The effectiveness of the functioning of some artificial baits in monitoring of pests in Beclean, Romania

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Abstract. In order to estabilish strategies for pest control it is extremely important to know the structure of the phytopathogens and their numerical density evolution. Agriculture is a dynamic system that continually changes to changing crop production practices. Integrated pest management (IPM) must continually change to meet pest management challenges. IPM is a continuum that will change with time. Every farmer practices some type of IPM, as long as they make progress to better in management. As new pest control techniques are discovered, the producer and crop advisor must adapt their pest control program to reflect these changes. Starting from the concept that IPM have to ensure a very low level of pesticides waste production, we have to take in consideration the relationship between usefull entomofauna and harmful species. For this reason it is necessary to establish a monitoring system of biodiversity for each culture. There are a lot of methods for monitoring pest population, but for this study we chosed a less usual named methode with artificial caterpillars. This method has given use differences between day and night activity of the entomofauna in three different ecosystems in forrest patch, pasture patch, and a protected area. The result obtained during this study showed that the entomofauna activity is different during day and night time, and type of artificial caterpillars. During the study predators reacted much more to the red colored caterpillars than to the green colored ones, and also we found significant differences between the three different ecosystems used.
Key Words: artificial caterpillars, attack marks, bite marks, insect herbivores, predation, plasticine.

Introduction. Predation is an important source of mortality for insect herbivores (Feeny et al 1985; Weseloh 1990; Berger & Wirth 2004; Berger & Gotthard 2008; Ferrante et al 2017a, b), contributing to the regulation of their abundance and preventing depletion of their host plants (Christiansen et al 1987; Sipura 1999).

A predator (Ehi-Eromosele et al 2013) is an animal that killes and eats other animals, named pray (Gentry & Dyer 2002). The last one can be an animal or a trap (artificial caterpillar - Sam et al 2015a, b; Ferrante et al 2014; Ferrante & Lövei 2015; Ferrante et al 2017a, b; Lövei & Ferrante 2017) and the relationship beetwen this two (pray and predator) is called predation (Koh & Menge 2006; Mäntylä et al 2008; Howe et al 2009; Magagnoli et al 2017). The relationship beetwen pray and predator is a very discussed subject since very old times (Hassell 1978; Reznick 1982). In order to survive and reproduce, many preys have developed cryptic coloring to escape, to camouflage, which is the ability to blend in with the surroundings (Rowland et al 2007). Some preys have adapted to reproduce in large numbers, such as rodents and insects, in this case a few will succeed to survive to adults and reproduce. Urbanisation is one of the main factors which is causing changes in biodiversity and natural habitats (McDonald et al 2008; McKinney 2008; Hilty & Merenlender 2000; Eötvös et al 2015; Knop 2016) and also influences several biological services (Ferrante et al 2014). Urbanisation has a big effect on diversity and density of many various groups of predators such like birds, ground beetles, spiders etc. (Hilty & Merenlender 2000; McKinney 2008; McDonald et al 2008; Eötvös et al 2015; Knop 2016).

There are a lot of indirect methods (Diamond et al 2015; Guedes et al 2016,) for monitoring predation, including the experimental removal or exclusion of predators (Marquis & Whelan 1994; Sipura 1999), monitoring disappearance rates of sentinel prey

(Feeny et al 1985; Weseloh 1990), or the use of artificial or model prey (Loiselle & Farji-Brener 2002; Richards & Coley 2007). The technique of using artificial caterpillars or model prey became a very popular method of assessing relative rates of predation. The methode involves confectioning prey from malleable, non-hardening modelling plasticine, placing them in the field and then observing predation from the marks left in the models (Seifert et al 2015, 2016). This new technique get more popular started to be successfully applied to predation studies on a range of prey animals including a very big groupe of predators like insect herbivores (Loiselle & Farji-Brener 2002; Richards & Windsor 2007; Richards & Coley 2007; Tvardikova & Novotny 2012; Low et al 2014; Lövei & Ferrante 2017), reptiles (Webb et al 2005), amphibians, and birds (Major et al 1996; Major & Kendal 1996). This method has a lot of benefits like the fact of being simple, easily adaptable, inexpensive, and allowing large samples, able to provide information on the identity of predators.

The aim of the present paper was to study predators behavior (Ferrante et al 2014; Ferrante & Lövei 2015; Ferrante et al 2017a, b; Sam et al 2015a, b) during day and night time by using two different colored caterpillars, green and red colors, in three different type of habitats, green spaces, forest patches and a protected area.

