MONITORING AND CONTROL OF THE DEFOLIATOR POPULATION *Lymantria monacha* (L., 1758) WITHIN THE FORESTRY FIELD RĂȘINARI (SIBIU, ROMANIA)

Cristina STANCĂ-MOISE*, Tom BRERETON**

* *"Lucian Blaga" University of Sibiu, Faculty of Faculty of Agricultural Sciences, Food Industry and Environmental Protection, Sibiu, Romania*
** *Butterfly Conservation, Manor Yard, East Lulworth, Wareham, Dorset, BH20 5QP, UK*
Correspondence author: Cristina Moise, "Lucian Blaga" University of Sibiu, Faculty of Agricultural Sciences, Food Industry and Environmental Protection, 5-7 Ion Ratiu, 550371 Sibiu, Romania, phone: 0040269234111, fax: 0040269234111, e-mail: cristinamoise1@yahoo.com

Abstract. Research on the ecology, distribution and monitoring of the forest pest *Lymantria monacha* (L. 1758) (Nun Moth) has been carried out in recent years by authors in various forest areas of Sibiu county.

In this study we describe the ecology, distribution and abundance of the species *L. monacha*, related to climatic factors in each year of study, within the Rasinari Forest. For a comparative analysis of the results obtained from the number of captured specimens of this pest, we centralized the data related to the number of traps located within the forest, the maximum number of butterflies captured in the traps and the total number of butterflies counted during the period 2005-2018.

Also, there are presented aspects related to the physico-geographic conditions, climate, maximum and minimum and the composition of the stands, as well as methods for limiting the populations with the help of pheromonal traps and proposals regarding the management of this dangerous pest which is currently latent, but in the future it can extend into the perimeter of the Rășinari Forestry.

Keywords: pheromonal traps, *Lymantria monacha* (L., 1758), Forest Range Rășinari (Sibiu county, Romania)

INTRODUCTION

Lymantria monacha (L., 1758) (Nun Moth) is a moth species that is considered to be one of the most important pests of Eurasian coniferous forests, causing damage through defoliation, leading to the death of spruce and pine species [4,5]. The frequency of reported outbreaks has increased worldwide over the last 40 years and has been reported in many areas of the world over the last 6 years [3]. In parts of Europe, outbreaks have been prevalent due to the establishment of pine (*Pinus sylvestris*) plantations with low resistance to the attack of this pest [30]. This species can spread is elevated because it can be accidentally transmitted through trade between states and introduced into other coniferous forest [9].

Studies on the evolution of this pest and the control populations using pheromone traps have been made worldwide [4,18,26,27,31]. The monitoring of the species in forests in Romania has been done over time by various collectives of researchers [2,12-17,20,21,23-25]. The use of different methods in order to capture the pest, the role of natural factors (biotic factor birds, and abiotic climatic factor) in population dynamics, the study of wing coloration as a prognostic factor and the tendency of the evolution of the population of the defoliator were studied in Harghita County [13]. Previous studies have shown that it is important to protect predatory birds, that can reduce moth densities by 30-40%. Before starting to consume the butterflies caught on the glue panel, the birds require a 1-2 weeks for adaptation period until they locate the food source well, then continue this activity, recording maximum success and about a week away of the flight of adults of the butterfly *L. monacha* [13].

According to some authors[6], the ecology of *Lymantria monacha* (Nun Moth), is strongly influenced by temperature. A team of researchers from Europe recently published a study on the effect of climate change on *L. monacha* populations in Finland's forests, where significant defoliations were reported [7]. In this present study we describe the ecology, distribution and abundance of *L. monacha*, in relation to climatic factors within the Rasinari Forest, Sibiu county, Romania over the period 2005-2018.

Rasinari Forest is situated at the Latitude of 45° 42' 32" N and the Longitude of 24° 4' 14" E. The surface extends over 7730,3 hectares (ha) and forms reconstituted forest land (repatriated back to the orginal owners) under Law 1/2000. The forest can be subdivided into two main areas: Oncesti UP V (4515.1 ha) and Rasinari UP VI (3215.2 ha). From a physico-geographical point of view, the Rășinari Forest are situated in the S-E of the Cindrel Mountains, on the Sadu Valley and in the N-E of the Cibin Mountains, on the Șteaza Valley. The forests are located altitudinal between 495 m (u.a. 4A from U.B.VI) and 1900 m (u.a. 25C from U.B. V), the modal altitude being between 1200-1225 m.

