“BABEȘ-BOLYAI” UNIVERSITY

Faculty of Biologie and Geologie

Integrative Biology Dorctoral School

PhD Thesis

-Summary-

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Cluj-Napoca
2019

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The structure and significance of the macrolepidopteran fauna of the Natura Site 2000 ”Dealurile Clujului Est”

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Key words:

Lepidoptera communities, high nature value medows, Nature 2000 Site, land use, traditional agriculture, mowing, grazing, cultural landscape, seminatural meadows, diurnal Lepidoptera, nocturnal Lepidoptera.

Introduction

In general, the land use was considered an environmental problem only at a local level, but slowly, it became one of global importance. The natural and semi-natural surfaces continue to decrease rapidly, at the same time with the intensification of agriculture in order to ensure the food needs for a growing human population. (Foley et al., 2005).

Human activities have altered the structure and composition of landscapes worldwide, especially by transforming natural habitats into agricultural lands. In areas with traditional, low intensity agriculture, many species can survive, while biodiversity is still high. However, the biodiversity characteristic of agricultural areas is increasingly threatened, due to the intensification of land use (Loss et al., 2014).

Today's European landscape is the result of many centuries of dynamic interaction between man and his natural environment. Currently, much of the biological and aesthetic value of the variety of cultural landscapes has been created and is maintained through long established agricultural systems, which are often well integrated and correlated with the environment. However, the rapid modernization that took place after 1930 resulted in the intensification of numerous European agricultural systems, having negative, severe effects on the environment (Bignal and McCracken, 2000).

A special cultural-historical area of Eastern Europe is Transylvania, which harbors a very high biodiversity specific to agricultural areas. Transylvania is characterized by a mosaic of low-intensity land use types, which provide many well-interconnected structures. The past management of the area has created a great heterogeneity, both local and regional. Recent studies (Loos et al., 2014) show that this mosaic structure of arable land and extensive agricultural practices in Transylvania are major benefits for butterfly conservation. Semi-natural elements appear everywhere in this type of landscape, which is an important reason why the species richness is so high along the different cultivated lands.

Unlike Western Europe, in the Transylvanian area the butterfly species richness is high not only in the meadows, but also in the arable areas. This suggests that more low-intensity agricultural practices and mosaic landscape management should be givin more importance, and arable land should be considered in butterfly conservation strategies (Bignal and McCracken, 2000; Rákosy, 2011; Lang et al. 2019). Some benefic actions for the species richness of the butterflies would be the continuation of small-scale agriculture, the production of a large variety of crops, including legume species and the maintenance of broad edges of crops and non-cultivated ruder areas. In the cultural landscape with

mosaic appearance, the shrubbery belts are true ecological corridors and places of refuge for invertebrates but also for numerous small vertebrates. (Loss et al., 2014).

Obiectivele acestui studiu sunt:

- Inventory of day and night butterflies fauna on the surface of the site;
- Identification of the effects of the different types of traditional land use on the butterfly communities in the studied site;
- Identifying the necessary measures for the protection and conservation of rare species and habitats within the site, in order to remove the threats and the negative evolution of the site.
- Highlighting the value and significance of lepidopteran communities for the semi-natural landscapes in the Natura 2000 Site "Dealurile Clujului Est" and for the local communities.

Chapter I. Study zone description

The present study was conducted within the Natura 2000 Site "Dealurile Clujului Est", located approximately 30 km N from the municipality of Cluj-Napoca, part of the geographical unit Dealurile Clujului and Dejului in the Someșan Plateau. Semi-natural grasslands are key habitats for maintaining biodiversity in Romania and Europe, sheltering numerous species whose habitats have been destroyed in quite large areas (Stoate et al., 2009). In the site these areas are occupying large surfaces and are still well preserved. The importance of the site ROSCI0295 – Dealurile Clujului Est arises from the syntropical presence of 4 species of the genus of butterflies *Maculinea* (*M. arion, M. alcon, M. teleius, M. nausithous*), rare species located in Europe, being a unique case in the world . Also important is the presence of endemic species, such as *Pseudophilotes bavius hungarica, Cucullia mixta lorica*. Moreover, in 2012, Wilson et al recorded in this area the world record for species richness for semi-dry basophil grasslands. There are numerous rare species of plants present on the site, such as *Salvia transsylvanica*, *Nepeta ucranica, Ranunculus illyricus, Astragalus asper*, etc. (Bădărău et al., 2000), the largest populations of *Geniolimon tataricum* in Romania and Europe. Unfortunately the proximity of the Cluj Napoca metropolitan area, is a real threat to the future of this site, of the rare habitats and populations within it, due to real estate developments, industrial and agricultural projects, which are developing and expanding rapidly. One of the reasons why these specific mosaic structures are so well preserved on this site, is that much of its surface was used as meadows until World War II, while other grasslands in Transylvania they were transformed into agricultural land or pastures that became overgrazed. But this

does not mean that this patchwork of grassland is not affected by changes in land use, such as intensive grazing, abandonment, drainage, industrialization, construction, etc.

Nature 2000 Site “Dealurile Clujului Est” covers an area of 18889.6 ha and is located in the North-West development region, in Cluj county, on the territorial administrative area of Cluj-Napoca municipality and of the communes of Apahida, Bonțida, Borșa, Chinteni, Dăbâca, Jucu, Panticeu and Vultureni (fig. 1.1). Dealurile Clujului Est is a site of community importance - SCI - and was established through the Order of the Minister of Environment and Sustainable Development no. 1964/2007 regarding the establishment of the regime of protected natural area of the sites of community importance, as an integral part of the European ecological network Natura 2000 in Romania, with the subsequent modifications and completions.

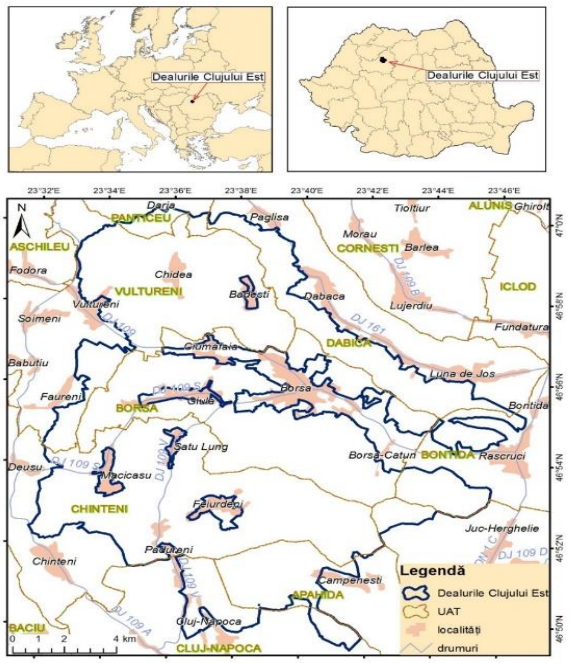


Figura 1.1. Location and limits of the site Dealurile Clujului Est (Planul de management integrat al sitului de importanță comunitară ROSCI0295, http://www.mmediu.ro/app/webroot/uploads/files/2016-04-11_PM_ROSCI0295.pdf)

The importance of the site ROSCI0295 – Dealurile Clujului Est is given by the presence of *Maculinea* butterflies, of the species-rich xero-mesophile meadows and of the valuable cultural landscapes (Timuș și colab., 2011).

The cultural landscapes within the site are particularly valuable, highlighting the traditional land use, which resulted in a mosaic structure of habitats, which proved to be so favorable to protected species of European interest (Rákosy 2011).

The general climatic regime is characteristic of the temperate transition climate with a pronounced dynamic of air masses. The relief contributes decisively to the territorial distribution of air temperature, through its own characteristics: altitude, massiveness, shape, orientation in relation to the cardinal points

and the circulation (Planul de management integrat al sitului de importanță comunitară ROSCI0295, http://www.mmediu.ro/app/webroot/uploads/files/2016-04-11_PM_ROSCI0295.pdf).

The most representative abiotiv elements of conservative the glimee or popular "copârșaie" (coffin) formations within the landslides of the Fânațele Clujului nature reserve "La Copârșaie".

Within the Dealurile Clujului Est site there were identified 6 types of ecosystems, distributed unevenly: xerophilous and meso-xerophilus meadows (24.23% of the site), mesophilic and meso-hygrophilic meadows (26.94% of the site), meadow forests (0.55%) from the site), thermonemoral forests (15.06% from the site), nemoral forests (0.37% from the site), shrub formations (6.24% from the site). The importance of all these categories of ecosystems, including the anthropic elements, is given by the fact that they can shelter or provide the trophic resources necessary for the various species of conservative interest present (Planul de management integrat al sitului de importanță comunitară ROSCI0295, http://www.mmediu.ro/app/webroot/uploads/files/2016-04-11_PM_ROSCI0295.pdf).

Chapter II. General aspects about high nature value systems in Romania

Agriculture is the dominant land use type in Europe, accounting for almost half of the total area of the European Union, therefore, its impact is large, affecting areas outside production. Rapid changes in agriculture in the post-war decades have led to unprecedented growth in productivity, but with negative effects on the ecological properties of agricultural systems, such as carbon storage, nutrient cycle, soil structure and function, water filtration, biodiversity. and pollination. These ecosystem services are based in particular on the diversity within the agricultural ecosystems (Stoate et al, 2009).

HNV-high nature value agriculture is increasingly recognized as an important tool for nature protection policies within the European Union. The concept of high natural value agriculture emerged in the early 1990s, with the growing recognition that the conservation of biodiversity in Europe depends on maintaining extensive agricultural systems on as large areas as possible (Beaufoy et al., 1994; Bignal and McCracken , 2000). This concept emphasizes that the goals of biodiversity conservation in Europe cannot be achieved only by protecting certain species or habitat types, or by designating certain areas for their management. (Kazakova and Peneva, 2015).