Material and Method. For the elaboration of the present paper we followed the entomofauna from three different ecosystems of which in two the protection action is very rarely performed. We conducted our study in late September early October 2015 and April 2016. The study location was in Beclean city, Bistrita-Nasaud county in 2015 and in 2016 in Reteag village, in Petru Rares commune.

Research was made in Beclean city in 2015, for three weeks. A city also known as the Beclean Somes (Hungarian Bethlen) is a town in Bistrita County, Transylvania, Romania (Figure 1). Beclean has a population of 10.403 inhabitants and is also an important railway junction. All the two type of habitats were located at the outside part of the city, the reason was to avoid human trass-passing. All the three sites of green spaces were located close to the city at 272 m altitude (lat. 47º10'45.5'' and longit. 24º09'07.6''), while the forest patches were also close to the city between 252-268 m altitude (lat. 47º10'46.4'' and longit. 24º09'04.6'').

In 2016 we continued monitoring insects activity using the same method as in 2015. Monitoring was conducted in April for 3 weeks in a vegetable farm in the village Reteag, Bistrita Nasaud. This farmhouse dating from 1965 with an area of over 62 hectares, occupying 30 acres for seedling production greenhouses used for both the set up in the field of culture and trade.

Figure 1. Bistriţa-Năsăud county, with the sampling locations (red arrows). (http://mdrl.ro/documente/lucrari_publice/infrastructura%20rurala/bistrita.jpg).

For the study we used three different areas, a forest patch and pasture patch in 2015 and a protected area in 2016. From each area we selected three different sites, so we had 9 sites totally, 3 of forest patch, three of pasture patch and three of protected area (Figure 2). We used red and green caterpillars confectioned from plasticine with a total number of 540 in all three ecosystems, 270 red and 270 green, 60 caterpillars per each site. Each caterpillar had 1.5 cm long, and 0.5 cm diameter. All this traps were grouped in pairs, three pairs in triangle samples with 1 meter distance between each. The entomofauna activity is different during a day time, for this reason we followed the activity of entomofauna during day and night time, by analyzing the baits at 7 AM for night activity and 19 PM for monitoring diurnal day activity. All caterpillars with bite marks were collected and replaced. Observations were performed over a three weeks interval.

Figure 2. Three different ecosystems used in the study (original).

We started monitoring the activity of predators from 30[th] of September 2015 three weeks once per week till 15[th] of October in two areas, forest patch and pasture patch, the two areas where protection action is very really performed, first checking the night activity of the insects using totally 360 artificial caterpillars, 180 red and 180 green at all six sites, and after the day activity, in the morning checking the caterpillars and replacing the predated one. We started the research checking the night activity of the predators by placing the traps in group of three pairs green-green/red-red/green-red and 10 pears per site. A-B-C were the green spaces and D-E-F forest patches. For help in identification of bite marks we used the paper of Low et al (2014) (Figure 3).

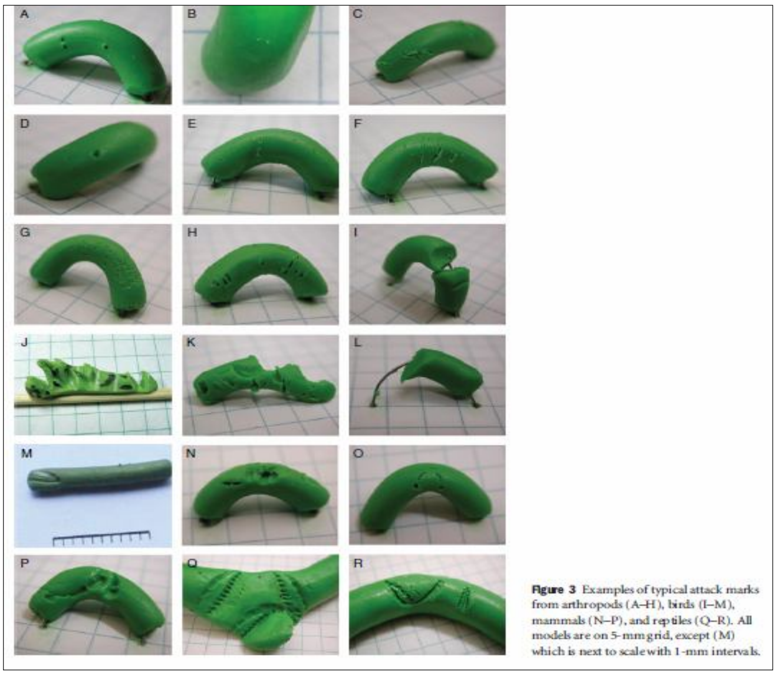

Figure 3. Examples of typical attack marks (after Low et al 2014).