In the Rasinari commune the main water sources are the Sadu River and Steaza Valley. Marked hydrological and altitudinal variation creates a varied forest structure and composition. In the hills the forest comprises *Quercus petraea* (Sessile Oak) with alder (*Alnus glutinosa*), whilst spruce (*Picea abies*) and *Fagus sylvatica* (Beech) forest and their mixtures with oak (*Quercus sp.*) and other species occur on the mountain slopes. The tree range in age from 5-120 years old. The chief habitats are: 1) Mountain slopes on skeletal soils, with mull flora, covering 788,9 ha (10% of then total) at high altitudes between 800-1200 m; 2) spruce (*Picea abies*) (forests with *Vaccinium myrtillus* (Bilberry) and *Oxalis acetosella* (Wood Sorrel), extending over 690,4 ha (9%) at altitudes between 1200-1600 m; 3) spruce forests with *Vaccinium myrtillus* covering 917,8 ha (12%) between altitudes of

1100-1800 m; and 4) spruce (*Picea abies*) with green moss totalling 1719,8 ha (22%) and only in U.B. V Onceşti, at altitudes of 1000-2000 m [19].

The soils present a variation from eumezobase browns, acid browns, luvic browns, feriiluvial browns, podzols and gleys.

The studied territory is part of the moderate, boreal, continental, and mountain climate. In Köppen's opinion [32], the region is located in the climatic province, corresponding to the high area with cool winters, precipitation all year round, with the coldest temperature below 5^{o}C and the maximum less than 18^{o}C. The average annual temperature varies between the values of 4^{0}C and 8^{0}C (mean 6^{0}C). In the warmest months (July-August) average temperatures are between 12^{0}C and 16^{0}C. The average temperature over the growing season is between 8^{0}C and 10^{0}C. The first frost usually occurs at the end of September and the last frost at the end of May [3].

Annual average precipitation ranges from 600 to 1200 mm (long-term average is 930 mm). The maximum amount of precipitation falls in June-July and the minimum in January-February. The average snow cover is 100 days. As for the wind regime, winds from the western sector have the highest frequency. Wind intensifications often occur, which cause kickbacks (at a speed of 30 m/s), especially on hills with spruce stands, where outbreaks of defoliators (*Ips typhographus, Hylobius abietis*, *Tortrix viridana*) is present. These are the subject of a future study but also about the pest population *L. monacha*.

The climate characterization of the area studied was based on the data provided by the Weather Station Sibiu [31].

The rate of survival of this species at high temperatures may affect the growth and development of the species in years of high temperatures. Therefore, in the context of global climate change, these differences may lead to changes in the distribution and spread of this insect species [10].

The study species

L. monacha shows a pronounced sexual dimorphism. The male is smaller, 35-45 mm in size and developed penateform antennae. Previous wings have black zigzag designs, and the posterior ones are gray-brown [27]. The abdomen is white, dorsal, with a black longitudinal line [28, 11]. The female is larger, with a wingspan of 45-60 mm; abdomen, to the top is colored in red. It has one generation a year. The female deposits 200-300 round eggs with a diameter of 1 mm. Eggs and the larvae hatch in the spring, when they attak the fruit first at their base [7]. Full development is achieved in 8-10 weeks when they are 40-50 mm long [11].

Studies on diapause in this species were made by researchers [18] who worked in laboratory conditions on successive age groups, incubated at 25°C then transferred to 5°C, indicating that the eggs must be at least 12-13 days to survive at higher temperatures [1].

The pupae of *L. monacha* is 15-25 mm in length, on the head with two blue short growths. The pupal stage lasts 2-3 weeks, and adult flight is signaled on mid-July and takes place in the evening and at night [16].

