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The effect of traditional land use of diurnal lepidoptera from Nature 2000 site "Dealurile Clujului Est"

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SUMMARY. The Natura 2000 site "Dealurile Clujului Est" is a vast area (approx. 18.000 ha), with valuable steppe-like and forest habitats still very well preserved. The importance of this site comes from the syntopic presence of 4 *Maculinea* taxons, an extremely rare situation in Europe, and from the fact that the mesophilic medows from this area have the highest plant diversity in the world. In this study we emphasize the effect of mowing and grazing on the butterfly diversity from the site. We used the transect method, walking 6 transects in mowed areas and 6 transects in grazed areas. We used similarity measures and unpaired t-test compare the two different land use types, regarding species number, number of individuals, species diversity and evenness.

Keywords: butterflies, grazing, mowing, similarity, traditional land use.

Introduction

The Natura 2000 site "Dealurile Clujului Est" is located at about 30 km from Cluj-Napoca in the geographical unit "Dealurile Clujului şi Dejului". Semi-natural grasslands are key habitats for maintaining biodiversity in European agricultural areas (Stoate *et al*., 2009), sheltering numerous species whose habitats have been destroyed on vast areas (Baur *et al*., 2006). The importance of the ROSCI0295 – Dealurile Clujului Est site comes from the syntopical presence of 4 *Maculinea* (*M. arion, M. alcon, M. teleius, M. nausithous*) taxons, which is extremely rare in Europe, the presence of some endemic Lepidoptera taxons, like *Pseudophilotes bavius hungarica, Cucullia mixta lorica* etc. Moreover, in 2012, Wilson *et al*. registered the global plant richness record for the semi-dry basiphilus grasslands in this area. There are numerous rare species present on the site area, like *Nepeta ucranica*, *Ranunculus*

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illyricus, Astragalus asper etc. (Bădărău *et al*., 2000). Also in the site we can find one of the largest populations of *Geniolimon tataricum* from Romania and Europe, and the largest populations of *Centaurrea trinervia* from our country. The proximity of Cluj-Napoca metropolitan area is a real menace for the future of the site, its habitats and rare populations within it, due to all the real estate, industrial and agricultural projects that are quickly developing and expanding. One of the reasons these specific structures of the mosaic grasslands from Dealurile Clujului area are still well preserved is that the most part of this site was used as mown meadows until War World Two, while other grasslands from Transylvania were transformed in agricultural crops or became overgrazed. But this doesn't mean that these mosaic grasslands are not affected by the changes in the land use, like intensive grazing, abandonment, drainages, industrial plans, etc. In this study we compare the effect of two traditional land uses, mowing and grazing, on the diurnal Lepidoptera communities from this Natura 2000 Site.

Materials and methods

The Natura 2000 Site "Dealurile Clujului Est" (Fig. 1) is locatet at about 30 km from Cluj Napoca city, in the geographic unit "Dealurile Clujului și Dejului", which is a part of the Someșan Plateau. It covers about 18.000 ha, with valuable steppe-like and forest habitats, still very well preserved. The xeric grasslands are used as pastures and the mesophile ones as meadows.

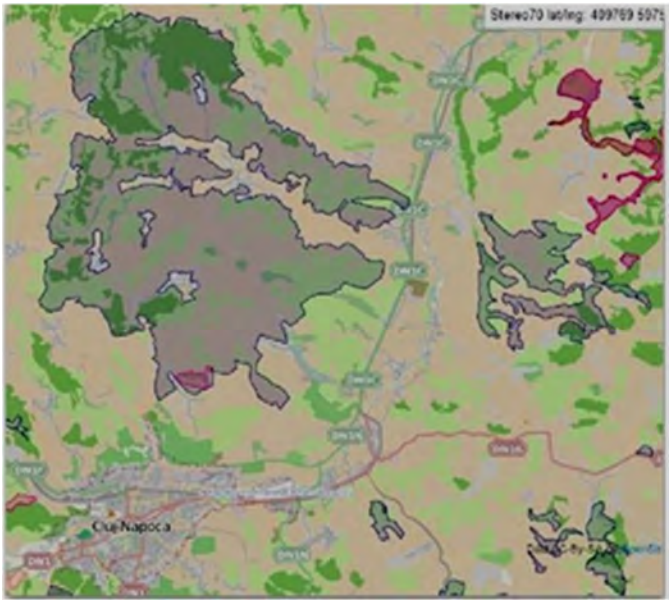

Figure 1. The Natura 2000 Site "Dealurile Clujului Est" map.