The long history of low intensity agriculture in Europe has created many unique and species rich assemblies. A large number of European species are currently dependent on a large part of their area of human influence on the habitats in which they live. However, industrialization has caused, directly and indirectly, a dramatic decline in flora and fauna, compared to the situation of about a century ago and the decline in ecosystem services, such as crop pollination or biological control of pests. Although

numerous conservation measures play an important role in mitigating the impact of intensive agriculture, supporting traditional low intensity practices in high value natural areas would be the most effective way to stop, or slow down, the decline of many species and rich communities. in species. (Sutcliff et al., 2014).

A common feature of central and eastern countries is the legacy left by communist agriculture from the beginning and middle of the century, which not only affected the structure and type of land use, but also it's biodiversity. However, even though the homogenization and intensification of agriculture, imposed by the communist regime led to increased agricultural productivity, it left behind many areas with semi-natural habitats (Young et al., 2007).

The proportion of high natural value land varies in Europe from less than 10%, in some countries (5% in Denmark), to over 50% in other countries, such as Slovenia (78%) (fig. 1). The average surface area of HNV in the European Union is 31.9% of the total agricultural area (Kazakova and Peneva, 2015), mostly located in the marginal areas of Eastern, Southern and North-Eastern Europe (Sutcliff et al., 2014). . This is generally represented by semi-natural grasslands in mountain areas, steppe areas, wetlands, permanent crops (Sutcliff et al., 2014).

In Romania the estimated percentage of HNV land is 33.7% of the total arable land, being quite high, compared to many other member states, being a strong point for the regions in which it is located, due to the wide range of public goods it offers (Kazakova and Peneva, 2015). Romania can boast with this figure due to the survival of thousands of semi-solstice farms and the traditional, non-intensive breeding of animals, especially in the mountain and sub-mountain areas. Currently, there are 3.9 million peasant households in the country, of which 2.8 million are less than one hectare (Page et al., 2012).

The land use types vary widely in the country. The arable areas, with more intense agriculture, are located in the south, east and west, while the growth of animals and meadows are characteristic of the central and northern areas. The agricultural areas in Romania have decreased slightly during the last twenty years, mainly due to constructions and afforestation, but also due to the population decline in rural areas (Page et al., 2012).

In the grassland areas, arable land and hayfields are usually owned by farmers in small parcels, while the pastures are owned by the municipality and rented partly by grazing associations from villages and partly by shepherds who have their own herds. This type of common pasture is a very important factor in the management of permanent grassland, especially the high natural value pastures, with extensive use, and plays a very important role in the viability of small farms. There are about 2 million

hectares of communal pasture, which represents almost half of our permanent pastures in the country. These common grasslands are generally on large areas, unorganized and often located in steppe areas, with low productivity.

In Romania thereare 3 types of HNV agriculture:

1. Extensive semi-natural pastures, spread over a large area of the country, but especially in the high areas (type 1 HNV), represented by the extensive grazing with sheep, for milk (Kazakova and Peneva, 2015).

2. Mosaic landscapes consisting of small farms, with a mix of permanent pastures and meadows (including wet meadows, which are very threatened at European level), rotating arable plots, forest pastures, shrubs and traditional orchards (HNV de type 2) (Kazakova and Peneva, 2015).

3. Arable areas that are home to birds of conservative importance, such as large and flat stretches along the Danube river, which host important migratory wild birds, such as the red-necked duck (*Branta rufficolis*) (HNV type 3) (Kazakova and Peneva , 2015).

HNV types 1 and 2 of agriculture occupy 4.8 million hectares of the total land with high natural value, ie 32% of the agricultural area used, compared with the European average of 12% (Page et al., 2012; Kazakova and Peneva , 2015).

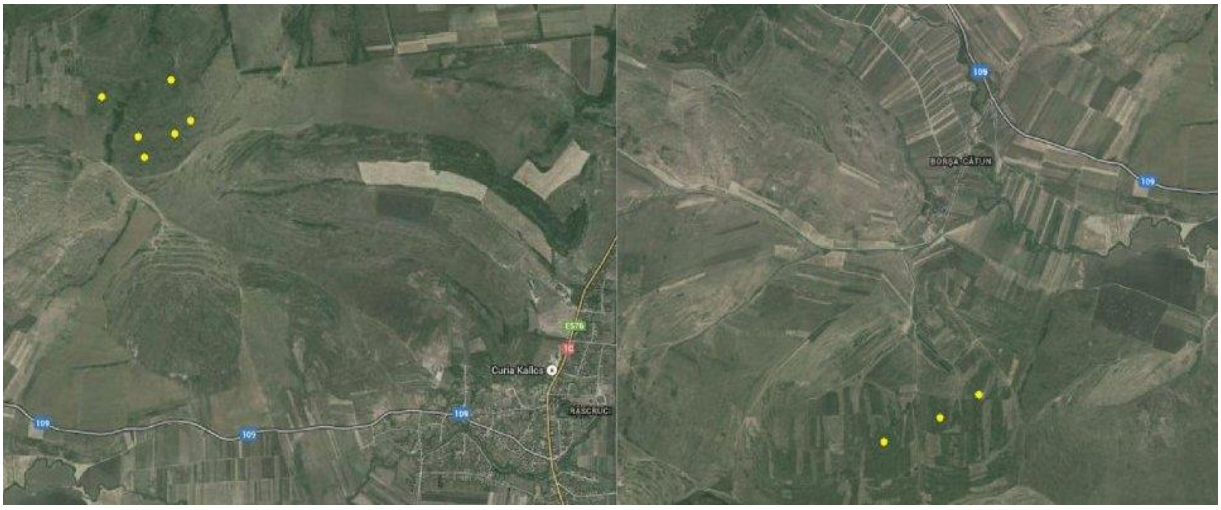
High nature value agriculture is also threatened in Romania, especially by intensification and abandonment. It is estimated that about 15% of the total area of permanent grassland is abandoned, especially in the mountain areas (Sârbu et al., 2004).

The predominance of small farms in Romania has long been considered a weakness of the agricultural system. But new concepts such as ecosystem services have called for the reassessment of the social and economic importance of semi-natural grasslands and small-scale farms, both at national and European level (Page et al., 2012).

Chapter III. Butterflies habitat preferences in Natura 2000 Site „Dealurile Clujului Est”

Materials and work methods

To determine the specific composition of the diurnal butterflies from the different types of habitats within the site, the linear transect method was used, collecting the individuals with the entomological fill. All butterflies were counted, by species, from an imaginary space of 2.5m on the sides and 5m on the front. The transects were located in 4 areas: Fânaţul Domnesc, Fânaţul Sătesc, Fânaia and Sechelişte (fig.1).



a b

Figure 1.Transect location (a- Fânaţul Domnesc and Fânaţul Sătesc, b- Fânaia and Sechelişte)

The datads were collected from 3 types of habitats and for each type were established 3 transects of 100 m length and 5 m width: sub-panonic steppe meadows (fig. 2) (2 transects in Fânaţul domnesc, 1 transect in Fânaia), Molinia grasslands (fig. 3) (2 transects in Fânaţul Domnesc, 1 in Sechelişte), sub-continental peripanonical shrubs (fig. 4) (1 transect in Fânaţul Domnesc, 1 in Fănaţul Sătesc, 1 transect in Sechelişte). Observations were made in good weather, sunny, with temperatures of at least 18˚C, wind speed less than 15 km / h, between 10:00 and 16:00, between April and September, 2013-2014, once every two weeks. We recorded all the species in the families Rophalocera and Hesperiidae, being determined after Rákosy,2013.

Figure 2. ub-panonic steppe meadows

Figure 3. *Molinia coerulea* grasslands

Figure 4. Sub-continental peripanonical shrubs

We assesed the species richness and number of individuals in all locations and habitat types. We calculated the Shannon-Wiener diversity index and the Pielou fairness index. To compare the different types of habitats we used the Kruskall-Wallis and Anova tests. To see the similarity between the butterfly communities, depending on the location and type of habitat, we used the single-link grouping method, with the Morisita similarity index. For data analysis we used the statistical programs Past 2.09 (Hammer and Harper, 2001) and Statview (SAS Institute, 1992-1998).

Results and discussions

In the two years of study we identified 65 species of butterflies, belonging to 5 families: Hesperiidae (6 species), Papilionidae (2 species), Pieridae (9 species), Lycaenidae (23 species) and Nymphalidae (26 species). The total number of observed individuals was 4317.

Of all these species, 28 (43% of the total number of species) have different degrees of endangerment: 14 near threatened, 9 vulnerable, 4 endangered, and one critically endangered species (*Maculinea nausitho*us) (Rákosy et al., 2003).

From the biogeographic elements, the most represented are the Siberian-European species, followed by the Palearctic and Eurasian species. The other categories (cosmopolitan, western-European Asian, European, Holarctic and Western-Palearctic) are present in a small number (Rákosy, 2007). From the point of view of the ecological profile, it can be observed that the dominant species are the mesophilic ones. Species with high ecological tolerance are also present in high numbers in the study, as well as those that prefer heat and dryness (Muntean et al., 2013).

The total number of species in each habitat is highest in the subcontinental peri-panonic scrubs, followed by the steppe grasslands, then those with Molinia (fig. 1). The high number of species in the studied shrub areas can be explained by the fact that in this habitat there is a favorable microclimate for butterflies, providing shelter against wind and excessive heat at noon. Another factor that could influence the higher number of species in shrub areas is the presence of woody plants (*Prunus spinosa*, *Crataegus monogina*), which represents an additional larval trophic base, compared to the two grassland habitats (Muntean et al., 2013).