Table 1. The sampling points

Trap No.	Plot number	Species composition	Topographic numbering	GPS coordinates
1	57	10 Mo	135 06 IV	45° 24' 43" N, 24° 42' 11" E
2	64	10 Mo	135 06 IV	45° 23' 37" N, 24° 35' 10" E
3	87	10 Mo	130 0.5 V	45° 23' 34" N, 24° 55' 16" E
4	89	10 Mo	460 0.7 IV	45° 22' 27" N, 24° 23' 19" E
5	91	10 Mo	60 09 III	45° 22' 21" N, 24° 31' 17" E
6	93	10 Mo	55 09 III	45° 21' 37" N, 24° 25' 27" E
7	103	10 Mo	60 09 III A	45° 21' 49" N, 24° 32' 21" E
8	116	10 Mo	90 08 III	45° 20' 27" N, 24° 51' 24" E
9	120	10 Mo	50 09 III	45° 20' 29" N, 24° 19' 29" E
10	122	5 Mo 4 Fa 1 DT	45 09 III	45° 19' 27" N, 24° 13' 43" E
11	112	5 Mo 4 Fa 1 DT	45 08 III	45° 19' 21" N, 24° 45' 12" E
12	111	7 Mo 4 Fa 2 Br	150 07 III	45° 18' 13" N, 24° 21' 11" E
13	109	4 Fa 4 Mo 2 Br	20 08 II	45° 18' 29" N, 24° 10' 19" E
14	98	10 Mo	80 05 III	45° 17' 28" N, 24° 37' 15" E
15	97	10 Mo	50 09 III	45° 17' 31" N, 24° 34' 21" E
16	80	10 M0	55 09 III	45° 16' 21" N, 24° 51' 19" E
17	66	10 Mo	40 09 III	45° 16' 37" N, 24° 53' 25" E
18	61	9 Mo 1 La	25 09 III	45° 15' 16" N, 24° 52' 19" E
19	59	10 Mo	10 08 III	45° 15' 59" N, 24° 53' 21" E
20	50	9 Mo 1 DT	50 0.9 III	45° 14' 27" N, 24° 21' 17" E
21	44	10 Mo	45 1.0 III	45° 14' 53" N, 24° 21' 13" E
22	39	10 Mo	40 0.9 III	45° 23' 43" N, 24° 32' 49' E
23	34	10 Mo	45 0.9 II	45° 23' 32" N, 24° 41' 16" E
24	32	10 Mo	40 0.9 III	45° 13' 29" N, 24° 43' 34" E
25	31	10 Mo	60 0.9 III	45° 13' 31" N, 24° 32' 19" E
26	30	10 Mo	70 0.9 III	45° 12' 17" N, 24° 21' 47" E
27	29	10 Mo	60 0.9 III	45° 12' 57" N, 24° 25' 13" E
28	23	10 Mo	70 0.8 III	45° 11' 48" N, 24° 32' 16" E
29	18	10 Mo	60 0.9 IV	45° 10' 25" N, 24° 31' 51" E
30	17	10 Mo	60 0.9 IV	45° 12' 37" N, 24° 26' 24" E

Abbreviations: Mo-spruce, Br-fir, Fa-beech

MATERIALS AND METHODS

Pheromone trapping

As a method of limiting the populations of this pest, in the Rasinari Forestry Center are used for many years panels with Romanian synthetic pheromone *Atralymon* [29] which are used in spruce and fir (*Abies alba, Pinus sylvestris*) stands or the mixture of these species with beech (*Fagus sylvatica*), in which spruce (*Picea abies*) and fir participate with over 30%, regardless of the tree age. The pheromone that is a sexual attractant emitted by the female can be used both for detection purposes and as a means of interrupting mating [8] those captured being male only. The capture of the species *L monacha* in forest is done with the help of panel-type adhesive gripping traps placed on tree trunks in the areas of known occurrence, with the bait being fixed in the centre of the panel. The dynamics of the number of catches by climatic factors (Table 2) were also observed in numerical variations of populations. Data obtained from 2005-2018 on catches of panel-type pheromone traps used in the two production units Oncesti UP V and Rasinari UP VI have also been used to determine the duration and dynamics fly of butterflies (Table 1).

Study period, trapping intensity and climate data

The present work has made an important contribution to the study of the pest evolution during the period 2005-2018 (Table 2), in the area of the Rasinari Forestry, where 459 traps were located and they served an area of 5397.9 hectares of forest. The production units monitored were: Oncesti UP V and Rasinari UP VI, where the composition of the forest is at least 30% MoBr (spruce-fir) and the tree age is between 5-120 years.

