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Forecasting defoliators found in Transylvanian oak forests

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Abstract. The purpose of this paper is the early prevention of pest occurrence in a given area, by applying at the right time, optimal control measures, before the pest can produce powerful attacks. The forecast can be made on short or long periods. The studies and analyses conducted in the Transylvania deciduous forests have shown that the most affected forest formations are those of oaks. Beech forests and especially pure forests are rarely affected by pests and even less by defoliating insects. In the case of the Forest District Ulmeni, the Forestry Department Baia Mare was observed a gradation of the defoliator *Lymantria dispar* in the pure beech stands in the spring of 2007, but was stopped after the application of an AVIO treatment. The analyzed defoliators *Lymantria dispar* and *Tortrix viridana* are in gradation in all the studied forest formations in most cases but without producing significant defoliations, except for the trees located within the Forestry Department Satu-Mare, the Forest District Carei and the Forest District Livada. The laboratory analysis performed at ICAS Cluj Research Station show that setting the forecasting for the main forestry defoliators is absolutely necessary and must be carried out every year, and that through the proposed measures is maintained the integrity and stability of the forest stands. The indirect density determination of the defoliating populations can be performed with sufficient precision in the egg stage from the qualitative analysis of the *Lymantria dispar* eggs and from the sequential analyses of *Tortrix viridana*. Long-term forecasting for the populations evolution of the two defoliators can be achieved by creating a system of permanent monitoring networks with variable density (between about 30 and approx. 300-500 ha), according to the history of attacks, the degree of forest stands fragmentation, phytosanitary and vegetation estate, the particularities of the climate regime. Besides the defoliators for which was conducted the forecast in 2014, it also presents a gradations risk in the studied area *Euproctys chrissorhoea*, *Malacosoma neustria* and various species of Geometridae.

Introduction. Protecting forests from the negative action of the biotic factors likely to endanger their existence, or to reduce their capacity of fulfilling ecological, or productive functions, assumes also among the knowledge of injury symptoms an appropriate technique for applying the protection measures (Meijerman & Ulenberg 2004; Şimonca et al 2011; Burduhos et al 2013). In this context a special role is assigned to the detection and forecast of harmful insect populations (Dissescu 1966; Fratian 1973; Prokopenko 1992; Marcu & Dieter 1995; Voicescu et al 2002; Tomescu & Neţoiu 2006; Şulea et al 2013).

In Transylvanian forests, in which are often found ecological imbalances or abnormal conditions, the most important damages are produced by defoliating insects in the bulk propagation period (Rudnev 1962; Gottschalk 1990; Netoiu & Taut 2006; Marc & Péré 2006; Meshkova 2007). Thus, it was found that from the total surface area of about 985.000 ha represented by the deciduous forests (52%), preponderant are pure or mixed oaks stands. For this reason and with priority in this mentioned forest groups studies were carried out on the prognosis of injuries.

These studies have taken into account the features of harmful insect populations (density, fecundity, gender ratio, natural mortality and external appearance).

In order to restore the ecological balance in these stands, are required the use of various means for maintaining under control the mass multiplication of pests, pest forecasting being the first mean under accessible level, reachable to forest engineers, serving to the best knowledge of the dynamic evolution of harmful population but also to anticipate the manifestation of limitative factors.

The purpose of this paper is the early prevention of pest occurrence in a given area, by applying at the right time, optimal control measures, before the pest can produce powerful attacks.

Material and Method. The knowledge of the phytosanitary estate is achieved through an informational system based on collecting the field data previously mentioned, their enrollment in technical and statistical records, the interpretation of these results and the report of pest occurrence, by indicating the development evolution of the population concerned (latency or gradation-with the four phases, namely: the early phase, the numerical growth phase, the eruption phase and the critical phase).

Further on, the signaling reports are checked and surfaces are determined by intensity degree after methodologies and specific values for each pest in part, operation which is called screening.

As we presented above, the purpose of this research is to make possible the early prevention of pest occurrence in a given area, by applying at the right time, optimal control measures, before the pest can produce advanced attacks. The forecast can be made on short or long periods.

