Ecological niche comparison of two cohabiting species, the threatened moth *Eriogaster catax* and *Eriogaster lanestris* (Lepidoptera: Lasiocampidae) - relevance for their conservation

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Summary: *Eriogaster catax* and *E. lanestris* (Lepidoptera: Lasiocampidae) are two cohabiting species with extremely isolated populations. The anthropic impact lead to a decrease in their distributional areas, which led to the inclusion of *E. catax* in Annexes II and IV of the Council Directive 92/43/EEC. There are few studies regarding the species in question, revealing the scarcity of data regarding their biology and ecology. Our study was conducted in a Natura 2000 protected area, Turda Gorge (Romania) where the two species are present in an agroecosystem used as a pasture, which is covered in patches of by their main host plants, *Prunus spinosa* and *Crataegus* spp. The present study provides important data which can be used for the species conservation of *E. catax*, and it reveals a series of similarities between *E. catax* and *E. lanestris* with regards to habitat preferences and ecological needs in choosing the oviposition site.

Keywords: *Eriogaster catax*, *E. lanestris*, ecological niche, oviposition strategy, protection, conservation

Introduction

Eriogaster catax (LINNAEUS, 1758) and *E. lanestris* (LINNAEUS, 1758), (Lepidoptera: Lasiocampidae) are two cohabiting species (SAFIAN 2006), associated to seminatural and agricultural landscapes with shrubby vegetation (KADEJ *et al*. 2018).

They can be found in natural, seminatural and anthropic habitats, in bushy meadows, alongside forest edges, deciduous forests, hedges, roads, railroads and other human impacted habitats, as long as their host plants are available (HÖTTINGER 2005; BAILLET 2013; BURY 2015).

As a consequence of traditional agricultural activities, landscapes with a highly diverse mosaic of habitats were formed (BEAUFOY 1998). Such landscapes are highly important to the fauna, serving as refuge or corridors for several species, including endangered ones, such as *E. catax* (FORMAN and BAUDRY 1984, DOVER and SPARKS 2000, ZECHMEISTER *et al*. 2002, WEHLING and DIEKMANN 2009, WUCZYŃSKI *et al*. 2011, 2014, KADEJ *et al*. 2018). Furthermore, this type of landscape is characterized by an increased biodiversity, which can be maintained by low-intensity land use practice (BIGNAL and MCCRACKEN 1996, PLIENINGER *et al*. 2006, LOOS *et al*. 2014). However, intensification of agriculture has a strong negative impact on biodiversity and currently, (MATSON *et al*. 1997, TSCHARNTKE *et al*. 2005), half of Europe´s total land surface is covered by agricultural land (HALADA *et al*. 2011). As a consequence, anthropic pressure by agriculture intensification has led to extreme isolation of populations of the two species, both in Romania and at European level. *E. lanestris* is a xero-thermophilic species (EBERT 1994; RUF *et al*. 2003), while *E. catax* is a xero-thermophilic or, by case, a thermo-hydrophilic species, having particular requirements regarding or concerning the habitat (DE FREINA 1996, BORGES 2012, BURY 2015, MALKIEWICZ 2015, KADEJ *et al*. 2018). According to MALKIEWICZ (2015) the habitat requirements are the main drivers of the isolation degree over its entire geographical distribution area.

The world-wide distribution of the two species covers the Palearctic Region. The geographical distribution of *E. catax* ranges from the Iberian Peninsula (Northern Spain) to the Balkans (DE FREINA 1996, BORGES 2012, BAILLET 2013; BURY 2015), up to the south of the Ural Mountains and Asia Minor (DE FREINA and WITT 1987, DE FREINA 1996, KARSHOLT and RAZOWSKI 1996, RUF *et al*. 2003, BORGES 2012, BAILLET 2013, BURY 2015). Until presently, the species has not been recorded in the Mediterranean region (BORGES 2012). The widely distributed *E. lanestris* is spread throughout Europe, excepting the tundra and Mediterranean regions, up to the northern Caucasus, Kazakhstan, southern Siberia, Central Yakutia and Amur basin. Thus, in some countries of Europe and Asia, there is a partial territorial overlap of the two species.

Materials and methods

Field sampling

The study was performed in an area situated in central Transylvania, in the upper part of the left slope of the Turda Gorges, Cluj County Romania, which is a natural reservation and part of the Natura 2000 Site Cheile Turzii - ROSCI0035 (Fig. 1).