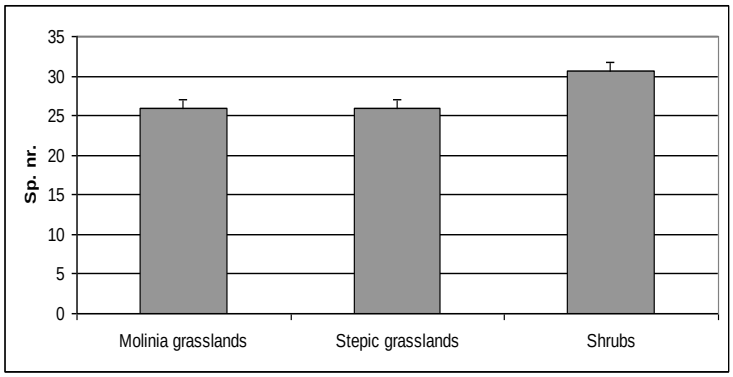


Figure 1. Species number according to habitat type

The Kruskal-Wallis analysis of the variance shows that there are significant differences between the three types of habitats studied, in terms of number of species ($p = 0.049$), and diversity ($p = 0.047$, but not from the point of view of of their evenness ($p = 0.88$) (Muntean et al., 2013).

The Anova similarity test showed that there are significant differences in the number of individuals, depending on the type of habitat ($F2 = 5.87$, $p = 0.049$) (Muntean et al., 2013).

The post-hoc test revealed that in the *Molinia* grasslands, the number of individuals is significantly higher than in the steppic grasslands (fig. 2). This is probably explained by the fact that the *Molinia* grasslands have a microclimate more favorable for butterflies, the higher height of the grassy vegetation than in the steppe meadows, representing a good shelter for them (Muntean et al., 2013).

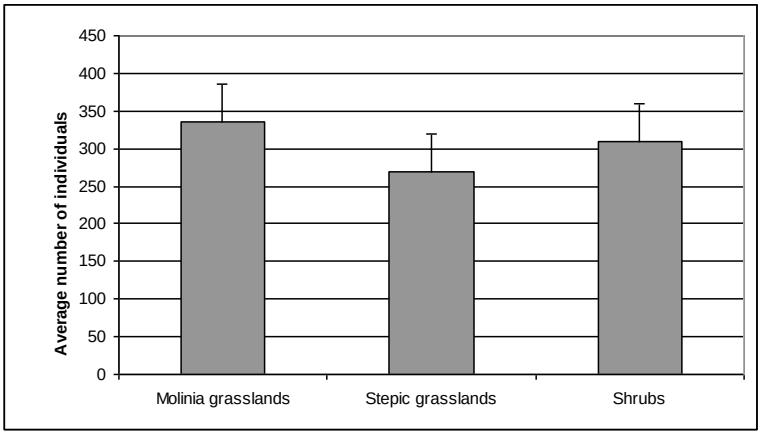


Figure 2. The average number of individuals in the three studied habitats.

Looking at the similarity in species composition, the investigated butterfly communities are grouped first by locality (fig. 3). The two transects in the Sechelişte area are very similar in terms of species composition, although they are located in different habitats (peri-panonic shrubs and *Molinia* grasslands), which can be explained by the rather small distance between the two transects from this area (less than 800 m). The communities in *Molinia* grasslands, in Fânaţul Domnesc are very similar, as well as those in the steppe meadows (Muntean et al., 2013).

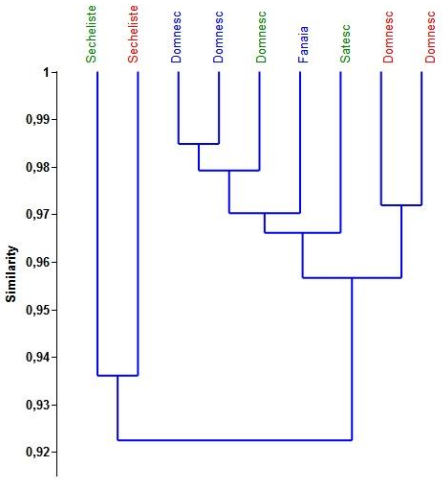


Figure 3. Similarity cluster (Morisita index) regarding species composition (single-linkage method) (red-*Molinia* grasslands, blue-steppic grasslands, green-peri-panonic shrubs).

Considering the species that are on the IUCN Red List (fig. 4), there is a significant difference between the grasslands with Molinia and the peri-panonic shrubs, the latter having a smaller number of species of interest than those with Molinia (Fdegrees of freedom = 5.672, p = 0.0414). Regarding non-endangered, near threatened, vulnerable and critically endangered species, no significant difference was observed (Muntean et al., 2013).

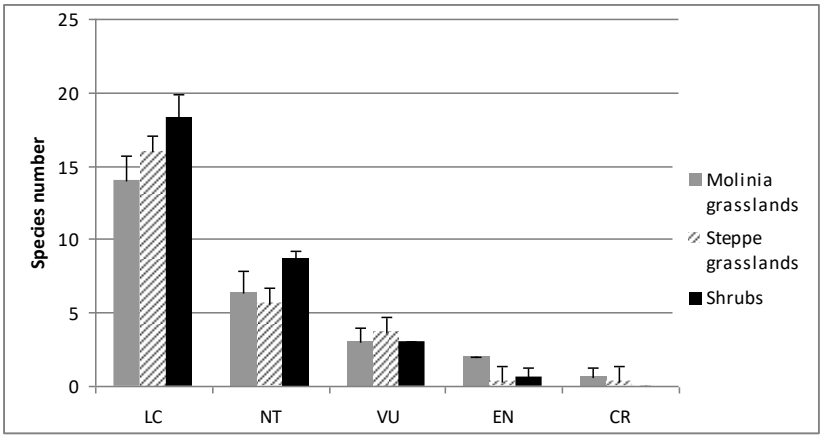


Figure 4 . Average number of Red List species, from each habitat type (LC-not threatened, NT-near threatened, VU-vulnerable, EN-endangered, CR-critically endangered)

Of the 65 species identified, 28 have different degrees of endangerment. The presence of such a large number of species of interest is due to the relatively intact preservation of the habitats they need, which was made possible by maintaining traditional practices over time (Muntean et al., 2013).

Capitolul IV. The influence of the traditional land use on the communities of butterflies in the high natural value grasslands from Natura 2000 Site „Dealurile Clujului Est”

In this study, we analyze the butterfly communities from semi-natural grasslands, mowed with lightweight mowers, intensive grazing and abandonment). Previous studies have shown that the traditional methods of using agricultural land, such as extensive grazing and manual mowing, maintain and stimulate a greater butterfly diversity (Schmitt and Rákosy, 2007).

The way the land is used today is not the only factor that has a major impact on butterfly species composition and richness in the mesophilic meadows that must be considered. Other factors, such as the land use type in the past, location, soil moisture, exposure and altitude can also play an important role in this regard. Due to the complexity and sometimes uncertainty of the type of use of grassland in Transylvania, this study aimed to verify whether butterfly communities have already reacted to land use changes, or if there are other important factors that influence the structure of these communities. .

Matherials and work methods

For this study we used the linear transect method (Taron and Ries, 2015), and was carried out between April and September 2014. Two types of land use were taken into consideration were the traditionally mowed grasslands and grazed grasslands. For this purpose, 12 linear transects, each 100 m

long, were located on slopes with Nordic, Northwest and Northeast exposure. Six transects were located in traditionally mowed grasslands (coded in graphs and tables with letter C), and the other 6 on grassland grazed with sheep (coded in graphs and tables with letter P). The surfaces studied within the site were Fânațul Domnesc, Fânațul Sătesc and Sechelișteе (fig. 1.1).

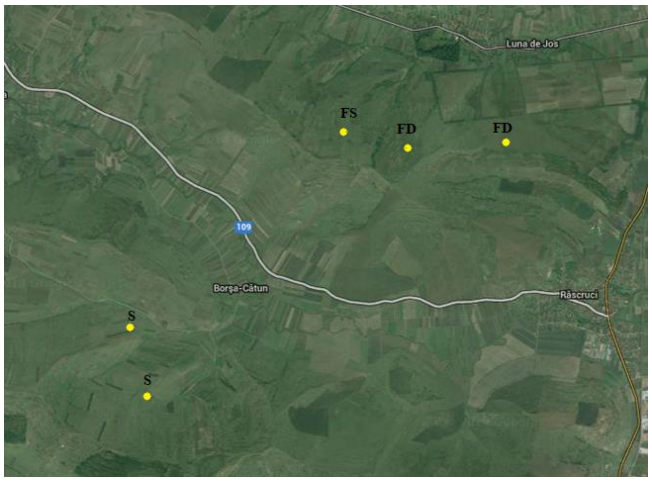


Figure 1. Localisation of the study ares (FD- Fânațul Domnesc, FS- Fânațul Sătesc, S- Sechelișteе)

Each transect was crossed once every two weeks, between April and September 2014. With the help of the entomological net, all the species of diurnal lepidoptera were recorded from a virtual space of 5m x 5m x 2m, in front of and in the sides of the person crossing the transect. . Observations and recordings were made only in good weather conditions (sunny weather, with a minimum temperature of 18°C, maximum wind speed of 15 km/h, between 10am and 4pm) (Muntean et al., 2015).