The detection and forecasting of forest pests represents an important measure in the forest protection activities, due to their action, the health state of forests can be known at any time of the year (Order no. 454 from 07/14/2003).

Establishing a forecast which can reflect the real situation in the forest, requires sampling from control surfaces permanent placed in stands where gradations exist or in favorable areas. From these areas will be obtained the information, both quantitative and qualitative data, and the possible injury rate for each pest in part.

The main pests, for which the forecasting is done, are shown below in Table 1, from which it can be seen that damages can appear both at seeds (stored acorn), as well as at seedling roots, in nurseries or in stands. This paper presents the forecast for the main defoliators of oaks stands.

Table 1

List of main pests that cause damages to forest crops and stands with oaks species in their composition, and for which can be achieved forecasting and control measures

Pests (Scientific name, popular name)	Damages
Melolontha melolontha - May beetle *Melolontha hippocastani* – Forest beetle *Amphimallon solstitialis* – June beetle *Polyphylla fullo* – Grained beetle	Causes damages mainly by biting the roots (larvae) in nurseries and plantations and adults leave stands leafless
Gryllotalpa gryllotalpa – fen cricket *Agriotes lineatus*, *A.ustulatus* – wire larva	In nurseries
Lymantria dispar – the hairy caterpillar of oaks *Tortrix viridana* – the green moth of oak *Malacosoma neustria* – the ring worm *Euproctis chrysorrhoea* – the butterfly with gold tail *Thaumatopoea processionea* - the oak caterpillar *Operophtera brumata* - cotar *Erannis sp*. – cotar *Tischeria complanella* – the mining moth of oak *Haltica quercetorum* – the beetle leaf of oak	In oaks forests, by tree defoliation
Aspeyresia splendana – the acon cartepilar *Balaninus glandinum*- the acon rammer	At acorns from storage spaces

Quantitative data refers to population density, expressed as the ratio between the number of insects at the unit of measure, as the case may be, tree, branch, bud or surface. Here we also discuss about the population growth coefficient R, which represents the ratio between the current population density (d1) and the population density from the previous year of mass multiplication (d2). Finally, also at quantitative data, we talk about frequency, as the ratio between the number of attacked trees and the total controlled trees.

The most important qualitative elements that give guidance on the future evolution of caterpillar populations are the gender report or sexual index (or) female fecundity and parasitism.

Fecundity is a mixed element. From the qualitative point of view provides information on the gradation phase and direction where is heading and from the quantitative point of view, is essential for determining the populations density of insects in the egg stage. It's easily and accurately determined for species that lay eggs grouped in a single deposit.

Fecundity is the element depending on which is being established the graduation phase and the sexual index (I) as the ratio between the number of females (F) and the total number of insects (F + M); I = F/F + M.

Depending on these items is being established the defoliation percentage as the ratio between the population density (d), and the critical number (n).

These elements were considered for defoliators *Lymantria dispar* and *Tortrix viridana.*

Results and Discussions. Analyses were carried out in deciduous forests, specifically in oaks forests from the Transylvania Forestry Directions, namely the private Forest Districts in this area, for the main defoliators, namely, *Lymantria dispar* and *Tortrix viridana.*

The detection and the forecasting of the defoliator *Lymantria dispar*. *Lymantria dispar* (the hairy caterpillar of oak) is the pest with the highest propagation potential. Over the time, the defoliator has formed graduations of amplitude, especially in oak forestry formations.

Reports on the defoliator's presence were done in all of its development stages and the detection of infested areas on which eggs were deposit, was made during September 2013 - February 2014 (Table 1).

The data in Table 2 show that from all the 14 analyzed samples from four forestry departments and six private forest districts, only in two samples the defoliator is found in the I-II phase of graduation, namely at the Forest District Tinca and at the Forest District Măgura Şimleul Silvaniei, the rest were found in phase III-IV, so in retrogradation.