As natural reservation, Turda Gorges is a renowned hot-spot of biodiversity, as a consequence of the interecosystemic effect (Rákosy 1995, Rákosy and Varga 2006), comprising over 900 known species of vascular plants (Nyárády 1939; Rákosy 2001) and over 1350 species of lepidopterans (Rákosy 2001). The plateau area of the Gorges consists in a meadow including numerous shrubs of *P. spinosa*, *Crataegus* spp. and *Rosa* spp., which ensure a suitable habitat for both *E. catax* and *E. lanestris* and also for other endangered species of butterflies, such as *Colias myrmidone* (Rákosy 2001). Annual mean temperature in Turda Gorges is 8,2° C and the annual precipitation is 624 mm (data obtained from http://worldclim.org for coordinates N 46.542139 E 23.627389).

However, the plateau area is used by the locals as pasture for sheep and goats. Sheep husbandry is sustained by agricultural subsidy of the Ministry of Agriculture and Rural Development (http://www.apia.org.ro/).

In the study area, populations of the two species were identified by visual identification of nest clustering (Fig. 2), followed by their inventory, mapping and measuring. For mapping, a hand held Garmin GPS*map 62s* with ±2 m error was used. For each nest, the height from the soil level and the total height of the host plant were recorded. The types of host plant were identified and divided based on their solitary or grouped pattern, if the shrub clustering was greater than 4 m².

The cardinal orientation of each location was determined by cardinal degrees for the following value intervals: N: 0-22.5 and 337.5-360; NE: 22.5-67.5; E: 67.5-112.5; SE: 112.5-157.5; S: 157.5-202.5; SW: 202.5-247.5;W: 247.5-292.5; NW: 292.5-337.5. Due to height and conformation of the shrubs, the cardinal orientation of the slope where the shrub was present was taken into account, not that of the nest.

To determine the number of eggs layed by each species, abandoned nests were collected, after the larvae started their solitary stage. The nests, which are built around the eggs,were cleaned of their protective