Results. The results obtained during the experiment are presented in Tables 1-6.

Table 1

Forest patch monitoring during night time

Site	*Attacked traps*			*Attacked by*				
	Total	*From*						
		red	*green*	*Insects*	*Slug*	*Mites*	*Mammals*	*Birds*
				First week				
A	1	1	-	1	-	-	-	-
B	14	11	3	12	1	-	1	-
C	15	9	6	11	1	-	3	-
Total	30	21	9	24	2	-	4	-
				Second week				
A	7	6	1	7	-	-	-	-
B	21	18	3	18	1	1	1	-
C	35	24	11	32	2	1	-	-
Total	63	48	15	57	3	2	1	-
				Third week				
A	10	5	5	7	-	2	-	1
B	9	8	1	8	-	-	1	-
C	17	13	4	14	-	-	3	
Total	36	26	10	29	-	2	4	1
				Monitorization period				
Total	129	87	34	110	5	4	9	1

Table 2

Forest patch monitoring during day time

Site	*Attacked traps*			*Attacked by*				
	Total	*From*						
		red	*green*	*Insects*	*Slug*	*Mites*	*Mammals*	*Birds*
				First week				
A	10	8	2	6	-	3	1	-
B	10	7	3	6	1	1	1	1
C	15	9	6	11	1	2	1	-
Total	35	24	11	23	2	6	3	1
				Second week				
A	13	9	4	9	3	1	-	-
B	13	6	7	12	1	-	-	-
C	17	8	9	15	-	-	1	1
Total	43	23	20	36	4	1	1	1
				Third week				
A	15	11	4	11	-	1	2	1
B	17	14	3	14	-	1	2	-
C	16	14	2	15	-	-	-	1
Total	48	39	9	40	-	2	4	2
				Monitorization period				
Total	126	86	40	99	6	9	8	4

Table 3

Pasture patch monitoring during night time

Site	Attacked traps			Attacked b				
	Total	From						
		red	*green*	*Insects*	*Slug*	*Mites*	*Mammals*	*Birds*
				First week				
D	8	3	5	5	1	1	1	-
E	17	9	8	15	1	1	-	-
F	14	9	5	9	2	-	3	-
Total	39	21	18	29	4	2	4	-
				Second week				
D	17	10	7	15	-	1	-	1
E	13	7	6	12	-	-	1	-
F	11	6	5	8	-	-	3	-
Total	41	23	18	35	-	1	4	1
				Third week				
D	9	6	3	5	-	2	2	-
E	7	6	1	5	-	-	-	2
F	7	4	3	4	-	-	3	-
Total	23	16	7	14	-	2	5	2
				Monitorization period				
Total	103	60	43	78	4	5	13	3

Table 4

Pasture patch monitoring during day time

Site	Attacked traps			Attacked b				
	Total	From						
		red	*green*	*Insects*	*Slug*	*Mites*	*Mammals*	*Birds*
				First week				
D	11	8	3	7	1	1	1	1
E	10	2	8	8	-	-	-	2
F	8	4	4	6	1	-	1	-
Total	29	14	15	21	2	1	2	3
				Second week				
D	11	8	3	7	1	1	1	1
E	10	6	4	8	1	1	-	-
F	10	7	3	9	-	1	-	-
Total	31	21	10	24	2	3	1	1
				Third week				
D	14	8	6	9	1	-	3	1
E	12	8	4	10	1	.	-	1
F	12	8	4	9	1	-	2	-
Total	38	24	14	28	3	-	5	2
				Monitorization period				
Total	98	59	39	73	7	4	8	6

Table 5

Protected area monitoring during night time

Site	*Attacked traps*			*Attacked by*			
	Total	*From:*					
		red	*green*	*Insects*	*Slug*	*Mites*	*Mammals*
				First week			
A	22	20	2	20	-	2	-
B	35	25	10	26	2	5	2
C	24	20	4	21	2	1	-
Total	81	65	16	67	4	8	2
				Second week			
A	35	31	4	33	-	2	-
B	41	35	6	32	2	5	2
C	29	24	5	21	2	5	1
Total	105	90	15	86	4	12	3
				Third week			
A	61	59	2	50	2	8	1
B	63	58	5	56	1	5	1
C	34	29	5	25	2	5	2
Total	158	146	12	131	5	18	4
				Monitorization period			
Total	344	301	43	284	13	38	9