In the Silvic Rășinari Field studied region, are the following climatic variables: the minimum winter temperature; the average temperature over the years; as well as the maximum and minimum (Table 3) have influenced the egg, larval and adult flight stages of this species, as well as its evolution within the studied area.

RESULTS

The results of the catches for the 14 years of study are shown in Table 1, whilst climate data collected is shown in Table 2. In total, there are 2.179 specimens of which 199 were captured at the trap. There was high inter-annual variability in numbers. Between 2005 and 2007, the number of captured specimens was insignificant (2-18 specimens), highllight no outbreak in the pest population. Most specimens were collected in 2010 (405 specimens), followed by 2008 (337 specimens) and 2013 (334 specimens) years where the average annual temperatures were between 11-11.4°C, the minimum temperatures were between -13.9°C and -23.9°C and the maximum 32.6°C and 34.6°C.

Capturing of between 201 and 260 specimens were made in 2011 and 2012, when average annual temperatures were between 10.1°C and 11.6°C, the minimum temperatures were between -20.2°C and -22.1°C, and the maximum temperatures had values between 32.7°C and 37.9°C.

Between 2014 and 2016, the number of captured specimens was down to between 51-84 specimens, average annual temperatures were between 11.1-11.7°C, minimum temperatures -9.8°C and -25.2°C, while the maximum temperatures exceeded 32°C.

In 2017, the infested area was 343 ha, the number of captured specimens being 119 individuals showing a decrease in the average temperature of the year to 10.8°C, a decrease in the minimum temperature to -27.7°C and a rise in the maximum temperature to 35.7°C. In 2018 the number of captured specimens remained constant as in the previous year, which certifies that the species is in a latent state of pest evolution due to climatic conditions in recent years, extreme winter temperatures and high temperatures in the summer during the flight period of the species (July-September). In 2012, 2014 and 2018, when the average annual temperatures were between 11.6 and 11.9 °C, the number of captured was lower. From the analysis we can conclude that the influence of minimum temperatures seems to be insignificant.

Table 2. The evolution of the harmful dangerous *L. monacha* in the Rasinari Forest, during 2005-2018

Year	Total nr. of placed traps	Total nr. of maximum captured moths with lure	Total nr. of moths	Average temperature (°C)
2005	24	1	2	+10.3
2006	25	2	8	+9.7
2007	30	2	18	+11.5
2008	30	39	337	+11.2
2009	30	15	186	+11.2
2010	40	26	405	+11.0
2011	40	19	201	+10.1
2012	40	18	260	+11.6
2013	40	23	334	+11.4
2014	40	4	51	+11.7
2015	40	13	55	+11.4
2016	20	10	84	+11.1
2017	30	17	119	+10.8
2018	30	10	119	+11.9
Total	**459**	**199**	**2179**	

Table 3. Average, minimum and maximum temperatures over the yesterday 2005-2018

Year	Average temp. (°C)	Minimum temp. (°C) (date)	Maximum temp. °C (date)
2018	+11.9	-16.8 (01.03.2018)	+30.5 (02.08.2018)
2017	+10.8	-27.7 (10.01.2017)	+35.7 (05.08.207)
2016	+11.1	-22.1 (20.01.2016)	+33.1 (17.06.2016)
2015	+11.4	-25.2 (01.01.2015)	+34.0 (20.07.2015)
2014	+11.7	-9.8 (31.01.2014)	+32.6 (13.08.2014)
2013	+11.4	-13.9 (10.01.2013)	+34.6 (29.07.2013)
2012	+11.6	-22.1 (01.02.2012)	+37.9 (25.08.2012)
2011	+10.1	-20.2 (31.01.2011)	+32.7 (13.06.2011)
2010	+11.0	-23.9 (25.01.2010)	+33.2 (13.06.2010)
2009	+11.2	-18.1(10.01.2009)	+32.2 (03.08.2009)
2008	+11.2	-17.1 (05.01.2008)	+33.7 (15.08.2008)
2007	+11.5	-8.8 (06.02.2007)	+37.3 (24.07.2007)
2006	+9.7	-22.1 (25.01.2006)	+31.6 (20.08.2006)
2005	+10.3	-23.2 (10.02.2005)	+31.9 (31.07.2005)

Abbreviations: u.a.- territorial administrative unit; U.P.- production unit; U.B.-basic unit; Mo-spruce; Br-fir

However, there is a positive correlation between average temperature values and the number of captured in 2010, 2008 and 2013, when the dynamics of captured during these years could be influenced by the contribution of insectivorous species and the precipitation regime.