The study locations were located at Fânațul Sătesc, Fânațul Domnesc and Sechelișteе, at about 300 m above sea level (Fig. 2). We used the transect method, taking the samples with the entomological net. The butterfly species and individuals were recorded in an imaginary space of 2.5 m on each side and 5 m ahead. The data was colected from 12 transects (100 m long each), 6 located in mowed areas (4 in Fânațul Domnesc and 2 in Sechelișteе) and 6 located in grazed areas (2 in Fânațul Sătesc, 2 in Fânațul Domnesc and 2 in Sechelișteе). The surveys where made in good, sunny weather conditions, with temperatures above 18°C, wind-speed less than 15 km/h, between 10:00 and 16:00 -hours, from 21.04.2014 to 15.09.2014, every two weeks. All Rhopalocera and Hesperiidae species from were recorded. The identification of diurnal Lepidoptera was made after Rakosy (2012).

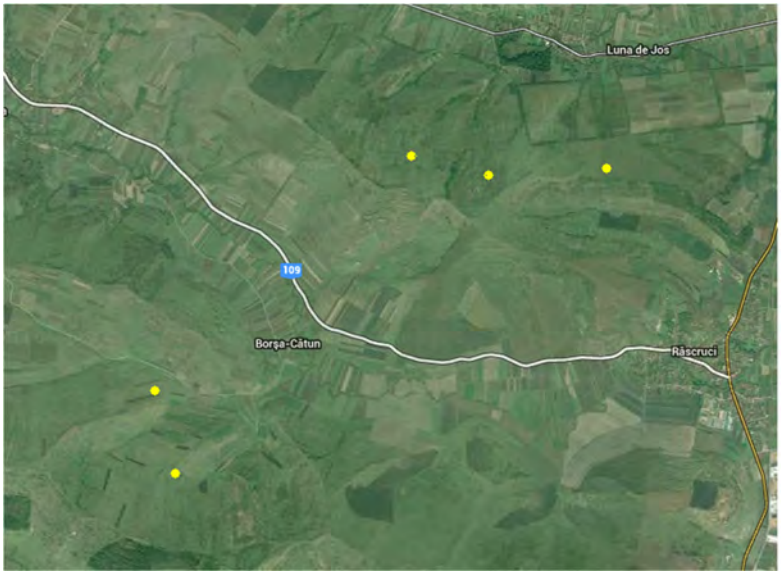

Figure 2. The localization of the study areas, whithin the Site.

In order to check whether we sampled a representative fraction of the local communities we calculated individual-based rarefaction curves (Krebs, 1998). For each transect species richness, individual abundance, Shannon-Wiener diversity index and Pielou evenness index were calculated.

In order to compare the two types of traditional land use, we used an unpaired t-test for individual abundances and diversity indices and Mann-Whitney U-test for species richness, because the data of the latterwas not following a normal distribution. To assess the similarity of the butterfly communities from grazed and mown sites we used single-linked clustering method with Morisita's index of similarity.

Indices, tests and clustering, as well as plots were computed with the program Past 3.0 Statistics (Hammer and Harper, 2001).

Results and discussion

A total number of 53 species of diurnal Lepidoptera (Table 1) were found in the 6 sampling months (from the total number of 213 found in Romania), belonging to 5 families: Nymphalidae (20), Lycaenidae (19), Pieridae (8), Hesperiidae (4), Papilionidae (2). The total number of individuals found in the 12 transects over the sampling period was 3135.

Table 1.