From of the analyses obtained and presented in Table 2, it appears that the defoliator *Lymantria dispar* will not produce significant damages in the spring of 2014 in Transylvanian forests, and the corresponding areas for the analyses carried out, will be introduced in the surveillance zone.

Tracing and forecasting the defoliator *Tortrix viridana*. *Tortrix viridana* (the green moth of oak) is the defoliator with the highest spreading in the oak area, which is confirmed also by our studies and analyses.

As well as for the previous defoliator, the detection and forecasting can be done in all the development stages, but most accurate date are obtained by egg forecasting.

This consists in the analysis of six branches for at least 1 m in length each, from a tree, two branches from the base, two from the middle and the other two from the top of the crown. These trees, usually three in a parcel, must be evenly distributed in the forest. On each branch are counted the developed buds and by using the binocular the eggs are identified. The data obtained from the samples analyzed are presented in the Table 3.

Table 2

Results of the analyses carried out on the populations of the defoliator *Lymantria dispar* within the forecast of year 2014

No.	Forestry Department	Forest District	Forest body (U.P., u.a.)	The number of analysis report	Qualitative characteristics					
					g.med. /dep.	Fertilized	Parasited	Sterile	Viable	Gradation phase
1	Bihor	Oradea	Lăzăreni	23	0.409	533.6	8.0	0.4	488.6	III
			Apateu		0.4	522.7	7.2	0.6	479.7	III
			Boboştea		0.422	549.2	8.5	0.9	497.2	III
			Ateaş		0.46	595.0	9.8	0.6	533.0	IV
			Chişirid		0.423	550.4	10.8	0.2	489.4	IV
			Mihişuş Mare		0.452	585.4	5.5	0.7	549.1	III
			Mihişul Mic		0.343	454.1	8.0	1.0	413.1	III
			Nojorid		0.35	462.5	9.7	0.5	415.3	IV
			Lemnul Morii		0.5	643.2	8.2	1.0	584.0	III
			Şuhaida		0.401	524.0	9.1	0.5	473.7	III
		Marghita	I, 45-62	31	0.353	466.1	19.8	1.0	369.1	IV
			II, 25-27		0.138	207.1	28.6	0.8	146.1	IV
			II, 40-46		0.432	561.3	9.4	0.3	506.9	III
			III, 13-62		0.394	515.5	6.6	0.8	477.4	III
			IV, 90-149		0.296	397.4	8.6	0.6	360.4	III