For each transect we calculated the species richness, the abundance of the individuals, the Shannon-Wiener diversity index and the Evenness index. To compare the two types of land management, the t test was used for the abundance of individuals and for the diversity index. The Mann-Whitney test was used for the species richness. In order to evaluate the similarity of the communities in the grazed and mowed areas, the Morisita similarity index and the single-linked clustering method was used (Muntean et al., 2015).

The advantage of this method is that the counts are directly proportional to the actual size of the population studied. The method is also widely used in many European countries, making it possible to compare data sets in different countries and to develop international butterfly monitoring databases. Another advantage is its simplicity. The protocol of the method, although it is quite rigorous, is not complicated, it can be easily explained to any citizen who is passionate about butterflies, even if he has no previous scientific training in this field (Taron and Ries, 2015). The diurnal lepidoptera species were

identified after Rákosy, 2013, and the data were statistically processed using the Excel and Past 3.0 Statistics programs (Hammer and Harper, 2001).

The study second study, conducted by serpentine transects method, was carried out in 2015 on 23 plots (fig. 2) and in 2016 and 2017 on 24 plots of 1 hectare each, located in the Natura 2000 Site "Dealurile Clujului Est" and in the immediate surroundings, in the meadows. mesophiles with homogeneous vegetation, on slopes with N-NV exposure. This type of grassland is most commonly found in Transylvania and is used for most agricultural practices. In the center of each plot was chosen a square with a size of 50 square meters. The plots beare located in the abandoned meadows, pastures and meadows.

Within the meadows, 3 types of mowing were chosen:

• traditional (manual): 4 MT coded plots

• with heavy tractors: 4 parcels coded MH

• with light mowers: initially 3 MB coding parcels (the mowers used are manufactured by Brielmaier), then in 2016, one was added.

The grazed plots were subdivided into:

• intensive pasture: 4 plots of coding PI, with a load of over 0.7 UnitățiVităMare/ ha

• extensive pastures 4 PE-coded plots, with a load of less than 0.7 UnitățiVităMare/ ha.

The abandoned meadows included 4 parcels, with the abbreviation AA, where any type of management was abandoned 5-6 years ago.

The main advantage of this method is a better coverage of the studied surface, thus having a greater chance of identifying a higher number of species characteristic of a particular area than in the case of the linear transect method, so the collected data reflects better the actual composition of the studied butterfly communities (Craioveanu et al, 2016).

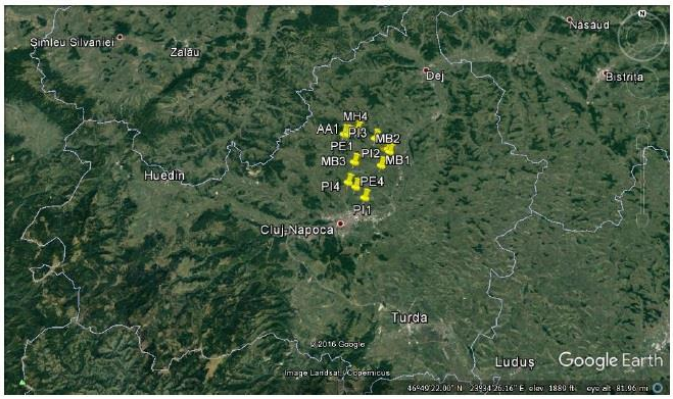


Figure 2. The map of the plots of mesophilic grasslands, on which different types of traditional and modern practices are applied (abandoned grasslands - AA, extensive grassland PE -intensive grassland - PI, mowed traditionally - MT, mowed with the tractor -MH, mowed with lightweights mowers -MB)

The species number and the abundance of butterflies were tracked using a modified transect method (the seprentine transect method) (Douwes, 1976; Hall, 1981) on each study square. Thus, each transect was crossef every two weeks, between May and September, 2015-2016. The squares were crossed in serpentine, with a distance of 5m between turns, all the species being recorded with the help of the entomological net, in a virtual space of 5m x 5m x 2m, in front and in the sides of the person who registers, thus covering the entire surface. square. The transects were only run in good weather conditions (sun, temperature over 18 ° C, wind speed below 16 km / h - corresponding to the value 3 on the Beaufort scale), between 9:00 and 17:00. The identification of diurnal lepidopteran species was done after Rákosy, 2013.

The Shannon-Wiener diversity index was calculated from the values of species number and abundance. Parameter variations, number of species, abundance and diversity between types of use were identified with the help of variance analyzes or the Kruskal-Wallis test (if the data did not have a normal distribution). In order to verify the similarity of the plots in terms of the composition of the butterfly communities, a cluster analysis was performed according to the UPGMA method, using Euclidean distances as an index of similarity. Data were analyzed statistically using Microsoft Office Excel 2016 and Past 3.14 (Hammer et al., 2001).

Results and discussions

For the study of the influence of the type of land use on the communities of diurnal butterflies from, by the linear transects method 53 species were identified, and by the one of the serpent transects 87 species.

In the study by the linear transects method, there were significant differences between the number of species identified in the meadows and pastures, whereas by the second method, in the 3 years of study there were no significant differences in the number of species between the plots with different types of land use. The species richness was significantly higher in the mowed plots than in the grazed ones in the 2014 study (fig. 1). In the study by the serpentine transects method, the specific wealth varied significantly between 2015 and 2016, being higher in 2015, but after adding the data from 2017 the variation was no longer significant (fig. 2). The abundance of individuals in the mowed plots was significantly higher than in the pastures, in the study carried out by the transects method, and by the second method the abundance of individuals of each species varied significantly between years, the biggest difference being between 2015 and 2017 The specific diversity (Shannon-Wiener index) in the study by the linear transects method was significantly lower in the grassland than in the meadows (fig. 3).

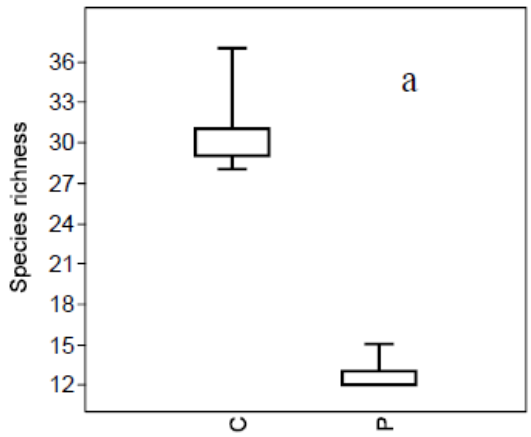


Figure 1. Differences between the species richness in the two types of land use studied in 2014, by the linear transects method (mowing-C and grazing-P)

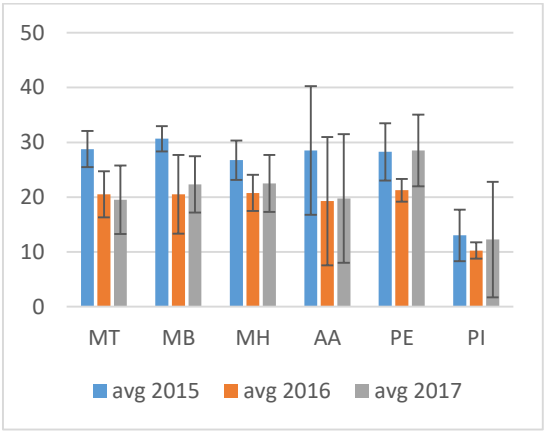


Figure 2. Differences in the number of species in all types of land use between the 2015, 2016 and 2017 study seasons.

In the study by the snake transects method, the value of the Shannon index (H) indicated a different diversity between the types of use in the 2015 season, but in the 2016 and 2017 seasons the Shannon

Wiener index did not change so much (fig. 4). In terms of species composition, the communities of butterflies studied in 2014 are grouped according to the type of land use, and in the 2015-2017 study, the cluster analysis indicated in all 3 seasons of the study a closer grouping of the plots. Traditionally

mowed and with Brielmaier light mowers

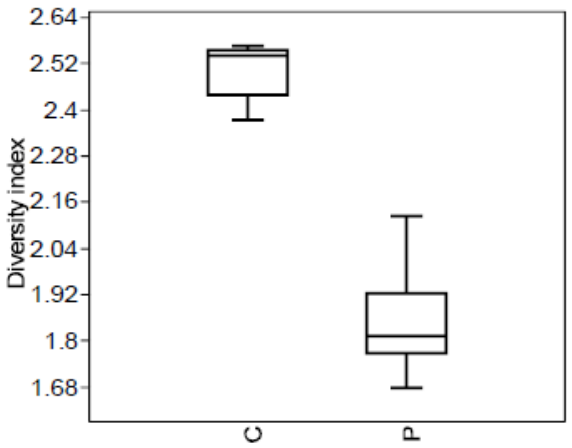


Figure 3. The butterfy diversity in the mowed areas (C) and the grazed areas (P) studied.

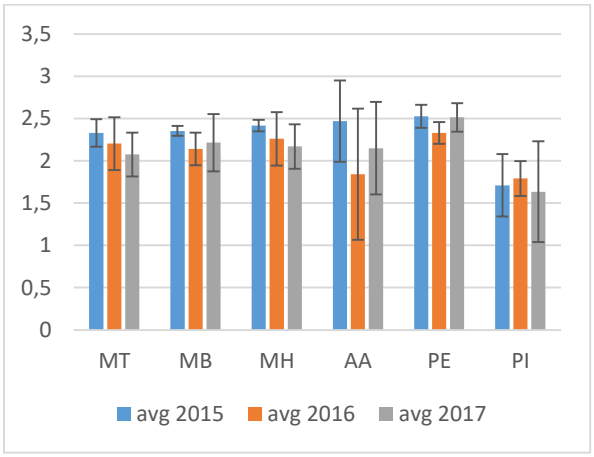


Figure 3. Mean diversity (Shannon's H) of diurnal lepidopterans from different land type uses (MT - manually mowed plots, MB - Brielmaier car mowed plots, MH - tractor mowed plots, AA - abandoned plots over 4 years, PE - extensively grazed plots, PI - intensively grazed plots) ± standard deviation.