The list of diurnal Lepidoptera from the studied areas.

Taxon	**T1 C**	**T2 C**	**T3 C**	**T4 C**	**T5 C**	**T6 C**	**T1 P**	**T2 P**	**T3 P**	**T4 P**	**T5 P**	**T6 P**	**Red List**
Hesperiidae													
Erynnistages	2	0	3	1	0	2	0	2	0	0	0	0	LC
Ochlodess ylvanus	2	0	1	23	0	0	0	0	0	0	0	0	LC
Pyrgus malvae	2	1	0	0	1	0	1	0	0	0	0	0	LC
Thymelicus lineola	9	6	0	6	0	0	0	0	2	0	0	0	LC
Lycaenidae													
Celastrina argiolus	2	0	2	0	1	2	0	0	0	0	0	0	LC
Cupido argiades	2	2	0	0	0	0	0	0	0	0	0	0	LC
Cupido minimus	3	1	1	2	1	3	0	0	0	0	0	0	NT
Cyaniris semiargus	4	0	0	2	2	3	0	0	0	0	0	0	LC
Glaucopsyche alexis	1	2	1	3	0	3	0	0	0	0	0	0	LC
Lycaena dispar	0	0	0	0	0	0	0	0	0	0	1	0	VU
Lycaena thersamon	0	2	0	0	1	0	0	0	0	0	0	0	VU
Lysandra coridon	0	1	0	0	0	0	0	0	0	0	0	0	LC
Maculine a alcon	0	10	34	19	19	3	0	0	0	0	0	0	VU
Maculinea alcon xerophila	3	1	1	0	0	0	0	0	0	0	0	0	VU
Maculinea arion	1	0	0	0	0	1	0	0	0	0	0	0	NT
Maculinea nausithous	0	1	22	16	24	18	0	0	0	0	0	0	CR

Table 1 (continued)

Maculinea teleius	0	1	34	24	27	3	0	0	0	0	0	0	EN
Plebejus argus	23	25	24	23	20	25	18	16	0	35	17	13	LC
Plebejus argyrognomon	1	0	1	1	1	0	0	0	0	0	0	0	NT
Polyommatus amandus	0	0	1	0	0	1	0	0	0	0	0	0	LC
Polyommatus daphnis	3	1	0	0	0	1	0	0	0	0	0	0	LC
Polyommatus icarus	22	9	7	11	8	4	9	4	2	2	6	4	LC
Satyrium spini	0	2	0	0	0	0	0	0	0	0	0	0	NT
Nymphalidae													
Apatura ilia	1	0	0	0	1	0	0	0	0	0	0	0	VU
Aphanthopus hyperanthus	3	2	2	2	3	1	1	0	0	0	0	2	LC
Argynnis aglaja	3	1	3	2	4	12	0	0	0	0	1	0	LC
Argynnis paphia	0	0	0	0	1	0	0	0	0	0	0	0	LC
Boloria dia	3	2	4	4	8	10	0	1	0	0	5	3	LC
Boloria selene	0	1	1	0	1	0	0	0	0	0	0	0	LC
Brenthis hecate	14	11	7	8	10	12	0	0	2	1	0	0	VU
Coenonympha arcania	2	0	0	0	0	0	0	0	0	0	0	0	LC
Coenonympha glycerion	9	11	10	7	8	4	2	1	0	1	0	2	LC
Coenonympha pamphilus	35	44	31	31	33	43	42	42	28	33	34	27	LC
Issoria lathonia	1	0	0	0	0	0	0	0	0	0	0	0	LC
Maniola jurtina	134	126	135	114	124	120	36	45	42	32	76	56	LC
Melanargia galathea	47	48	40	37	25	20	14	12	14	21	23	17	LC
Melitaea athalia	2	1	4	1	3	4	0	0	0	0	0	0	LC
Melitaea aurelia	0	0	0	0	0	0	0	0	0	0	1	0	LC
Melitaea cinxia	1	0	1	0	0	0	1	0	2	0	0	0	LC
Melitaea didyma	3	0	0	3	0	0	0	0	0	0	0	0	LC
Melitaea phoebe	2	4	6	4	4	1		0	0	0	0	0	LC
Minois dryas	14	11	1	7	9	8	0	1	3	5	0	0	LC
Vanessa atalanta	1	0	0	1	0	0	0	0	0	0	0	0	LC