		Săcueni Bihor	II, 50-106	32	0.39	510.7	6.6	0.5	474.4	III
			III, 14-69		0.146	216.8	18.4	4.4	167.4	IV
			IV, 1-96		0.196	277.0	26.8	2.8	195.0	IV
		Tinca	I, 149-173	17	0.432	524.5	7.7	0.4	482.5	I-II
			I, 66-127		0.52	630.5	8.4	0.3	575.5	I-II
			I, 1-90		0.432	524.5	12.8	1.7	448.5	I-II
			II, 1-90		0.44	535.1	7.6	0.5	492.1	I-II
			III, 42-50		0.46	558.2	6.5	0.5	520.2	I-II
2	Maramureş	Şomcuta Mare	IV, 31-44	30	0.276	332.5	10.8	0.8	293.5	IV
3	Satu Mare	Satu Mare	III, 19-35	20	0.452	585.4	11.4	0.3	516.9	IV
			III, 4-18		0.451	584.1	13.3	0.5	503.1	IV
			V, 85-89		0.493	634.7	6.3	0.9	588.7	III
			V, 51-72		0.505	649.2	15.6	0.5	544.2	IV
		Tăşnad	I, 15-31	22	0.523	670.9	12.6	-	585.9	IV
			II, 14-57		0.42	547.0	8.8	0.4	496.7	III
			III, 27-57		0.42	547.0	8.5	0.3	498.9	III
			IV, 8-52		0.63	799.8	10.0	0.5	715.8	IV
			V, 22-94		0.44	571.0	10.9	0.1	508.0	IV
			VI, 6-45		0.514	660.0	11.8	0.2	580.8	IV
			VII, 14-61		0.51	655.2	11.4	0.5	577.2	IV
4	Zalău	Măgura Şimleul Silvaniei	I, 56	19	0.513	658.8	5.8	0.5	617.3	I-II
5	ITRSV Oradea	Sfânta Ana	I, 102-109	52	0.283	381.8	7.8	1.4	346.7	III
			VI, 123-125		0.22	305.9	15.8	0.6	255.7	IV
			VI, 163-164		0.276	373.3	11.4	0.4	329.3	IV
			VII, 4		0.143	213.1	14.2	2.6	177.1	IV
			VII,69-71		0.286	385.4	11.4	1.2	336.8	IV
			VII,107-113		0.259	352.9	12.7	0.6	306.9	IV
		Codrii Beiuşului	I, 25	51	0.503	646.8	7.9	0.4	592.8	III
			II,24-30		0.55	703.4	5.8	0.3	660.4	III
		Salcâmul Ciumeşti	II,28-39	50	0.353	466.1	19.8	1.0	369.1	IV
			II, 1-7		0.138	207.1	28.6	0.8	146.1	IV
			IV,60-64		0.296	397.4	8.6	0.6	360.4	III
		Brătcuţa R.A.	I-II,142-144	45	0.693	875.7	7.8	0.4	803.7	I-II
			I-VII,106-110		0.305	408.3	14.2	1.6	356.0	IV
		Ardud R.A.	IV, 1-3	42	0.454	587.8	13.3	0.7	505.5	IV
			IV,48-88		0.343	454.1	13.9	0.5	388.7	IV
			IV,5-18		0.344	455.3	12.7	0.5	395.2	IV
			V,54-59		0.261	355.3	13.4	0.8	304.8	IV
			Pir		0.405	528.7	14.5	0.3	450.5	IV
		Codrii Sătmarului R.A.	III,50-53	29	0.533	658.8	10.0	1.1	607.0	IV
			IV-V,1,49		0.29	390.2	16.1	0.5	325.2	IV
			VII,19-44		0.44	570.9	12.1	0.6	497.9	IV
			I-IV,21-50		0.57	727.5	12.5	1.0	629.3	IV
			IV,74-77		0.378	496.2	10.8	0.8	11.6	IV