Comparing the two types of land use, in the study by the linear transects method, significant differences were observed regarding the species richness, abundance and diversity, demonstrating a greater complexity and natural value of the butterfly communities in meadows, compared to pastures.

From the study by the serpentine transects method, the meadows were in all the years of study richer in diurnal lepidopteran species, thus resulting in the importance of encouraging in the future the extensive mowing of the meadows (mowed once a year, after the middle of June, preferably with traditional methods or with light mowers). Plots mowed with Brielmaier mowers had a greater abundance of individuals, which confirms the biodiversity utility of such mowers, that can replace the manual mowing. Intensive grazing with sheep has a clear negative effect, proved by the decrease in the number of species, individuals and overall diversity indexes in diurnal lepidopterans. The communities of diurnal moths in the meadows mowed with Brielmaier light mowers were closest to the index of similarity to those mowed manually, so it can be concluded that these mowers could replace the traditional manual mowing, without adversely affecting the communities of day butterflies.

Considering other factors, such as the past land use type, location, soil humidity, exposure and altitude, it turned out that land use today, while important, is not the only factor modeling the butterfly

communities. In addition, soil locality and moisture play an important role in determining species composition, most butterfly species identified as being mesophilic in terms of ecological preferences, in accordance with the dominant type of grassland. Estimates of the parameters regarding the speciess richness showed that this was different depending on the use of the past lands, being highest in the pastures that were mowed in the past and the lowest in the pastures that were in the past arable land.

Looking at the degree of endangerment of the species, only the managed grasslands (mowed and grazed) have sheltered species with different degrees of threat, these missing from the abandoned grasslands. More threatened species have been identified on the meadows than on grasslands. All these results regarding the specific richness, the ecological profile and the conservative status, indicate that most butterflies prefer meadows, and the combination between mowing once a year, late in the summer, followed by grazing was the best management method for the biodiversity of the butterflies and for the presence of species with different degrees of threat. The extensively grazed meadows are also quite rich in butterfly species, but due to the large difference between intensive and extensive grazing, our study has overall shown a lower quality of this type of management. The abandonment has benefited more species of butterflies, especially those that depend on a higher soil moisture or the presence of forest edges, such as *Argynis aglaja* and *Anthocharis cardamines*, but has reduced the abundance of species of high natural value meadows, such as *Aricia agestis*, *Cupido osiris*, *Euphydrias aurinia*, *Melanargia galathea.*

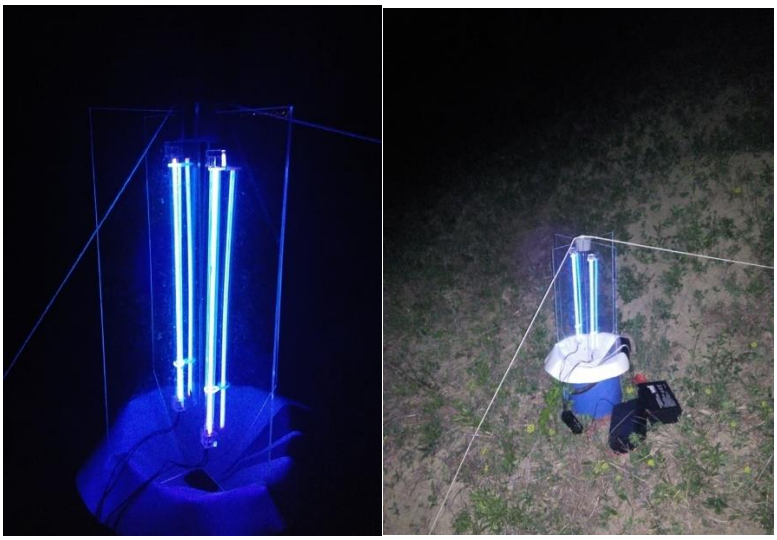
Chapter V. The influence of the traditional land use on the communities of moths in the high natural value grasslands from Natura 2000 Site „Dealurile Clujului Est”

The present study tries to highlight the variations in the nocturnal lepidopteran communities from the Natura 2000 site. The research was conducted over two years, between 2015-2016.

Matherials and work methods

The data cllecting was made using "bucket" type portable traps, provided with 8W UV tubes, powered by 12 V batteries (Fig. 1 a and b). The traps were placed on the ground at least once a month, between March and October of each year. 12 meadows were selected from the Natura 2000 site "Dealurile Clujului Est", with 4 different uses: 3 meadows (C), 3 extensive pastures (PE, with a load of less than 0.7 UnitățiVităMare/ ha), 3 pastures intensively (PI, with a load of over 0.7 UnitățiVităMare/ ha) and 3 abandoned grasslands (A) (fig. 2). Species determinations were made after works on the fauna of Romania (Rákosy, 1996; Szekely, 2010; Szekely, 2011), but also on those related to the fauna of

Europe (Hausmann, 2004; Segerer and Hausmann, 2011; Varga et al, 2012). For the identification of the species on the Red List, the Lepidopteran Catagulum of Romania was used (Rákosy et al., 2003). The geographical and ecological classification of the determined species was made following the system proposed by Rákosy, 1997.



a b

Figure 1. UV "bucket" portable trap, equipped with 8W UV tubes, powered by 12 V battery

Figure. 2. Location of study areas (A-dropout, C-meadow, PE-extensive grazing, PI-intensive grazing)

The Shannon-Wiener diversity index and the evenness index were calculated from the values of the number of species and abundance. In order to be able to compare the data of different types of land use, the normal distribution of the data was verified using the Shapiro-Wilk test (Shapiro and Wilk, 1965). The arithmetic means of the values of number of species, abundance of individuals, and diversity were calculated for each type of use (PE, PI, C, A). The variations of the parameters number of species,

abundance and diversity between the types of use were identified with the help of variance analyzes. Microsoft Office Excel 2016 and Past 3.14 were used for statistical analysis of data (Hammer et al., 2001).

Results and discussions

In total, during the two years of study, 258 species of nocturnal macrolepidoptera were identified, summing up 19873 individuals, belonging to 16 different families.

In terms of biogeographic spread, the vast majority of species are Eurasian (163 species), followed by the Palearctic (20 species), the Holarctic (19 species) and Pontomedirean species (18 species).

From the point of view of the ecological character, the majority species are the mesophilic ones (141 species), followed by the mesohygrophilous ones (35 species) and the mesotermophilous ones (27 species).

Between the two years of study there were no significant differences regarding the species richness (test t: t = 1, p = 0.5), in 2015 (257 species) was slightly larger than in 2016 (252), as is the case for the total number of individuals collected.

The total number of species identified on each type of land use did not show significant differences between the two years of study (ANOVA: df = 1, F = 0.11, p = 0.75), but the intensively grazed grasslands had a significantly smaller number of species than in the other types of meadows, in both years of study. However, the differences between extensively grazed, mowed and abandoned pastures were not significant (fig. 1). In intensively grazed meadows the communities of nocturnal macrolepidoptera were dominated by a small number of common species, without high ecological needs (such as *Deillephila porcellus, Noctua pronuba, Spilosoma lubricipeda*), whereas in the extensive pastures, meadows and abandoned meadows, more specialized taxa dominated (such as *Trichiura crataegi, Mythimna pudorina, Catocala fulminea, Herminia tarsicrinalis*).

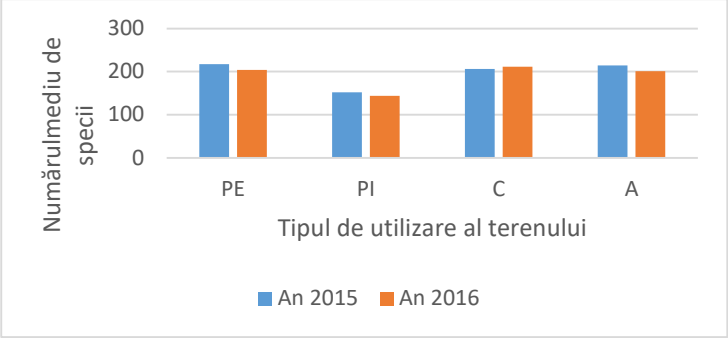


Figure 1. The total number of species recorded in the 4 types of grassland (PI = intensively grazed grassland; PE = extensively grazed grassland; C = mowed grassland; A = abandoned grassland), in the two years of study

. The total number of individuals collected from each type of land use did not show significant differences between the two years of study (ANOVA: df = 1, F = 0.032, p = 0.86), but the total number of individuals from intensively grazed grassland was significantly smaller than in the other grasslantypes in both years (fig. 2.)

