with 2,157 insect copies, then 2011 with a total of 1,989 males captured. In 2015 it was recorded the capture of 1,179 insect copies; the fewest captures were in 2014, when it was recorded 781 male insects captured (see Table 1).

Results of the captures in different types of traps are presented in Fig.4.

Regarding the average captures made on in different repetitions, it was ascertained that there are differences between them, this fact proving the influence of the stationary conditions both on the pheromone attraction and on the level of the insect populations.

Fig. 3. Atralymon pheromone traps (orig.)

Table 1. The disposition in the forest of the traps placed on the tree trunks in the four production units and monitoring the captures *of Lymantria monacha* L., 1758, during 2015

UP	Surface (ha)	Tree composition	Age of the trees (years)	Average number of moths captured in a pheromone trap / Tree number/ha)	Traps installed/ captures number
III BISTRA	4.300	8Mo2Fa	50-110	21.86 moths/993 trees	29 traps/634 moths
IV CIBAN	2.400	10 Mo	50-120	13.46 moths/1150 trees	29 traps /391 moths
V FODE	2.000	10 Mo	85-125	5.87 moths/582 trees	23 traps/ 135 moths
U.B.I. TILIŞCA	800	10 Mo	50-120	4.75 moths/367 trees	4 traps/19 moths
TOTAL	9.500			13.87 moths/773 trees	85 traps/ 1179 moths captured

The number of moths captured in the downstream panels (traps 59 and 81) was larger than the number captured in the panels located upstream (traps 1 and 29), respectively 634 compared with 135.

This situation can be explained by interpreting the ecology of the moth and the direction of air currents when adults are active. Previous research [8-12] has shown that the adult activity mainly takes place between 22.00-04.00, with the peak 23.00-01.00.

These flight intervals vary, depending on local weather conditions and microclimate factors.

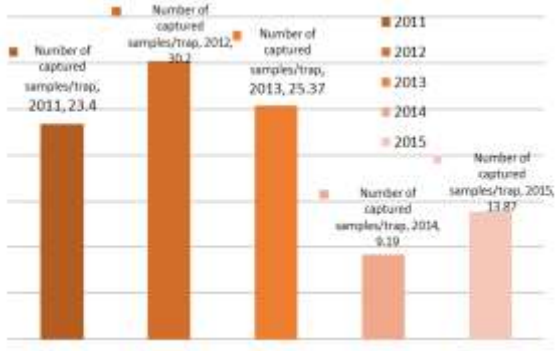

Fig. 4. Number of insect copies captured in a trap

The movements of air masses in the slopes, respectively in experimental areas, are governed, in the absence of strong winds, by the mountain breeze. This breeze causes descending air currents on the slopes and along the valleys. By combining the two components of the direction of the air movements, it is obtained a result which goes over the slope from upstream to downstream, intersecting obliquely the contour lines.

Under these circumstances Atralymon, which is a volatile product, is carried downstream by the mountain breeze and is received by *Lymantria monacha L.* 1758 males. The flight of the male moths will follow the direction of the mountain breeze, but to the opposite direction, to the source which is spreading the substance attractive for them. In their nocturnal flight, the moths will meet mainly the panels 59-81.

The discrepancies between the captures from the traps located downstream and those located upstream recorded values of 9.19 % in 2014, 13.87 % in 2015 and values ranging between 23.40-30.20% in the period 2011-2013 (Fig.4).

Duration and dynamics of the flight

Lymantria monacha was on the wing from July-September, but the beginning and the end of the flight varied, depending on year and trap location. The flight dynamics in the four production units: III Bistra, IV Ciban, V Fode and UBI Tilişca studied during the years 2011-2015. The occurrence of two broods of *Lymantria* monacha is indicated only by data from the III Bistra area, where a higher discontinuity in all years of study is remarked. However, until the genetic data, which must prove the existence of two or more populations of *Lymantria monacha* L., 1758 in the area, are not obtained, this assumption cannot be scientifically sustained.

Over the five-year study period, most captures were made from mid-July to the end of August. A later peak with lower abundance was noted in 2012, presumably due to unseasonally wet and cool weather.

CONCLUSIONS

During the activity of mounting the pheromone traps panels in the Forest Range Miercurea Sibiului, which were utilized to detect and capture the pest, it was ascertained, over the years, that the traps are more effective if mounted on the downstream side of the tree trunk, as in this position the captures are 20-35% higher than on the upstream side of the same trunk.

The flight of the moths in the four investigated areas: III Bistra, IV Ciban, V Fode and UBI Tilişca started during the second and third decade of July, earlier or later, subject to the local conditions of standing and arboretum.

The flight activity took place mostly until the first decade of August, when over 75% of all males was captured. From this point of view and considering the yearly captures, the development of the flights in 2012 was similar to 2013, respectively 2015 and 2014, when it registered a postponement of the captures towards the autumn.

Moth density (number of male/trap) was significantly influenced by the changes in maximum temperature in May each year, by the precipitations recorded during the flight period and by the annual aridity. The level of the captures is positively correlated with maximum temperature and negatively with the precipitations and the index of aridity.

Density measures for 2011-2015, indicate the moth was at latent levels, with no evidence of an imminent outbreak.

REFERENCES

[1] Altenkirch, W., Huber, J., Krieg, A., 1986, Field trials on the biological control of the nun moth (*Lymantria monacha*). Zeitschrift für Pflanzenkrankheiten und Pflanzenschutz, 93(5):479-493.