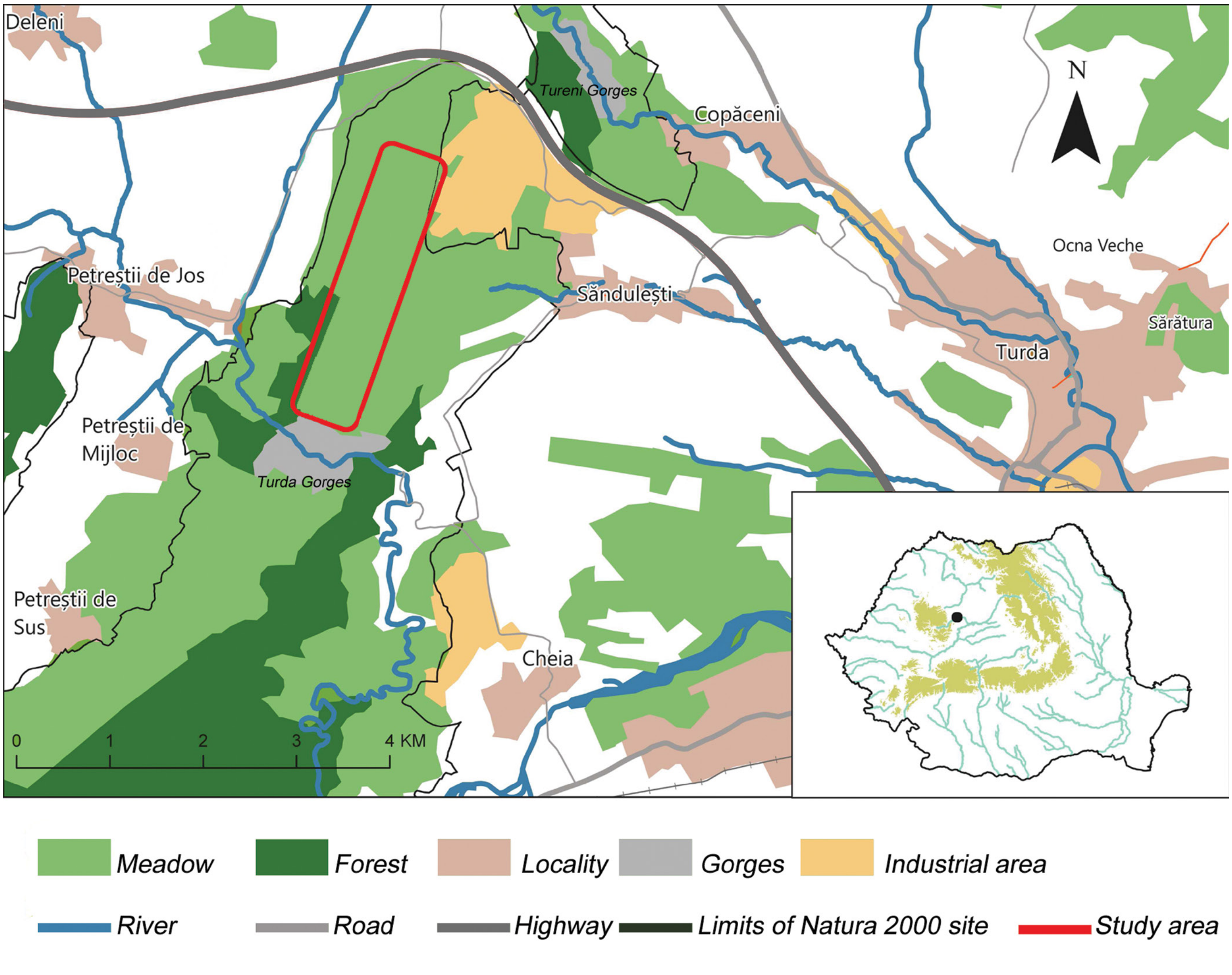

Fig. 1. Map of the studied area and its surroundings.

Fig. 2. Nest and caterpillars of *E. catax* (left) and nest and caterpillars of *E. lanestris* (right)

hairs coming from the abdominal area of the females and counted using an Olympus stereo microscope. In order to avoid double counting, the eggs were stained with a permanent marker. The total number of eggs, total number of hatched and unhatched eggs were conclusive for the fertility percent.

Statistical analysis

Statistical analysis were performed using the EpiInfo7™software (CDC, USA) and the EpiTools website (http://epitools.ausvet.com.au). For each type of plant, the frequency and its 95% confidence interval (95% CI) were calculated and differences were assessed by chi square testing. On the basis of chi square values, in respect to the degrees of freedom (d.f.), the differences were considered significant for $p < 0.05$. For determining oviposition preferences, 20 cm height intervals were designated from soil level, up to the interval of the highest recorded clutch. The designated intervals were from0-20 cm, up to 161-180 cm. For each interval, the frequency and 95% confidence intervals (95% CI) were calculated and chi square test was used for comparison. The mean values for the two species were compared using Mann-Whitney/Wilcoxon Two-Sample Test (Kruskal-Wallis test for two groups). The correlation between the total height of the host plant and clutch height was inferred by Spearman's rank correlation test. The mean number of deposited and unhatched eggs was established for each species and the differences were assessed by means of T-test. All metric data are reported as mean values ± standard deviation.

Results

During our study, 48 nests of *E. catax* between 481-739 m altitude and 111 nests of *E. lanestris* between 550-752 m altitude were inventoried and measured. The mean altitude of the recorded *E. catax* nests was 686.64 ±76.53 m and that of *E lanestris* was 710.67 ±57.74 m.

The cardinal orientation of the slope for sampling locations

In our study site, both species occupied shrubs located in the plateau region of the left slope of the Gorges, in full sunlight.

A higher frequency in *E. catax* distribution was attributed to the SE slope 37.5% (95% CI 23.95-52.65%), with a lower frequency, of 27.08% (95% CI 15.28-41.85%) on E and NW slopes (Fig. 3). The distribution of the nests according to cardinal points