Table 1 (continued)

Papilionidae													
Iphiclides podalirius	1	0	0	0	1	0	1	1	19	11	6	2	VU
Papilio machaon	0	0	0	0	0	0	0	0	4	2	0	0	NT
Pieridae													
Anthocaris cardamines	2	1	2	0	3	0	0	0	0	0	0	0	LC
Aporia crataegi	10	6	1	3	3	3	0	1	3	4	0	0	NT
Colias crocea	0	1	0	1	0	1	0	0	0	0	0	1	LC
Colias hyale /alfacariensis	10	16	15	18	16	22	7	4	3	0	14	6	LC
Leptidea sinapis	20	15	12	12	11	13	1	0	4	3	0	0	LC
Pieri snapi	0	0	0	0	0	1	0	0	0	0	0	0	LC
Pieris rapae	0	0	0	0	0	0	0	0	1	0	1	0	LC
Pontia edusa	0	0	0	0	1	0	0	0	0	0	0	0	LC

Abbreviations:

T1C-Transect 1 mowed, T2C-transect two mowed, T3C-transect 3 mowed, T4C-transect 4 mowed, T5C-transect 5 mowed, T6C-transect 6 mowed, T1P- transect 1 grazed, T2P-transect 2 grazed, T3P-transect 3 Grazed, T4P-transect 4 grazed, T5P-transect 5 grazed, T6P-transect 6 grazed, LC-least concern, NT-near threatened, EN-endangered, VU-vulnerable, CR-critically endangered.

Of all the identified species, 15 (28%) are red-listed (Rakosy *et al*. 2002): 6 near threatened (*Cupido minimus*, *Maculinea arion*, *Plebejus argyrognomon*, *Satyrium spini*, *Papilio machaon*, *Aporia crataegi* etc.), 7 vulnerable (*Lycaena dispar*, *Lycaena thersamon*, *Maculinea alcon*, *Maculinea alcon xerophila*, *Apatura ilia*, *Brenthis hecate*, *Iphiclides podalirius* etc.), 1 endangered (*Maculinea teleius*) and 1 critically endangered (*Maculinea nausithous*). Three of the species we found, are on the annex II of The Habitats Directive (*Lycaena dispar*, *Maculinea nausithous* and *Maculinea teleius*).

The rarefaction curve (Fig. 3) shows that for the grazed areas a resonable number of samples have been taken, so a more intensive sampling would help discover only very few more species. But for the mown areas we can see that a higher number of transescts would have yielded an additional number of species to the study.

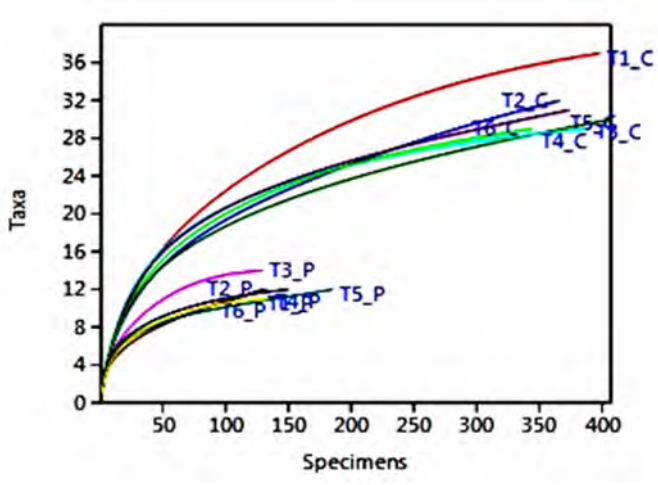

Figure 3. Rarefaction curve for the transects performed in 2014 in two traditional land use types (C-mowed, P-grazed) of the Natura 2000 Site "Dealurile Clujului Est".