DISCUSSION

After centralizing the data obtained between 2005-2018, following the monitoring of the species, a slight attack of the *L. monacha* pest was observed, which was in a latent state. As measures to protect the forestry fund in the case of a low degree of infection, we recommend an effective prophylactic control. In order to maintain a good phyto-sanitary condition of the in Rasinari Forest, the following measures are proposed: increase of the number of trees with traps for capturing males and use in an optimal number of pheromone traps; peeling of resinous trunks where outbreaks of this pest may develop; to cleanse the forest as efficiently as possible; the preservation of natural forests and the promotion of resistant coniferous species that are specific to the area; afforestation of the gaps in the perimeter of the forest, prohibition of grazing and resin collection. It is known that the inhabitants of Rășinari are famous sheep breeders.

Similar studies have been conducted in different collective forest areas of researchers [14-17], in the Harghita area, more precisely in the Gurghiu area and the Lunca Bradului area [2] in the Sibiu County by the same team of authors in the forest areas of the Forest Range Miercurea Sibiului, Săliște and Sibiu [22-25]. At European level, research has been carried out to spread and limit populations of this defect in Poland [4], Germany and Austria [5] but also in other countries [6-10]. The results of the monitoring in our country by pheromonal method of the species *L. monacha* led to the conclusion that on large forest areas the pest was in the latency phase. At the level of Sibiu county, outbreaks have been detected in large areas within the Forest Range Miercurea Sibiului, where measures have been taken to limit the population of the pest. At the level of Europe the attack of this pest has spread and significant areas of forest have been affected.

Considering that some stands have advanced attak of old oak trees (*Quercus petraea, Quercus robur*) shoots and vitality in decline, are required to continuously pursue their vegetation status as they are very vulnerable to the action of the pests in which is the case of the studied species *L. monacha*. If the attack of diseases and pests in the coming years will increase alarmingly, chemical combats are not excluded, but they are recommended to be made on small surfaces in order not to destroy useful entomofauna, applying the method only in extreme cases.

REFERENCES

[1] Bell, R.A., (1996): Manipulation of diapause in the gypsy moth, *Lymantria dispar* L., by application of KK-42 and precocious chilling of eggs. Journal of Insect Physiology, 42: 557–563.

[2] Bexa, A., Oltean, I., Florian, T., Micu L. M., Varga, M., (2013): Monitoring *Lymantria monacha* L. species using the excrements method in Lunca Bradului Forestry District in 2013. Bulletin UASVM Agriculture. Anul V, 3,4 (17): 1-7.

[3] CABI (2015). Inv asive Species Compendium: *Lymantria monacha* (nun moth). http://www.cabi.org/isc/datasheet/31811 accessed on 8 March 2018.

[4] 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.

[5] 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.

[6] Fält-Nardmann, J., Tikkanen, O.P., Ruohomäki, K., Otto, L.F., Leinonen, R., Pöyry, J., Saikkonen, K., Neuvonen, S., (2018): The recent northward expansion of *Lymantria monacha* in relation to realised changes in temperatures of different seasons, Forest Ecology and Management, 427(1): 96-105.

[7] Fält-Nardmann, J.J.J., Ruohomäki, K., Tikkanen, O.P., Neuvonen, S., (2018): Cold hardiness of *Lymantria monacha* and *L. dispar* (Lepidoptera: Erebiidae) eggs to extreme winter temperatures: implications for predicting