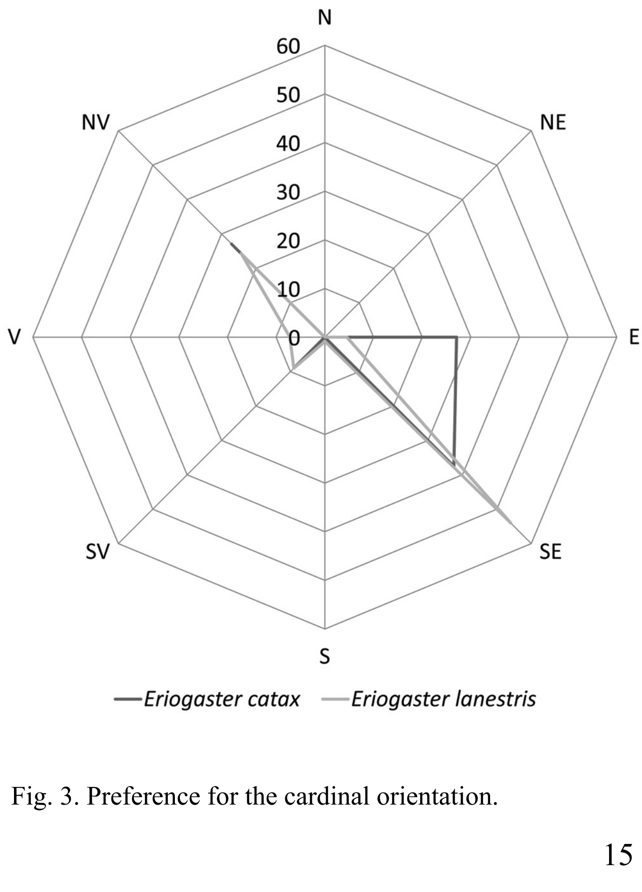

Fig. 3. Preference for the cardinal orientation.

was significant (χ^2=11.33; d.f.=5; p=0.0101).

E. lanestris was more abundant on SE slopes, with a frequency of 54.05% (95% CI44.33-63.55%), with a low threshold on NW slopes, 24.32% (95% CI16.68-33.38%).

E. lanestris was more confined to the cardinal direction when compared to *E. catax,* but with no statistical significance (χ^2=3.04; d.f.=1; p=0.0811).

The choice of host plant used as larval food source

The larvae of *E. catax* were found with a higher frequency on *P. spinosa*, 62.5% (95% CI 47.35-76.05%) and in reduced numbers on *Crataegus* spp. 37.5% (95% CI 23.95-52.65%). The preference for *P. spinosa* was statistically significant (χ^2=5.04; d.f.=1; p=0.0242). The larvae of *E. lanestris* also displayed a higher frequency on *P. spinosa,* 86.49% (95% CI -78.69-92.23) and a low presence on *Crataegus* spp. 13.51% (95% CI 7.77-21.31%), having a significant preference for *P. spinosa* (χ^2=115.31; d.f.=1; p=0).

Both species showed significant affinities towards the same host plant, but more markedly *E. lanestris* (χ^2=10.3; d.f.=1; p=0.0011).

Oviposition choice in relation to the shape and structure of the shrub

E. catax was more confined to grouped shrubs, with a frequency of 62.5% (95% CI 47.35-76.05%), as opposed to solitary ones, with 37.5% frequency (95% CI 23.95-52.65%), with a statistical significance (χ^2=5.04; d.f.=1; p=0.0242).

E. lanestris displayed a higher frequency 90.09% (95% CI 82.96-94.95%) of oviposition on grouped shrubs, while solitary shrubs presented a low percentage, of 9.91% (95% CI 5.05-17.04%). The differences were statistically significant (χ^2=139.53; d.f.=1; p=0).

E. lanestris exhibited significantly increased confinement to grouped shrubs as opposed to *E. catax* (χ^2=15.3; d.f.=1; p<0,0001).

Host plant height

The mean height of the host plants reflecting the affinities of *E. catax* was of 90.6 ±59.99 cm, while for the other species, *E. lanestris*, it was of 52.88 ±31.57 cm. According to data from *P. spinosa* shrubs, the mean height preference of *E. catax* was 74.93 ±50.23 cm, while that of *E. lanestris* was of 50.66 ±24.87 cm. For the second host plant, *Crataegus* spp., the mean height for *E. catax* clutches was of 116.72 ±67.01cm, while *E. lanestris* displayed a lower threshold, of 67.06 ±58.18 cm. The global height difference between the host plants in relation to species oviposition preferences was significant (H=13.74; df=1; p=0.0002). Significant differences in height preferences of the two species were recorded for both *P. spinosa* (H=5.62; df=1; p=0.0177) and *Crataegus* spp. (H=4.274; df=1; p=0.0318).