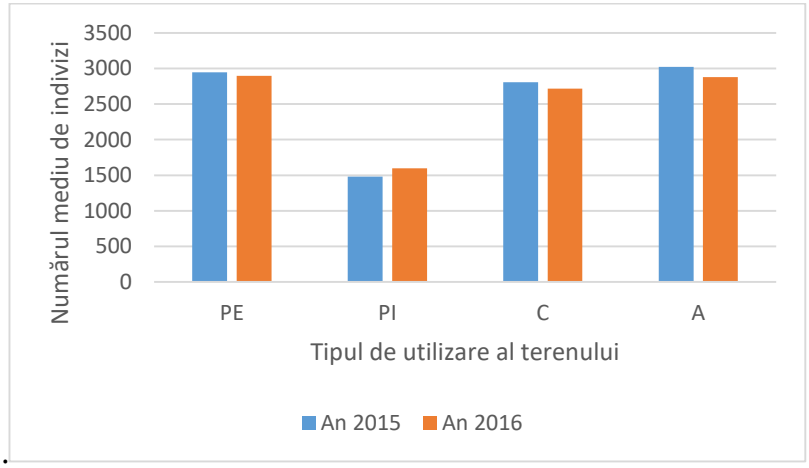


Figure 2. The average number of individuals recorded in the four types of grassland (PI = intensively grazed grassland; PE = extensively grazed grassland; C = mowed grassland; A = abandoned grassland) in the two years of study.

The variety of night lepidoptera species (Shannon-Wiener index) was significantly lower in the case of intensive pastures, compared to the other types of land use on which the study was conducted (t test for PI and PE: t = 196, p = 0.003 ; PI and C: t = -321, p = 0.001; PI and A: t = -111.92, p = 0.05) (Fig. 3). There were no significant differences between the other types of land use. The highest diversity was recorded in the abandoned meadows. This is because the grasslands included in the study were abandoned for a maximum of 10 years. As Erhardt explained in 1985, in the newly abandoned meadows,

there is initially an increase of the specific diversity, due to the increase of the number of plant species, which is in a direct correlation with the species richness of the butterflies. But as the bushes invade the land, the diversity of plants begins to decline, followed closely by that of lepidopterans. In more recent studies, Balmer and Erhart (2000) have shown that the later successive stages of abandoned grasslands show a decline in the specific richness and diversity of lepidopterans, the most affected species being those specialized in grasslands, which are gradually being replaced by generalist ones.

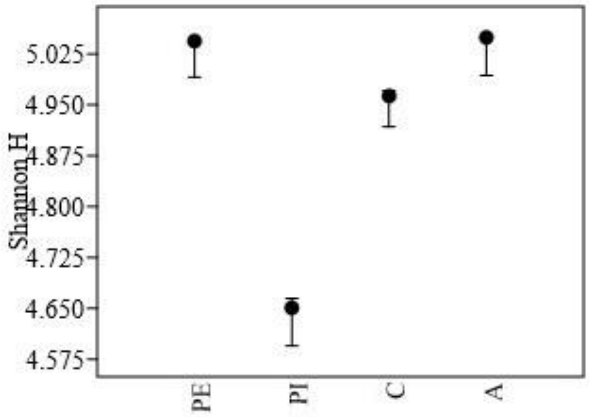


Figure 3. Species diversity for the 4 land use types (PI = intensively grazed grasslands; PE = extensively grazed grasslands; C = mowed grasslands; A = abandoned grasslands)

Of the 258 species identified, 79, ie 31% have different degrees of endangerment (53 near threatened, 21 vulnerable, 2endangered and 3 critically endangered). This emphasizes the importance of high value semi-natural grasslands in biodiversity conservation. The two endangered species are *Archanara dissoluta* and *Chazaria incarnata,* both belonging to the Noctuidae family, and the 2 critically endangeredd species are *Plusidia cheiranthi* and *Pyrocleptria cora*.

The number of species with different endangerement categories was considerably lower in the case of intensively grazed grassland than in the extensive, mowed or abandoned fields. Out of the 79 species listed on the Red List, only 19 are found on the intensive pastures, unlike the rest of the land use types, where there are over 50 (fig. 4).

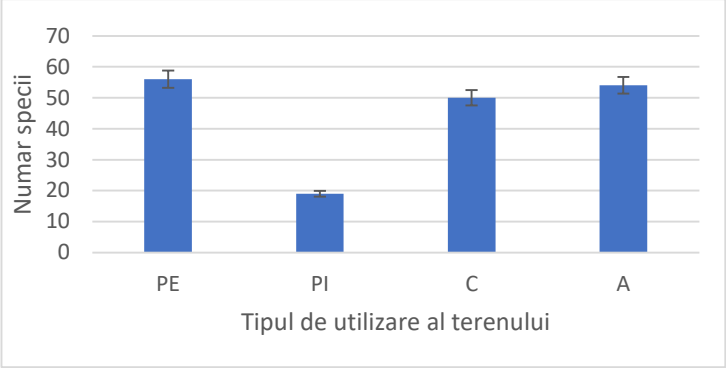


Figure 4. The number of species with different degrees of endangerment from each type of land use (PI = intensively grazed grasslands; PE = extensively grazed grasslands; C = mowed grasslands; A = abandoned grasslands).

This distribution of the endangered species, together with the large differences of the specific wealth, the total number of individuals and the specific diversity between intensively grazed grasslands and the other 3 types of grassland included in the study, demonstrates the negative effect of this practice on biodiversity, but also the importance of traditional agricultural practices. extensive in maintaining it.

Chapter VI. Protection and conservation measures macrolepidopteras and their characteristic habitats in Natura 2000 Site„Dealurile Clujului Est”

The Natura 2000 site "Dealurile Clujului Est" already has an Integrated Management Plan, where there are clearly presented pressures and threats that have a negative impact on butterfly communities, and their characteristic habitats, such as overgrazing, intensive agriculture, the transformation of forests and grasslands in arable land, their abandonment and arson, pesticide use, etc. In order to maintain the favorable conservation status of the habitats and species for which the site was established, it is necessary to monitor and apply the measures to ensure their conservation status, to improve the management of the land in the site, but also to increase the public's information regarding the natural values of the site and the activities with negative impact on them.

One way to encourage the population to comply with the requirements necessary for the conservation of this site, is the agri-environment and climate payments, which create the framework necessary for the large-scale application of general extensive agricultural methods, which respond to the conservation needs to a wide range of species or habitats. Due to the large areas of high natural value meadows present on the site, but also to certain species of protected butterflies (*Maculinea teleius, M. nausithous*), many owners/administrators of land in the site may benefit from agri-environment and

climate payments. Measure 10 agro-environment and Package 6- Important grassland for butterflies (*Maculinea* sp) are already well known by the land owners that fall for the compensatory payments of these management measures. However, compliance with the requirements of these measures by the owners enrolled in the programs must be verified and monitored. For *Maculinea* butterfly species, for example, annual monitoring of their populations on the site and compliance with the requirements of Package 6 does not involve a great deal of effort, neither in terms of time nor financially.

In addition to the management measures already in place, a few targeted measures would be needed for some species with particular ecological needs. For example, *Lycaena disappear rutila* (VU) and *Euphidrias aurinia* (EN)) are hydrophilic species, and in order to conserve and maintain their populations on site, it would be necessary to stop: drainage, which destroys wetlands of any kind, overgrazing, which does not just destroy the vegetal layer, but also fills the soil and waters with nitrates and nitrites, drastically reducing their quality, the use of pesticides, which affect all insects, not only the above-mentioned species and the fires of dry vegetation in spring and autumn.

Muschampia cribrellum (CR), *Muschampia tesellum* (CR) and *Eriogaster catax* (VU) are species characteristic for shrub medows from the Natura 2000 site "Dealurile Clujului Est". In order to conserve these species in the site, it is necessary to stop the burning of grasslands, which don’t just destroy grassy vegetation, but also destroy the shrubs. Intensive grazing, especially with sheeps, but also intensive mowing, several times a year, with heavy machinery, should be replaced by extensive grazing and traditional mowing, or with lightweight machinery. The complete abandonment of traditional practices in these types of meadows eventually leads to the complete invasion of the land whith shrubsand the loss of flowering herbaceous species. For this reason, this practice should be avoided.

Plusidia cheiranthi is an extremely rare species, and identifying it in the site "Dealurile Clujului Est" is extremely important. And in this case, new research is required to establish the population numbers and ecological requirements for this species in order to propose an appropriate management program.

All our studies show the importance of preserving traditional agricultural practices, such as manual mowing, extensive grazing, but also the negative effect of intensifying agriculture (heavy machinery, intensive grazing).

In agro-ecosystems, monitoring the environmental factors is fundamental to finding and overseeing changes in land use, management practices, chemical use, or climate change (Zaks and

Kucharik, 2011). The results of these monitoring help to establish and improve agri-environment schemes and to evaluate and draft environmental policies (Lovett et al., 2007).

The effort required to monitor a particular environmental indicator is determined by the spatial and temporal variation of the measured parameter, the probability of detecting an effect on the target parameter, the magnitude of the effect and the acceptable standard error. The main purpose of the monitoring schemes is collecting of a good quality data set, with an acceptable and justified effort, that is to balance the quality of the data and the costs needed to obtain them (Lovett et al., 2007; Brands et al., 2017). The statistical analysis of the variation can be used to improve the efficiency of monitoring the environmental factors, allowing the sampling models to maximize the obtained information, in relation to the resources invested in the data collection (Perry et al., 2003; Clark et al., 2006; Levine et al., 2006; 2014).

A cost-effective scheme for monitoring stress factors for butterflies is realistic and feasible and requires much less monitoring effort than previously estimated. Thus, following the studies of Lang et al. (2019), the number of transects required to detect a 10% loss in the number of species 3-5, ie a much smaller number of transects for an efficient monitoring scheme compared to previous studies (e.g. Lang, 2004; Aviron et al., 2009; Lang et al., 2016). For monitoring of butterfly species in general, the costs involved are not very high. For example, fieldwork and data entry for two transects 4 times a year would take approximately 29 hours per year. In order to analyze certain specific subgroups (such as the Red List species) and to observe the effects on their abundance, an increase in the number of transects was required. Thus, processing the data resulted in the need for 3-12 transects to observe a 30% reduction in species abundance.