[2] Bejer, B., 1988, The nun moth in European spruce forests. In Berryman AA, ed. Dynamics of forest insect populations: Patterns, causes, implications. New York, USA: Plenum Press, 211-231.
[3]Dziadowiec, H., Plichta, W., 1985, The effect of nun moth (Lymantria monacha L.) outbreak on characteristics of litter fall in the pine forest. Ekologia Polska, 33(4):715-728.
[4]Fuester, R.W., Drea, J.J., Gruber, F., 1975, The distribution of *Lymantria dispa*r and *L. monach*a (Lepidoptera: Lymantriidae) in Austria and West Germany. Zeitschrift fur Pflanzenkrankheiten und Pflanzenschutz, 82(11/12):695-698.
[5]Gruber, F., Fuester, R.W., Drea, J.J., Jr, 1978, Distribution of *Lymantria dispar* (L.) and *L. monacha* (L.) in France (Lepidoptera, Lymantriidae). Annales de la Societe Entomologique de France, 14(4):599-602.
[6]Humphreys and Allen, 2002, Part II profiles of selected forest pests Insect pests, 103-105.
[7]Keena, M.A., 2003, Survival and development of *Lymantria monacha* (Lepidoptera: Lymantriidae) on North American and introduced Eurasian tree species. Journal of Economic Entomology, 96(1):43-52.
[8]Mihalciuc, V., Diter S., Olenici, N., Creangă, I., Bândiu, C., Ghizdavu, L., Ceianu, I. Simionescu, A., 1988, The establishment of *Lymantria monacha* population dynamics and technologies of warning against the mass propagation - the early detection of mass propagation to prevent the attacks by the application of control measures in due time. Final scientific report. Manuscript I.C.A.S. Bucharest, 55 pp.
[9]Mihalciuc, V., Simionescu, A., 1989, Considerations about the evolution of *Lymantria monacha* populations all over the country during the period 1974-1986. Forests Magazine, (1): 31-33.
[10]Mihalciuc, V., Mircioiu, L., I. Oprean, 1997, The influence of climatic factors on the numerical variation of *Lymantria monacha* populations in Romania. In: Knizek, M., Zahradní, P. Divis, K. (eds.) Proceedings of the Workshop on Forest Insects and Disease Surey, Pisek, Czech Republic, April 7-10, 1997, Forestry and Game Management Research Institute Jiloviste - Strnady, Prague, 119-131.
[11]Mihalciuc, V., Olenici, V., Mircioiu, L., Bujilă, M., Oprean, I., Tautan, L., Gânscă, L. Chis, V. Popovici, N., Pop, L. Gocan, A., Ciupe, H., Olenici, N., 1998, Research on pests dangerous for species of coniferae. Final scientific report. Manuscript I.C.A.S. Bucharest, 118 p. + 24 annexes.
[12]Mihalciuc V., Mircioiu L., Mihalciuc A., 2000, Improved detection and control of *Lymantria monacha* L., Forestry Bucovina VIII 1. Research Articles 8 (1): 1-14.
[13] Peng Wang, Guo Fa Chen, Jun-Sheng Zhang, Qi Xue, Jin-Hua Zhang, Chao Chen, Qing-He Zhang, 2016, Pheromone trapping the nun moth, *Limantria monacha* (Lepidoptera: Lymantriidae) in inner Mongolia, China, Insect Sci Apr 28.
[14] Schwerdtfeger F, 1981, Die Waldkrankheiten. Vol.4. Hamburg/Berlin: Paul Parey.
[15]Schmutzenhofer, H., 1986, Monitoring and disruption of mating of the nun moth, *Lymantria monacha*, with the pheromone disparlure. Anzeiger fur Schadlingskunde, Pflanzenschutz, Umweltschutz, 59(7):125-130.
[16] Stancă-Moise, C., 2014, Controlul populațiilor de dăunători, Editura Universitatii Lucian Blaga din Sibiu.
[17] Stancă-Moise, C., 2014, Method of analysis for population limitation of the lepidoptera pest in fruiters (Lepidoptera: Tortricidae) in Sibiel village, Sibiu city in conditions of year 2013. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 14(1):333-336.
[18] Stancă-Moise, C., 2014, Diversity and the main ecological requirements of the epigeic species of forest ecosystems in the Sibiu county, in the years 2013-2014. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 14(3): 323-326.
[19]Stancă-Moise, C., 2015, Contributions to (Coleoptera: Staphylinidae) in Dumbrava Sibiului forest, Romania in terms of the years 2013-2014. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 15(1):301-305
[20]Stancă-Moise, C., 2015, Observations on Coleoptera fauna from the Dumbrava Sibiului forest (Sibiu, Romania) in the 2015 yea. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 15(3):289-292
[21] Stancă-Moise, C., 2015, The presence of species *Morimus funereus* Mulsat, 1862 (long horned beetle) Coleoptera:Cerambycidae in a forest of oak conditions, 2015. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol. 15(4):315 -318.
[22]Stancă-Moise, C., 2016, Migratory species of butterflies in the surroundings of Sibiu (Romania). Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development. 16(1): 319-324.
[23]Stancă-Moise, C., 2016, Defoliating insects impacts on forest ecosystems, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development. 16(4): 339-343.
[24] Stancă-Moise, C., Blaj R., 2017, *Ips thypographus* (Coleoptera, Scolytidae) at" Ocolul Silvic Miercurea Sibiului"(Sibiu County, Romania), Analele Universitatii din Oradea, Fascicula Biologie, 24(1):14-18.
[25]Wellenstein, G., 1978, *Lymantria monacha* L., Nonnenspinner, Nonne. In: Schwenke W, ed. Die Forstschädlinge Europas. Hamburg, Germany: Verlag Paul Parey.
[26]http://www.bucovina-forestiera.ro/article/imbunatatirea-sistemului-de-depistare-si-control-a-defoliatorului-lymantria-monacha/