The analysis of shrub height distribution on 50 cm intervals revealed a different oviposition pattern of *E. catax,* with first choice for the 0-50 cm interval, with a frequency of 41.67% (95% CI 27.61-56.79%), followed by the 51-100 cm interval, with a frequency of 27.08% (95% CI 15.28-41.85%), with significant differences among intervals (χ^2=28.02; d.f.=4; p=0).

The analysis of shrub height distribution on 50 cm intervals exhibited the same oviposition pattern for *E. lanestris,* with first choice for the 0-50 cm interval, 63.06% frequency (95% CI 53.38-72.03%), followed by the 51-100 cm interval, 32.43% frequency (95% CI 23,85-41,97%), with significant differences between

Table 1. The frequency and 95% CI of height intervals of host plants. Maximum values are highlighted in grey.

		Eriogaster catax			*Eriogaster lanestris*		
	Sp	*Prunus spinosa*	*Crataegus* spp.	Total	*Prunus spinosa*	*Crataegus* spp.	Total
0-50 cm	%	46.67	33.33	41.67	60	63.54	63.06
	95% CI	28,34-65,67	13,34-59,01	27,61-56,79	32,29-83,66		53,38-72,03
50-100 cm	%	36.67	11.11	27.08	26.67	33.33	32.43
	95% CI	19,93-56,14	1,38-34,71	15,28-41,85	7,79-55,10		23,85-41,97
101-150 cm	%	6.67	16.67	10.42	0	1.04	0.9
	95% CI	0,82-22,07	3,58-41,42	3,47-22,66	-		0,02-4,92
151-200 cm	%	6.67	38.89	18.75	6.67	2.08	2.7
	95% CI	0,82-22,07	17,30-64,25	8,95-32,63	0,17-31,95		0,56-7,7
201-250 cm	%	3.33	0	2.08	6.67	0	0.9
	95% CI	0,08-17,22	-	0,05-11,07	0,17-31,95	-	0,02-4,92
	χ^2 (df=4)	30.41	11.52	28.02	25.81	189.24	210.74
	p	0	0.021	0	0	0	0
	Obs	significant	significant	significant	significant	significant	significant

intervals (χ^2=210.74; d.f.=4; p=0) (Table 1).

As revealed previously, *E.lanestris* is significantly more confined to the 0-50 cm height interval when compared to *E. catax* (χ^2=5.40; d.f.=1; p=0.0149).

Oviposition height

The mean height of oviposition on the host plants was 57.89 ± 25.34 cm for *E. catax* and 45.12 ± 23.87 cm for *E. lanestris.* The global difference between the two species was significant (H=13.6; d.f.=1; p=0.0002). On *P. spinosa*, the mean oviposition height was 53.23 ±22.84 cm for *E. catax* and 43.84 ±20.15 cm for *E. lanestris*. The difference was statistically significant (H=5.27; d.f.=1; p=0.0217). On *Crataegus* spp., the mean oviposition height was 65.66 ±27.97cm for *E. catax* and 53.33 ±40.5 cm for *E. lanestris*. The difference was statistically significant (H=4.26; d.f.=1; p=0.0390).

Analyzing the distribution of the nests on 20 cm height intervals, *E. catax* displayed a preference for the 41-60 cm interval, with a frequency of 37.5% (95% CI 23.95-52.65%), closely followed by the 21-40 cm interval, with a frequency of 27.08% (95% CI 15.28-41.85%). The differences between height intervals were statistically significant (χ^2=75.51; d.f.=8; p=0).

E. lanestris showed a different pattern of oviposition, with first choice for the 21-40 cm interval, with a frequency of 47.75% (95% CI 38.18-57.44%) and second for the 41-60 cm interval, with a frequency of 34.23% (95% CI 25.49-43.84%). The differences between height intervals were statistically significant (χ^2=92.97; d.f.=8; p=0) (Table 2).

By analyzing the nests distribution on 20 cm height intervals and taking into account the host plant, *E. catax* displayed slightly different patterns. On *P. spinosa* the most frequent interval was 21-40 cm, with 36.67% frequency (95% CI 19.93-56.14%), followed by 41-60 cm with 33.33% frequency (95% CI 17,29-52,81) and the differences among intervals were significant(χ^2=52.65; d.f.=8; p=0). On *Crataegus* spp. most frequent interval was 41-60 cm, with 44.44% frequency (95% CI 21.53-69.24%), followed by 61-80 cm with 27.78% frequency (95% CI 9.69-53.48%) and the differences among intervals were significant (χ^2=33.75; d.f.=8; p=0).