Concluzii

Following the studies carried out in the Natura 2000 Site "Dealurile Clujului Est" during 2013-2017, we identified 345 species of macrolepidoptera. Of these, 87 were butterfly species, belonging to 6 families and 258 mothspecies , belonging to 16 families.

From the study for the identification of butterflies habitat preferences, it appears that the total number of species in each habitat is highest in the sub-continental peri-panonic shrubs, followed by the steppe grasslands, then those with *Molinia.* This can be explained by the fact that the shrubs present a favorable microclimate for butterflies, providing shelter against both wind and excessive heat during the midday hours, and woody plants are an additional trophic base compared to grassland habitats. However, the number of individuals was highest in the meadows with *Molinia* and here we also encountered the

most Red Listed species, so the conservation of this habitat in the site is of high importance.

Comparing the different types of land use, significant differences were observed regarding the specific richness, abundance and diversity of the diurnal butterflies, proving a greater complexity and natural value of the communities of butterflies in meadows, compared to those in pastures. Plots mowed with Brielmaier mowerss had a greater abundance of individuals, which confirms the biodiversity utility of such mowers that successfully replace the manual mowing. The type and duration of land use in the past is also a very important factor in the structure of the day butterfly communities today, the highest species richness being in the pastures that were mowed in the past and the lowest in the pastures that in the past were arable land. The combination of mowing once a year, late in the summer, followed by grazing, was the best management method for the biodiversity of butterflies and for the presence of species with varying degrees of threat.

The nocturnal macrolepidoptera were also negatively influenced by the intensive grazing, the species richness, the diversity and the number of individuals being significantly smaller in these pastures, compared to the meadows and abandoned lands. Also in the intensively grazed meadows the communities of nocturnal macrolepidoptera were dominated by a small number of common species, without high ecological needs, the number of species of interest being much lower here than in the other types of meadows. The highest diversity was recorded in the abandoned meadows. This situation can be explained by the fact that the land has been relatively recently abandoned (maximum 10 years), and in the first years after the abandonement there is an increase of the specific diversity of invertebrates, due to the increase of the number of plant species, which is in direct correlation with the butterfly species richness (Erhardt, 1985). After the increase of invertebrate biodiversity on abandoned land in the first years, a stagnation follows, then a decrease, concomitantly with the invasion of the lands by shrubs (Balmer and Erhart, 2000). The number of species with different endangered categories was considerably lower in the case of intensively grazed grassland than in the extensive, mowed or abandoned fields.

In order to conserve species with special ecological needs, in addition to the management measures already in force, a few targeted measures would be necessary. For example, *Lycaena disappear rutila* (VU) and *Euphidrias aurinia* (EN)) are hydrophilic species, and in order to conserve and maintain their populations on site, drainage, overgrowth, pesticide use, dry vegetation fires in spring and fall should be stopped. These fires and intensive land use are threats that need to be removed for some major species as well, such as *Muschampia cribrellum* (CR), *Muschampia tesellum* (CR) and *Eriogaster catax* (VU), which are characteristic for meadows with shrubs. In order to maintain the favorable conservation status of the habitats and species for which the site was established, it is necessary to monitor and apply

the measures to ensure their conservation status, to improve the management of the land in the site, but also to increase the public's information regarding the natural values of the site and the activities with negative impact on them. Two of the most important Natura 2000 site sites "Dealurile Clujului Est", *Maculinea teleius* (EN) and *Maculinea nausithous* (CR) have in this area among the strongest populations in Europe, but intensive grazing has a strong negative impact on their characteristic habitat (the *Molinia* medows) which have a scattered distribution, with quite small coverage in the site. In addition to livestock grazing, other factors that endanger the two species, which should be stoped, are mowing before August 25, land abandonment, vegetation fires and wetland drainage.

The semi-natural landscapes of the Natura 2000 Site "Dealurile Clujului Est" have an invaluable importance, their surface being reduced in the whole European Union. The structure of butterfly communities can tell a lot about the quality of habitats in these types of landscapes. Local communities should be encouraged to protect both their natural habitats and their characteristic butterflies, as they can have a lot to gain from the agri-environment payments and the tourism potential of the area, but especially because they would live in a natural and healthy environment.

Acknowledgments

This thesis could not have been completed without the help of Prof. Dr. Laszlo Rákosy, to whom I am grateful for the scientific guidance offered, the patience, the interest, the constructive ideas and criticism throughout the doctoral stage.

I would like to thank colleagues Cristian Sitar and Dr. Cristina Craioveanu, who helped me enormously with the field work, species determination and statistical data analysis.

I would also like to thank the members of the guidance committee for their support during the doctoral stage.

Last but not least, I dedicate this doctoral thesis to my mother, in appreciation for the unconditional support and help she has offered me throughout my studies and in my life.

The present doctoral work was also supported by the financial support granted through the Partnership program in priority areas PN II, carried out with the support of MEN - UEFISCDI, project no. 79/2014.

Selective Bibliography

Aviron S, Sanvido O, Romeis J, Herzog F, Bigler F. 2009, Case-specific monitoring of butterflies to determine potential effects of transgenic Bt-maize in Switzerland. Agriculture, Ecosystems & Environment, 131: 137–144.

Bădărău AS, Deszi S, Comes O. 2000, Analiza biogeografică a două specii xerofile din Câmpia Transilvaniei: Nepeta ucrainica L. şi Centaurea trinervia Steph., Studia UBB Biologia, 45(1), 51-58.

Beaufoy G, Baldock D, and Clark J. 1994, The nature of farming: low-intensity farming systems in nine European countries. Institute for European Environmental Policy, London, U.K.

Bignal EM, McCracken DI. 2000, The nature conservation value of European traditional farming systems. Environmental Reviews8(3): 149-171.

Craioveanu C, Muntean I, Crișan A, Rákosy L, 2016, Diversitatea comparativă a chrisomelidaelor și a lepidopterelor diurne din pajiști mezofile gestionate prin practici agricole tradiționale și modern - studiu preliminar -. Buletin de informare entmologică, Societatea Lepidopterologică Română Supliment**:** 7-12,

Cremene C, Groza G, Rákosy L, Schileyko AA, Baur A, Erhardt A, Baur B. 2005, Alterations of Steppe-Like Grasslands in Eastern Europe: a Threat to Regional Biodiversity Hotspots. Conservation Biology :1606–1618.

Douwes P. 1976, An area census method for estimating butterfly population numbers. Journal of Research on the Lepidoptera 15: 146–152,

Foley JA, DeFries R, Asner GP, Barford C, Bonan G, Carpenter SR, Chapin FS, Coe MT, Daily GC, Gibbs HK, Helkowski JH, Holloway T, Howard EA, Kucharik CJ, Monfreda C, Patz JA, Prentice IC, Ramankutty N, Snyder PK. 2014, Global Consequences of Land Use. Science 309, 570 (2005).

Hall ML. 1981. Butterfly monitoring scheme: instructions for independent recorders. Institute of Terrestrial Ecology, Cambridge, United Kingdom.

Hammer O, Harper DAT. 2001, PAST: Paleontological Statistics software package for education and data analysis. Palaeontologia Electronica, 4 (1),

Haussman A. 2004, Sterrhinae. – În A. Hausmann (ed.): The Geometrid Moths of Europe Apollo Books, Stenstrup.

Kazakova Y, Peneva M. 2015, High Nature Value Farmlands: A strength or a weakness to regional development? Case studies from three Black sea countries. International Conference of Black Sea Countries And EU Special 1: 24-36.

Lang A, Bühler C, Dolek M, Roth T, Zughart W. 2016, Estimating sampling efficiency of diurnal Lepidoptera in farmland. J. Insect Conservation 20: 35–48.

Lang A, Kallhardt F, Lee MS, Loos J, Molander MA, Muntean I, Pettersson LB, Rákosy L, Stefanescu C, Messéan A. 2019, Monitoring environmental effects on farmland Lepidoptera: Does necessary sampling effort vary between different bio-geographic regions in Europe? Ecological Indicators 102: 791–800.

Lang A, Vojtech E. 2006, The effects of pollen consumption of transgenic Bt maize on the common swallowtail, Papilio machaon L. (Lepidoptera, Papilionidae). Basic and Applied Ecology 7: 296–306.

Levine CR, Yanai RD, Lampman GG, Burns DA, Driscoll CT, Lawrence GB, Lynch JA, Schoch N. 2014, Evaluating the efficiency of environmental monitoring programs. Ecological Indicators 39: 94–101.

Loos J, Dorresteijn I, Hanspach J, Fust P, Rákosy L, Fischer J. 2014, Low-Intensity Agricultural Landscapes in Transylvania Support High Butterfly Diversity: Implications for Conservation. Plos One 9 (7): 1-11.

Lovett GM, Burns DA, Driscoll CT, Jenkins, JC, Mitchell MJ, Rustad L, Shanley JB, Likens GE, Haeuber R. 2007, Who needs environmental monitoring? Frontiers in Ecology and the Environment 5(5):253-260.

Marchi M, Ferrara C, Bertini G, Fares S, Salvati L. 2017, A sampling design strategy to reduce survey costs in forest monitoring. Ecological Indicators 81: 182–191.

Muntean I, Popa R, Rákosy L. 2013, Diurnal lepidoptera communities from Natura 2000 Site „Dealurile Clujului Est". Studia Universitat Babeș-Bolyai Biologia LVIII (2): 69-78.

Muntean I, Sitar C, Craioveanu C, Rákosy L. 2015, The effect of traditional land use on diurnal lepidoptera from Nature 2000 Site "Dealurile Clujului Est". Studia Universitat Babeș-Bolyai Biologia LX (1): 95-105.