Table 6

Protected area monitoring durring day time

Site	*Attacked traps*			*Attacked by*			
	Total	*From:*					
		red	*green*	*Insects*	*Slug*	*Mites*	*Mammals*
				First week			
A	23	14	9	20	1	2	-
B	22	17	5	17	2	1	2
C	26	20	6	23	2	1	-
Total	71	51	20	60	5	4	2
				Second week			
A	35	30	5	30	1	4	-
B	29	26	3	20	2	5	2
C	31	23	8	25	1	5	-
Total	95	79	16	75	4	14	2
				Third week			
A	59	49	10	50	2	6	1
B	49	30	19	40	2	5	2
C	59	45	14	52	2	5	-
Total	167	124	43	142	6	16	3
				Monitorization period			
Total	333	254	79	277	15	34	7

Discussion. During the full period of monitoring in the night time in the forest patch we had 129 caterpillars with bite marks, from this 87 were observed on red caterpillars and just 34 on green caterpillars. From the total number of 129 caterpillars, 110 were caused by the insect group, 5 slug, 4 mites, 9 mammals and 1 bird (Table 1). In the day time we collected 126 caterpillars, 86 red with bite marks and 40 green. From 126 of attacked caterpillars, 99 were caused by insects, 6 by slug, 9 by mites, 8 mammals and 4 birds (Table 2).

During full period of observation in the pasture patch during night time we obtained 103 artificial caterpillars with bite marks, from the total number 60 were founded on red baits, and 43 on green baits. From 103 baits 78 were caused by insects, 4 slug, 5 mites, 13 mammals and 3 birds (Table 3). In the day time the situation was similar, we found 98 caterpillars with marks, from this 59 were on red and 39 on green caterpillars. 73 were caused by insects, 4 slug, 4 mites, 8 mammals and 6 birds (Table 4).

In 2016 we continued monitoring insects activity using the same colors as in 2015 in a protected area. Monitoring was conducted in April for 3 weeks in a vegetable farm in the village Reteag, Bistrita Nasaud. In the protected area the results were very different from the other two ecosystems. During the full period of monitoring we found in the night time 344 caterpillars with bite marks, from this 301 on red colored caterpillars and 43 on green ones. From the total number, 284 were caused by insects, 13 slug, 38 mites and 9 mammals (Table 5). During the day observations 333 caterpillars were collected, 254 red and 79 green. From the total number, 277 were caused by insects, 15 slug, 34 mites and 7 mammals (Table 6).

In the last week of monitoring, plants have reached the stage of subculturing procedure - transplanting. We noticed during the monitoring that external factors such as weather conditions and the stage of development of culture greatly influenced insect activity. In the last week we had two days to monitor with temperatures of 14-16^{o}C and 25-27^{o}C respectively. Temperatures in protected area were greater than that measured outdoors.

In the forest patch and pasture patch during the study we didn’t found significant difference, obtaining 255 caterpillars in the forest patch and 201 in the pasture patch during both periods, day and night time. In protected area we observed a lot more of bite marks than in the other two ecosystems, a total number of 667 (Table 7). The number of slugs is also high because of the high humidity in this area. During the full period of monitoring the most visited baits were found in this area. This is explained by the fact that in restricted area the density of entomofauna is much higher than in larger/bigger areas like a skirt (forest) or pasture patch. The result clearly showed us that no mather of ecosystem red baits was much more visited by entomofauna during both periods, day and night time. This study demonstrates that predation pressure on artificial caterpillars depends on habitat type, type of caterpillars used and exposure time. The composition of predator groups also differed between habitats and time periods.

Table 7

Data centralizing

Area	*Total*	*Day*		*Night*	
		Red	*Green*	*Red*	*Green*
Forest	255	86	40	95	34
Pasture	201	59	39	60	43
Protected area	667	254	79	301	43

Conclusions. In open spaces, forest and pastures where the area where species are looking for food is much higher, however, fewer biting baits have been reported than protected areas where species have a much smaller spectrum and biodiversity is much lower, but the population density per unit area is much higher. In the study we followed 5 groups of predators: insects, slugs, mites, mammals and birds, from this all in the insect group most bites were reported. The number of traces of snails left by snails was much higher in the protected area due to high humidity. In monitoring the activity of insects during the study proved to be more receptive to red color no mather of day period or ecosystem.

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