By analyzing the clutch distribution on 20 cm height intervals and taking into account the host plant, *E. lanestris* displayed similar results. On *P. spinosa* the most frequent interval was 21-40 cm with 46.88% frequency (95% CI 36.61-57.34%), followed by 41-60 cm with 36.46% frequency (95% CI 26.87-46.21%) and significant differences among intervals (χ^2=71.96; d.f.=8; p=0). On *Crataegus* spp. the most frequent interval was 21-40 cm with 53.33% frequency (95% CI 26.59-78.73%), followed by 41-

Table 2. The frequency and 95% CI of oviposition intervals. Maximum values are highlighted in grey.

		Eriogaster catax			*Eriogaster lanestris*		
	Sp	*Prunus spinosa*	*Crataegus spp.*	Total	*Prunus spinosa*	*Crataegus spp.*	Total
0-20 cm	%	0	0	0	4.16	0	3.6
	95% CI	-	-	-	1,15-10,33	-	0,99-8,97
21-40 cm	%	36.67	11.11	27.08	46.88	53.33	47.75
	95% CI	19,93-56,14	1,38-34,71	15,28-41,85	36,61-57,34	26,59-78,73	38,18-57,44
41-60 cm	%	33.33	44.44	37.5	36.46	20	34.23
	95% CI	17,29-52,81	21,53-69,24	23,95-52,65	26,87-46,21	4,33-48,09	25,49-43,84
61-80 cm	%	16.67	27.78	20.83	8.33	13.33	9.01
	95% CI	5,64-34,72	9,69-53,48	10,47-34,99	3,67-15,76	1,66-40,46	4,41-15,94
81-100 cm	%	10	5.56	8.33	2.08	6.67	2.7
	95% CI	2,11-26,53	0,14-27,29	2,32-19,98	0,25-7,32	0,17-31,95	0,56-7,7
101-120 cm	%	0	5.56	2.08	0	0	0
	95% CI	-	0,14-27,29	0,05-11,07	-	-	-
121-140 cm	%	3.33	5.56	4.17	2.08	0	1.8
	95% CI	0,08-17,22	0,14-27,29	0,51-14,25	0,25-7,32	-	0,22-6,36
141-160 cm	%	0	0	0	0	0	0
	95% CI	-	-	-	-	-	-
161-180 cm	%	0	0	0	0	6.67	0.9
	95% CI	-	-	-	-	0,17-31,95	0,02-4,92
	χ^2 (df=8)	52.65	33.75	75.51	71.96	25.51	92.97
	p	0	0	0	0	0.0003	0
	Obs	significant	significant	significant	significant	significant	significant

60 cm with 20% frequency (95% CI 4.33-48.09%) and significant differences among intervals (χ^2=25.51; d.f.=8; p=0.0003).

In relation to *P. spinosa*, both species exhibited a specific preference for the 21-40 cm height interval, without significant differences among them (χ^2=0.2208; d.f.=1; p=0.4016).

For both species, a very strong and statistically significant correlation between host plant height and oviposition height was noted (R= 0.80274; p=0 for *E. catax* and R= 0.86508; p=0 for *E. lanestris*).

Deposited eggs and fertility

The mean number of deposited eggs was of 273.48 ± 50.19 (N= 54) for *E. lanestris* and 181.67 ± 48.24 (N= 48) for *E. catax*, with statistically significant differences among the two species (p= 0.003). With regards to fertility, the number of unhatched eggs per nest ranged between 0 and 61 (mean 7.46 ±13.03)for *E. lanestris* andbetween 0 and 5 (mean 3.67 ±2.16) for *E. catax*. However, the differences were not statistically significant (p= 0.06).

Discussion

Regarding the altitude, these species are confined to lowland areas, but in Eastern Europe and Asia Minor, they were recorded also from over 1500 m. In Spain, the species are confined to submontane areas, at altitudes ranging between 530 and 1500 m (De Freina 1996; García-Pérez *et al*. 2009). In our case, the mean altitude for the recorded clutches of *E. catax* and *E. lanestris* are at the mean of the 500 -1500 m interval.