Species richness of the mown transects was significantly higher than that of the gazed transects (Mann-Whitney U-test: NC=6, NP=6, MedianC=30.5, U=0, p=0.004) (Table 2, Fig. 4a). Individual abundance in mown transects was also significantly higher than in grazed transects (unpaired t-test: NC=6, NP=6, MeanC=375.2, MeanP=146.5, t=17.8 p<0.001) (Table 2, Fig. 4b).

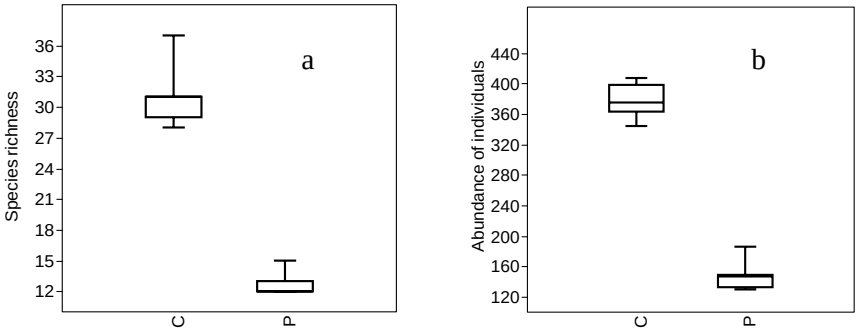

Figure 4. Butterfly species richness (a) and individual abundance (b) in the year 2014, in mown (C) and grazed (P) grasslands from the Natura 2000 Site "Dealurile Clujului Est". Box plots represent 25-75 percent quartiles (boxes), median (line inside the box) and standard deviation (whiskers).

Butterfly diversity (Shannon-Wiener index) of the mown transects was significantly higher than that of the gazed transects (unpaired t-test: NC=6, NP=6, MeanC=2.5, MeanP=1.9, t=9.0, p<0.001) (Table 2, Fig. 5a). Evenness index in mown transects was significantly lower than in grazed transects (unpaired t-test: NC=6, NP=6, MeanC=0.4, MeanP=0.5, t=-4.5, p=0.001) (Table 2, Fig. 5b).

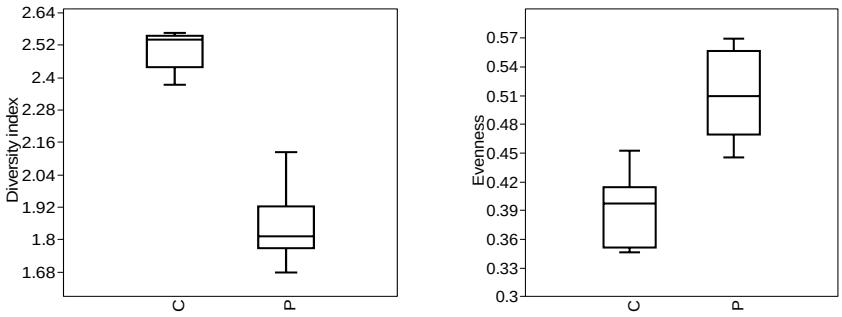

Figure 5. Butterfly diversity (a) and evenness index (b) in the year 2014, in mown (C) and grazed (P) grasslands from the Natura 2000 Site "Dealurile Clujului Est". Box plots represent 25-75 percent quartiles (boxes), median (line inside the box) and standard deviation (whiskers).

Table 2.

Butterfly species richness, abundance, Shannon-Wiener diversity index and Pielou evenness index for each transect performed in the year 2014, in the Natura 2000 Site "Dealurile Clujului Est".