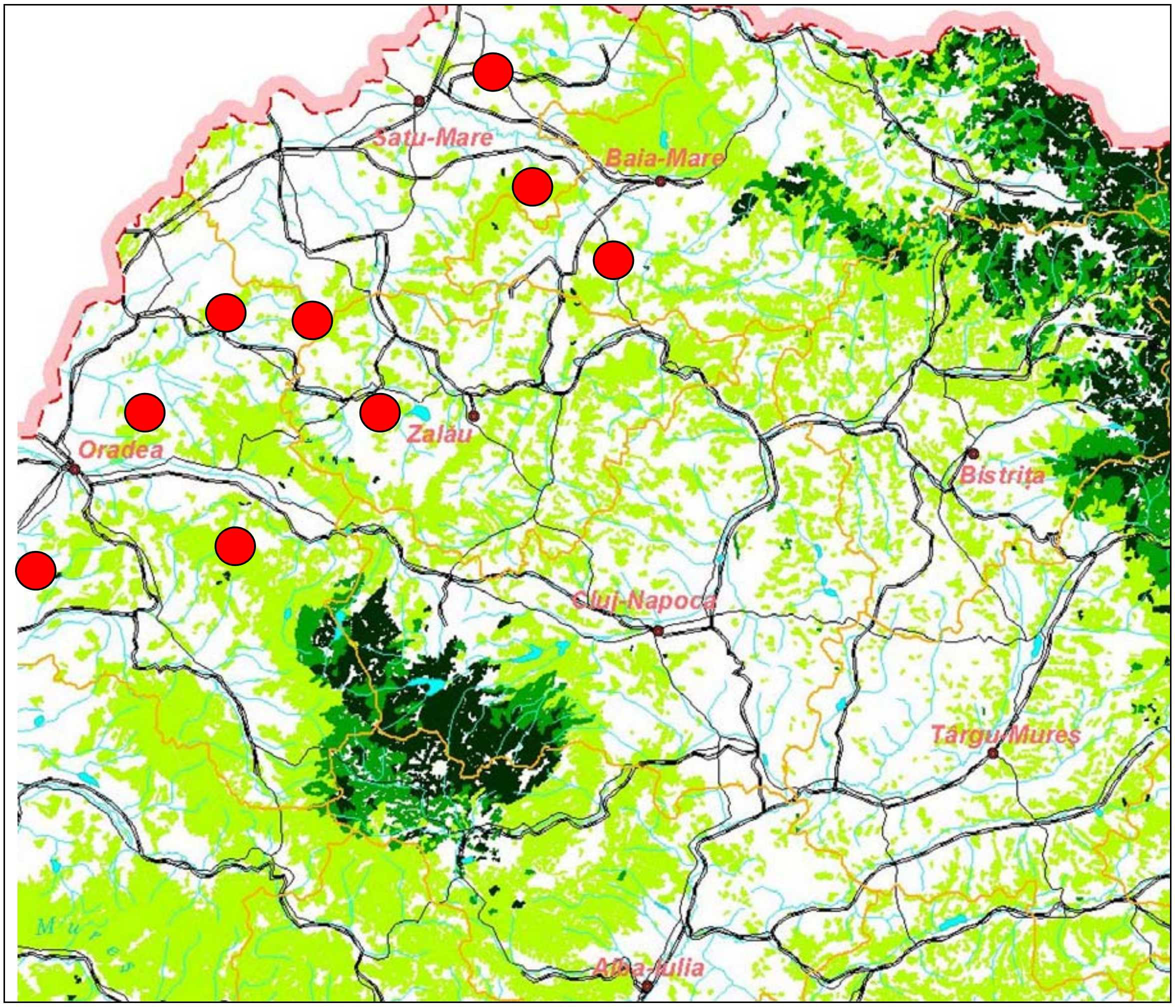

Figure 1. Locating the populations of the defoliator *Lymantria dispar* (processing after the Forestry Map of Romania, source: www.icas.ro)

From Table 3 we can observe that from all the 19 analyzed samples, only in two situations, namely, within the Forestry Department Satu Mare (Forest District Livada), and the Forest District Ardud R.A., the likely defoliation degree was weak, and in the rest of the cases very weak, situation in which the areas corresponding the analyzed samples will be proposed to be included in the surveillance zone.

Table 3

The results of the analyses performed on the defoliator *Tortrix viridana*, 2013-2014