The solar intensity may influence the oviposition sites for both species. *E. catax* is confined to thermo-hydrophilic habitats in Germany and Switzerland (Bolz 2001, Carron 2009), while in France and Austria, it occurs xero-thermophilic areas (Hottinger 2005, Baillet 2013), on sunny calcareous slopes, forest edges or glades (De Freina 1996, Borges 2012). The habitat included in our study from Turda Gorges is characterised by xero-thermophilic conditions on calcareous bedrock, a suitable condition for xero-thermophilic species like *E. lanestris* (Ebert 1994, Ruf *et al*. 2003). *E. catax* lays its eggs on branches with southern, south-eastern or eastern exposure (Malkiewicz 2015). In our study site, both species were mostly confined to SE slopes (*E. catax* 37.5%, and *E. lanestris* 54.05%), with the nest built on the sunny side of the branch.

In Romania, the two species are mainly found in grassland-type agroecosystems, used both for animal grazing and hay production. The traditional management of these terrains has allowed the maintenance of mosaic landscape including hedges of *P. spinosa*, *Crataegus* spp., *Rosa* spp., *Pyrus pyraster*, *Amygdalus nana* etc. This type of habitat with bushes belongs to type 40A0* - Subcontinental peri-Pannonic scrub according to Annex I of Council Directive 92/43/EEC (Doniță *et al*. 2005).The primary larval food plants of the species are *P. spinosa* and *Crataegus* spp. Other host plants like *C. laevigata*, *Pyrus* spp., *Quercus* spp. or *Berberis* spp., were reported (Ruf and Fiedler 2005, Höttinger 2005, Borges 2012, Baillet 2013, Chrzanowski *et al*. 2013, Bury 2015, Malkiewicz 2015). In the studied area, all the nests were encountered on *P. spinosa* and *Crataegus* spp. with the exception of a single *E. catax* nest observed on *Berberis* spp. Some authors (Malkiewicz 2015) report *P. spinosa* as the main food plant for *E. catax* and rarely *Crataegus* spp. as a secondary food plant. Our data further confirm this aspect. However, in Eastern Austria, the females lay on *Crataegus* spp. as a first option and only secondary on *P. spinosa*. This assumption relies on the identification of hundreds of nests and entomological inquiries (Bolz 1998, 2001, Höttinger 2005). The study of Carron (2009) also showed a greater preference for *Crataegus* spp. (52% of cases). The same preference was noted in Spain, where *E. catax* was encountered with a higher frequency on *Crataegus* spp. (63%, N =35) (García-Pérez *et al*. 2009). In contrast, studies conducted in Germany (Weidemann and Kohler 1996), as well as in Poland (Bury 2015, Malkiewicz 2015, Kadej *et al*. 2018) also confirm more nests identified on *P. spinosa* in opposition to *Crataegus* spp. Our study suggests significant preferences of both species in relation to larval host plant, with *E. lanestris* displaying a greater preference than *E. catax*. Both species exhibited a greater affinity for *P. spinosa* (*E. catax* 62.5%, *E. lanestris* 86.49%). The preference for the host plant is most probably reflected by the parameter of the area that may vary from one population to another.

Studies emphasizing oviposition preferences of *E. catax* females showed edges of dense and isolated shrubs as preferred sites (Malkiewicz 2015). Our results display a greater preference for grouped shrubs than isolated ones (*E. catax* 62.5% grouped, 37.5% isolated and *E. lanestris* 90.09% grouped). Considering the height, and implicitly the reduced height of the shrubs, grouped shrubs may be favorable for larval access to food during the whole developmental period, without the necessity of migration to other shrubs.

Females of *E. catax* and *E. lanestris* always lay their full egg complement into one egg batch (Ruf *et al*. 2003), thus an exact determination of the number of eggs laid by the two species of moths was possible. According to Ruf *et al*. (2003), *E. lanestris* lays 323±71 eggs/cluster (N= 20), while *E. catax* has a mean number of 183±40 eggs/cluster (N=39). The number of eggs/cluster determined in the present study was similar. However, the percentage of hatched eggs herein reported (97.28% for *E. lanestris* and 97.99%

for *E. catax*) was greater than the one determined by Ruf *et al*., (2003) (86% for *E. lanestris,* 79% for *E. catax).* Our study was performed exclusively in the field, showing the existence of vigorous populations. The difference in the number of laid eggs between the two species can be explained by the larger size of *E. catax* eggs compared to those of *E. lanestris*, as noted during personal observations, but also by other authors (Ruf *et al*. 2003).