	Species richness		**Abundance**		**Diversity**		**Evenness**	
	C	P	C	P	C	P	C	P
T1	37	12	398	133	2.564	1.810	0.351	0.509
T2	31	12	364	130	2.372	1.676	0.346	0.445
T3	30	15	407	147	2.437	2.122	0.381	0.556
T4	28	12	363	149	2.539	1.921	0.452	0.569
T5	31	13	375	186	2.553	1.807	0.414	0.469
T6	29	12	344	134	2.444	1.766	0.397	0.487

Regarding the species composition, the sampled butterfly communities are grouped by the type of land use (Fig. 6). The comunities from the grazed areas are very similar, as well as the ones from the mown areas.

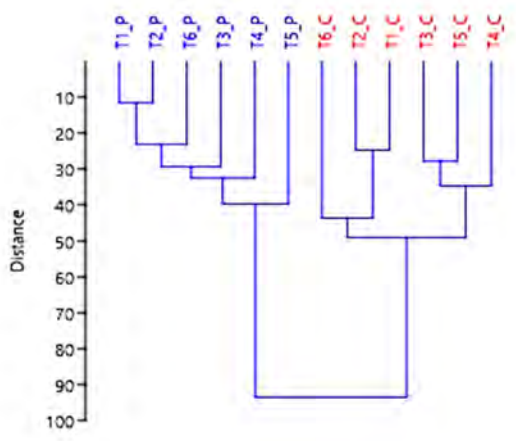

Figure 6. Similarity (Morisita index) of butterfly communities(single-linkage method) of mown and grazed transects, in 2014, in the Natura 2000 Site "Dealurile Clujului Est" (P-grazed, C-mowed).

Overall, we sampled 53 diurnal Lepidoptera species in 12 transects covering two types of land use: mown and grazed grasslands in the area of the Natura 2000 Site "Dealurile Clujului Est". Comparing our results to those of Rakosy and Laszloffy (1997) there are up to 27 further species present in this Natura 2000 Site, however these might be species connected to other habitat types. Furthermore our rarefaction plot showed that we might have discovered several other species in the mown meadows if sampling would have been more intensive. However, when comparing the two land use types, we found significant differences in the butterfly species richness, abundance, diversity and evenness index, showing a higher complexity and higher nature-value of the communities present in mown meadows. If the mown communities would have been sampled even more intensively, the difference between the two land use types would have been even more dramatic.

Even though mown meadows had a higher diversity in butterflies than grazed sites, their evenness was significantly lower, meaning that the number of species is not as evenly distributed over the total number of individuals as in grazed sites. This doesn't mean that they are less valuable communities, but rather that they have several species with higher abundance and many species with very little abundance (1-3 individuals) in the mown meadows, compared to the grazed sites, where there are only few species with a more even distribution of individuals per species. Indeed, if we look at table 1 we can identify several species with low abundaces in mown meadows. These are mostly species with high mobility, low habitat specificity and find

nectar sources or shelter in the mown meadows. Traditionally mown meadows tend to also have a higher structural diversity harbouring also small shrubs. Comparatively grazed areas tend to have a lower structural diversity: vegetation is kept short by constant grazing and shrubs have no opportunity to develop or are intentionally removed. On the other hand if we look at the typical grassland species (e.g. *Erinnis tages*, *Plebejus argus*, *Polyommatus icarus*, *Maniola jurtina* etc.) we will observe a higher abundance in mown meadows. Furthermore, especially sensitive species from the *Maculinea* genus are completely missing in the grazed sites. All these indicate that grazed sites tend to be impoverishd in butterfly communities, and that land use through traditional mowing is a more effective land use to promote butterfly diversity.

Conclusions

To maintain the high biodiversity of the Natura 2000 site "Dealurile Clujului Est", in general, and the diurnal Lepidoptera diversity in particular, we must maintain the grassland ecosystems with traditional mowing and preserve the mosaic landscape by alternating shrub areas, grassland areas and extensive grazing (Page *et al*. 2012). In order to point out even more subtle differences between types of land use (e.g. intensively vs. extensively grazed, hand-mown vs. machine mown) we will continue our study in the following two seasons with a more complex study of the butterfly communities in the same areas.

In addition to this, public awareness and information actions are very important for maintaining the biodiversity of these cultural landscapes.

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