climate change impacts. Ecological Entomology, 43: 422-430.
[8] Humphreys, N., Allen, E., (2002): Nun moth - *Lymantria monacha*. Exotic Forest Pest Advisory 6, Victoria, BC, NRC, CFS, Pacific Forestry Centre, pp. 4.
[9] Hydén, N., (2006): *Lymantria monacha* barrskogsnunna and Lymantria dispar lövskogsnunna. In: Hydén N., Jilg K. & Östman T. (eds.), The National Key to Flora and Fauna of Sweden. Lepidoptera: Lasiocampidae – Lymantriidae. ArtDatabanken, Sveriges lantbruksuniversitet, Uppsala, pp. 424–429.
[10] Karolewski, P., Grzebyta, J., Oleksyn, J., Giertyvh, M.J., (2007): Effects of temperature on larval survival rate and duration of development of *Lymantria monacha* (L.) on needles of *Pinus sylvestris* (L.) and of *L. dispar* (L.) on leaves of *Quercus robur* (L.). Polish Journal of Ecology, 55: 595-600.
[11] Kimoto, T., Duthie-Holt, M., (2006): Exotic Forest Insect Guidebook 2006. Ottawa, Canadian Food Inspection Agency, originally published in 2004. 124 p.
[12] 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 p.
[13] 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.
[14] Mihalciuc, V., Mircioiu, L., Oprean, I. (1997): The influence of climatic factors on the numerical variation of *Lymantria monacha* populations in Romania. pp. 119-131, 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.
[15] 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., 118 p.
[16] Mihalciuc, V., Mircioiu, L., Mihalciuc, A., (2000): Improved detection and control of *Lymantria monacha* L., Forestry Bucovina VIII 1. 8(1): 1-14.
[17] Oltean, I., Porca, M.M., Horia, B., Bodis, I., (2003): *Lymantria monacha* L. species monitoring with the aid of sexual attractants. Journal of Central European Agriculture, 4(3): 245-250.
[18] Skuhravý, V., (1987): A review of research on the nun moth (*Lymantria monacha* L.) conducted with pheromone traps in Czechoslovakia, 1973–1984. Anzeiger für Schädlingskunde, Pflanzenschutz, Umweltschutz, 60: 96–98.
[19] Schneider-Binder, E., (1973): Pădurile din depresiunea Sibiului și dealurile marginale. Studii și Comunicări Științele Naturii. Brukenthal Press, Sibiu, 18: 71-100.
[20] Stancă-Moise, C., (2014): Controlul populațiilor de dăunători. Editura Universitatii Lucian Blaga din Sibiu, 224 p.
[21] 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.
[22] 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.
[23] Stancă-Moise, C., Brereton, T., Blaj, R., (2017): 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. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 17(4): 327-331.
[24] Stancă-Moise, C., Blaj, R., Sbîrcea, S., (2018): The forestry ecosystems management in the Forest District Sibiu, against the defoliator species *Lymantria monacha* L., 1758 (Lepidoptera: Lymantriidae) during the period 2013-2017. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 18(1): 473-476.
[25] Stancă-Moise, C., Brereton, T., Blaj, (2018), New contributions to the knowledge of the pest *Lymantria monacha* l. 1758 (Lepidoptera, Lymantriidae) populations by pheromonal traps within the Forest District Miercurea Sibiului (Romania) during the year 2017. Analele Universității din Oradea, Fascicula Biologie, 25(1):19-25.
[26] Wallner, W.E., (2000): *Lymantria monacha*. NAFC-ExFor Pest Report. Created 1998, modified 2000. (available at: http://www.fao.org/forestry/13571-0a6f529afd04cc3d5bcd60e24bafab2fa.pdf).
[27] Withers, T.M., Keena, M.A., (2001): *Lymantria monacha* (nun moth) and *L. dispar* (gypsy moth) survival and development on improved *Pinus radiata*. New Zealand Journal of Forestry Science, 31: 66-77.
[28] https://www.protectiapadurilor.ro/nade-feromonale/23-nada-feromonala-lymodor.html (accessed on 31 June 2019)
[29] http://feromoni.iccrr.institute.ubbcluj.ro/?page_id=71 (accessed on 11 June 2019).
[30]http://www.utupub.fi/bitstream/handle/10024/145847/AnnalesAII347_Julia_Falt-Nardmann.pdf?sequence=1&isAllowed=y (accessed on 10 June 2019).
[31]https://rp5.ru/Arhiva_meteo_%C3%AEn_Sibiu_(aeroport) (accessed on 6 June 2019).
[32]https://www.hydrol-earth-syst-sci.net/11/1633/2007/hess-11-1633-2007.html (accessed on 2 November 2019).

Received: 18 June 2019
Accepted: 24 February 2020
Published Online: 26 February 2020
Analele Universității din Oradea, Fascicula Biologie
http://www.bioresearch.ro/revistaen.html
Print-ISSN: 1224-5119
e-ISSN: 1844-7589
CD-ISSN: 1842-6433
University of Oradea Publishing House