The previously reported clutches of *E. catax* were placed at a height of minimum 100 cm (Borges 2012), almost twice the size of the mean (57.89 ± 25.34cm) identified in the colonies from our study. Also, a study on clutch height conducted in Poland displays a height interval of 50-200 cm (Malkiewicz 2015). However, the first study that statistically demonstrates the existence of a preferred oviposition interval was recently conducted (Kadej *et al*. 2018) indicating an interval ranging between 75 and 127 cm, with a median value of 91 cm. The mean height of the *E. lanestris* clutches identified in our study, (45.12 ± 23.87 cm),is close to that of *E. catax* (57.89 ± 25.34 cm). For both species, the majority of clutches were recorded at a height ranging from 21 to 60 cm. However, *E. catax* mainly oviposits in the 41-60 cm interval, while *E. lanestris* prefers the 21-40 cm interval.

In the absence of other studies referring to oviposition height of *E. lanestris* no comparison degree between more populations is currently available.

A differentiated analysis of the oviposition height of *E. catax* in relation to host plant in the canton of Geneva reported a mean oviposition height of 120 cm for clutches laid on *Crataegus* spp. (Carron 2009). In contrast, our study showed a lower mean height, of 65.66 ±27.97 cm on *Crataegus* spp. On *P. spinosa* the oviposition height ranged between 30 and 170 cm, with a mean height of 90 cm, which is also higher compared toour results (53.23 ±22.84). Data from literature (Carron 2009) and our study indicate higher oviposition sites on *Crataegus* spp. in opposition to *P. spinosa* for both *E. catax* and *E. lanestris.* The mean oviposition height according to host plant were slightly higher in the case of *E. catax*, but they are nevertheless similar.

The lower oviposition height from our study, as compared to previous data, may be explained by reduced size of the host plants. The mean oviposition height may vary also among different populations. This aspect needs further studies on other populations and the correlation of the results with the physic-geographical and climatic variables. Our results indicate preference for the low height shrubs for both species. Both species lay eggs on the shrubs with a height ranging between 0-50 cm (*E. catax* 41.67% and *E. lanestris* 63.96%), but *E. lanestris* showed a significantly greater preference in comparison to *E. catax* for this height interval. Kadej *et al*. (2018) obtained a moderate correlation between the oviposition height and the total plant height for *E. catax*. The strong correlation revealed by the present study may be linked to the general low height of the shrubs, as a consequence of sheep and goat grazing in the area. In Romania, sheep rearing is encouraged and sustained by the government, grazing being allowed including in Natura 2000 sites. The regulations for obtaining agricultural subsidy state a minimum number of sheep that farmers should own but not a maximum one, which may result in overgrazing on pastures. Most pastures are concessional for a limited period of time, consequently sheep farmers have no interest in sustainable exploitation of the land. Furthermore, farmers have the obligation to remove shrubs from pastures. In some cases, this is performed by mechanical removal, but in most situations, fire is being used in spring or autumn, with no regard for the potential occurrence of endangered species.

Knowledge on the oviposition in the entire distribution area is essential for establishing adequate management measures for the conservation of meadows with shrubs, which represent a particular type of habitat including high biodiversity of insects (Baur *et al*. 2006, Loos *et al*. 2014), an important food source for pollinators such as solitary bees (Gresty *et al*. 2018), a high diversity of birds (Carlos and Gibson 2010) and numerous small or medium-sized mammals (Biala *et al*. 2005).

Another important aspect for the conservation of *E. catax* is the distance between terrains harboring potential habitats and the existence of ecological corridors to ensure genetic exchange between populations, considering the low dispersal capacity of the females (Carron 2009). Therefore, more data concerning the dispersion capacity of this species is required (Kadej *et al.* 2018).

Conclusions

The present study provides important data which can be used to design an appropriate management plan for the species conservation of *E. catax*. Furthermore, it reveals a series of similarities between *E. catax* and *E. lanestris* concerning habitat preferences and ecological needs when choosing the oviposition site. According to these requirements, more attention should be given to *E. lanestris*, as its occurrence may be an indicator for the potential concurrent presence of *E. catax*.

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