No.	Forestry Department	Forest District	Forest body (U.P., u.a.)	No. of analysis report	Infestation coefficient	Infestation degree	Likely % of defoliation
1	Bistriţa	Bistriţa	I, 9-10	28	0.017	Very weak	1.7
			I,14-15		0.023	Very weak	2.3
			II, 4-5		0.015	Very weak	1.5
		Beclean	I, 39	27	0.021	Very weak	2.1
			IV, 149		0.018	Very weak	1.8
			IV, 13		0.023	Very weak	2.3
2	Cluj	Cluj	II,107	45	0.035	Very weak	3.5
		Gherla	V, 88	38	0.049	Very weak	4.9
3	Satu Mare	Livada	III, 1-4	40	0.17	Weak	17.0
			III, 55-79		0.062	Very weak	6.2
			III, 93-103		0.66	Very weak	6.6
			III, 25		0.070	Very weak	7.0
			III, 406-418		0.066	Very weak	6.6
			III, 34-84		0.056	Very weak	5.6
			III, 14		0.059	Very weak	5.9
		Satu Mare	I, 62-63,92	21	0.095	Very weak	9.5
			I, 47,73		0.014	Very weak	1.4
			I, 32,53,97		0.09	Very weak	9.0
4	Târgu Mureş	Gurghiu	X, 71	16	0.02	Very weak	2.0
			X, 42		0.013	Very weak	1.3
			X, 79		0.02	Very weak	2.0
			X, 25		0.02	Very weak	2.0
		Luduş	I, 49	36	0.037	Very weak	3.7
			II, 34		0.072	Very weak	7.2
			Iv, 32		0.092	Very weak	9.2
		Reghin	I, 48-104	46	0.33	Very weak	3.3
			II, 10-51		0.27	Very weak	2.7
			III, 31-98		0.041	Very weak	4.1
			IV, 106-109		0.026	Very weak	2.6
			V, 8-87		0.031	Very weak	3.1
			VI, 46-55		0.024	Very weak	2.4
		Sovata	IV, 5	25	0.021	Very weak	2.1
			IV, 132		0.023	Very weak	2.3
		Târnăveni	II, 18-19	26	0.019	Very weak	1.9
			IV, 21		0.025	Very weak	2.5
			III, 64		0.022	Very weak	2.2
		Târgu Mureş	III, 22	48	0.027	Very weak	2.7
5	Zalău	Almaş	III, 36	24	0.02	Very weak	2.0
			IV, 51-54		0.015	Very weak	1.5
			V, 43,64-69		0.027	Very weak	2.7
		Ileanda	VII, 1	33	0.016	Very weak	1.6
		Jibou	V, 35	35	0.068	Very weak	6.8
		Cehu Silvaniei	III, 19-22	37	0.054	Very weak	5.4
		Şimleul Silvaniei	I, 44	18	0.016	Very weak	1.6
6	ITRSV Cluj	Municipal Bistriţa	I, 36-43	49	0.029	Very weak	2.9
			I, 138-144		0.03	Very weak	3.0
			I, 8-12		0.023	Very weak	2.3
			I, 27-29		0.041	Very weak	4.1
			I, 77		0.049	Very weak	4.9
			I, 90-96		0.029	Very weak	2.9
			I, 52		0.026	Very weak	2.6
			I, 131-132		0.025	Very weak	2.5
			II, 1-2		0.027	Very weak	2.7
			II, 54		0.032	Very weak	3.2
7	ITRSV Oradea	Ardud R.A.	IV, 5-42	43	0.043	Very weak	4.3
			IV, 1-3		0.037	Very weak	3.7
			IV, 48-52		0.085	Very weak	8.5
			V, 25-59		0.11	Weak	11.0

Conclusions and Recommendations. The studies and analyses conducted in the Transylvanian deciduous forests have shown that the most affected forest formations are those of oaks. Beech forests and especially pure forests are rarely affected by pests and even less by defoliating insects.

Here we can steel recall that in the case of the Forest District Ulmeni, the Forestry Department Baia Mare was observed a gradation of the defoliator *Lymantria* *dispar* in the pure beech stands in the spring of 2007, but was stopped after the application of an AVIO treatment.

The analyzed defoliators *Lymantria dispar* and *Tortrix viridana* are in gradation in all the studied forest formations in most cases but without producing significant defoliations, except for the trees located within the Forestry Department Satu-Mare, the Forest District Carei and the Forest District Livada.

The laboratory analysis performed at ICAS Cluj Research Station show that setting the forecasting for the main forestry defoliators is absolutely necessary and must be carried out every year, and that through the proposed measures is maintained the integrity and stability of the forest stands.

The indirect density determination of the defoliating populations can be performed with sufficient precision in the egg stage from the qualitative analysis of the *Lymantria dispar* eggs and from the sequential analyses of *Tortrix viridana*.

Long-term forecasting for the populations evolution of the two defoliators can be achieved by creating a system of permanent monitoring networks with variable density (between about 30 and approx. 300-500 ha), according to the history of attacks, the degree of forest stands fragmentation, phytosanitary and vegetation estate, the particularities of the climate regime.

Besides the defoliators for which was conducted the forecast in 2014, it also presents a gradations risk in the studied area *Euproctys chrissorhoea*, *Malacosoma neustria* and various species of *Geometridae.*

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