Page N, Bălan A, Huband S, Popa R, Rákosy L, Sutcliffe L. 2012,35 European countries-Experiences and perspectives: România. În În Operman R, Beaufoy G, Jones G (Editori)-High Nature Value Farming in Europe. 35 European countries-experiences and perspectives. Editura Verlag Regionalkultur.

Perry JN, Rothery P, Clark SJ, Heard MS, Hawes C. 2003, Design, analysis and power of the Farm-Scale Evaluations of genetically modified herbicide-tolerant crops.Journal of Applied Ecology 40(1):17 – 31.

Rákosy L, Goia M, Kovacs Z. 2003, Catalogul Lepidopterelor României, Societatea Lepidopterologică Română, Cluj Napoca.

Rákosy L, Schmitt T 2011. Are butterflies and moths suitable ecological indicators systems for restoration measures of semi natural calcareous grassland habitats? Ecological Indicators 11(5): 1040-1045.

Rákosy L. 1996, Die Noctuidae Rumäniens. Biologiezentrum Linz, Stapfia 46.

Rákosy L. 2011. Originea şi geneza landschaftului natural-cultural din Transilvania. Ecologia în România – Tradiţii şi Perspective. Prof. univ. dr. Bogdan Stugren: volum comemorativ, Presa Universitară Clujeană, Cluj-Napoca: 27-38.

Rákosy L. 2013, Fluturii diurni din Romania. Cunoastere, protectie, conservare. Ed. Mega, Cluj Napoca.

SAS Institute, 1992-1998

Schmitt T, Rákosy L. 2007, Changes of traditional agrarian landscapes and their conservation implications: a case study of butterflies in Romania. Diversity and Distributions, 13(6):855 – 862.

Serger HA, Hausmman A. 2011, Die Gross-Schmetterlinge Deutschlands. Heterocera Press, Budapesta.

Shapiro SS, WILK MB. 1965, An analysis of variance test for normality (complete samples). Biometrika 52:591–611.

Stoate C, Baldi A, Beja P, Boatman ND, HerzonI, Doorn A, Snoo GR, Rákosy L, Ramwel C . 2009, Ecological impacts of earl y 21st century agricultural changein Europe- a review. Jurnal of Environmentam Management 91: 22-46.

Sutcliffe L, Batary P, Kormann U, Baldi A, Dicks LV, Herzon I, Kleijn D, Tryjanowski P, Apostolova I, Arlettaz R, Aunins A, Aviron S, Baležentienė L, Fischer C, Halada L, Hartel T, Helm A, Hristov I, Jelaska SD, Kaligaric M, Kamp J, Klimek S, Koorberg P, Kostiuková J, Kovács-Hostyánszki A, Kuemmerle T, Mathe O, Paulini I, Proenca V, Rey-Benayas J, Sans FX, Seifert C, Stalenga J, Timaeus J, Torok P, van Swaay C, Viik E, Tscharntke T. 2014, Harnessing the biodiversity value of Central and Eastern European farmland. Diversity and Distributions 21 (6): 722-730.

Szekely L. 2010, Moths of Romania 1 –Fluturi de noapte din Romania 1, - Hepialidae, Limacodidae, Cossidae, Thyrididae, Lasiocampidae, Endromidae, Saturniidae, Lemoniidae, Sphingidae, Drepanidae, Thaumetopoeidae, Notodontidae, Pantheidae, Lymantriidae, Arctiidae. Tipografia Săcele.

Szekely L. 2011, Moths of Romania 2 –Fluturi de noapte din Romania 2, -Geometridae – 1-Archiearinae, Ennominae, Alsophilinae, Orthostixinae, Geometrinae. Tipografia Săcele.

Taron D, Ries L. 2015, Butterfly Monitoring for Conservation. În Daniels JC (Editor). Butterfly Conservation in North America, Editura Spriger, Dordrecht: 35-57

Young J, Richards C, Fischer A, Halada L, Kull T, Kuzniar A, Tartes U, Uzunov Y., Watt A. 2007, Conflicts between biodiversity conservation and human activities in the Central and Eastern European countries. Ambio 36: 545–550.

Zaks DPM, Kucharik CJ. 2011, Data and monitoring needs for a more ecological agriculture. Environmental Research Letters 9210(6):144-14017.

http://www.mmediu.ro/app/webroot/uploads/files/2016-04-11_PM_ROSCI0295.pdf - Planul de Management Integrat al Sitului Natura 2000 Dealurile Clujului Est

Scientific performance

Published scientific papers

Muntean I, Sitar C, Craioveanu C, Rákosy L. 2015, The effect of traditional land use on diurnal lepidoptera from Nature 2000 Site "Dealurile Clujului Est". Studia Universitat Babeș-Bolyai Biologia LX (1): 95-105.

Muntean I, Popa R, Rákosy L. 2013, Diurnal lepidoptera communities from Natura 2000 Site „Dealurile Clujului Est". Studia Universitat Babeș-Bolyai Biologia LVIII (2): 69-78.

Craioveanu C, Muntean I, Rákosy L. 2016, Variații în comunitățile de fluturi diurni din parcele gestionate tradițional sau modern din Situl Natura 2000 Dealurile Clujului Est. Buletin de informare entmologică, Societatea Lepidopterologică Română Supliment 2: 13-24.

Craioveanu C, Muntean I, Crișan A, Rákosy L, 2016, Diversitatea comparativă a chrisomelidaelor și a lepidopterelor diurne din pajiști mezofile gestionate prin practici agricole tradiționale și modern - studiu preliminar -. Buletin de informare entmologică, Societatea Lepidopterologică Română Supliment**:** 7-12.

Lang A, Kallhardt F, Lee MS, Loos J, Molander MA, Muntean I, Pettersson LB, Rákosy L, Stefanescu C, Messéan A. 2019, Monitoring environmental effects on farmland Lepidoptera: Does necessary sampling effort vary between different bio-geographic regions in Europe? Ecological Indicators 102: 791–800. Factor de impact: 5.06. https://doi.org/10.1016/j.ecolind.2019.03.035 .

Scientific papers under review

Sitar C, Muntean I, David DC, Iacob GM, Ionică AM, Rákosy L. The multi-annual study of the oviposition strategy of *Eriogaster catax* (Lepidoptera: Lasiocapidae) in the largest population of Transylvania, Romania.

Scientific communications

Cristina Craioveanu, Iulia Muntean, Andrei Crișan, László Rákosy. 2017, Variații în comunitățile de fluturi diurni din parcele gestionate tradițional și modern din situl Natura 2000 Dealurile Clujului Est. Al XXVII-lea Simpozion Național de Entomologie organizat de Societatea Lepidopterologică Română, Cluj Napoca.

Cristina Craioveanu, Iulia Muntean, Andrei Crișan, László Rákosy. 2016, Diversitatea fluturilor diurni în pajiști cu înaltă valoare naturală din zona sitului Natura 2000 Dealurile Clujului Est. Al XXVI-lea Simpozion Național al Societății Lepidopterologice Române, Cluj Napoca.

Cristian Sitar, Angela Ionica, Iulia Muntean, Cristina Craioveanu, László Rákosy. 2016, *Eriogaster catax* (Lepidoptera, Lasiocampidae) - dinamica populațională în situl Natura 2000 Dealurile Clujului Est. Al XXVI-lea Simpozion Național al Societății Lepidopterologice Române, Cluj Napoca.

Cristian Sitar, Angela Ionica, Iulia Muntean, Cristina Craioveanu, László Rákosy. 2016, Strategia de ovipozitare la *Eriogaster catax* în situl Natura 2000 Dealurile Clujului Est. Al XXVI-lea Simpozion Național al Societății Lepidopterologice Române, Cluj Napoca.

Iulia Muntean, Cristian Sitar, László Rákosy. 2015, Influența utilizării diferențiate a terenului asupra comunităților de fluturi diurni din Situl Natura 2000 "Dealurile Clujului Est". Al XXV-lea Simpozion Național al Societății Lepidopterologice Române, Cluj Napoca.

Cristian Sitar, Andrei Crișan, Iulia Muntean, Cristina Craioveanu, László Rákosy. 2015, Strategii de ovipozitare la *Eriogaster catax* (Lepidoptera: Lasiocampidae). Al XXV-lea Simpozion Național al Societății Lepidopterologice Române, Cluj Napoca.

Rakosy Laszlo, Iulia Muntean. 2014, Lepidoptere diurne din Situl Natura 2000 Dealurile Clujului Est. Al XXIV-lea Simpozion Național al Societății Lepidopterologice Române, Cluj Napoca.

Andrei Crișan, Cristina Craioveanu, Csaba-Tibor Vizauer, Cristian Sitar, Iulia Muntean, László Rákosy. 2014, Cetatea fluturilor - Dealurile Clujului Est. Al XXIV-lea Simpozion Național al Societății Lepidopterologice Române, Cluj Napoca.

Muntean Iulia, Sitar Cristian, Rákosy László. 2013, Comunităţi de lepidoptere nocturne caracteristice zăvoaielor. Al XXIII-lea Simpozion Național al Societății Lepidopterologice Române, Cluj Napoca.

Sitar Cristian, Popa Răzvan, Muntean Iulia, Craioveanu Cristina, Timuş Natalia, Rákosy László. 2013, Fluturii diurni (Lepidoptera, Rapalocera) de pe “Dealul Cocoşului”(Luna de Jos, Comuna Dăbâca, Jud. Cluj), Al XXIII-lea Simpozion Național al Societății Lepidopterologice Române, Cluj Napoca.

International workshops

Burren Winterage School 2015 “Supporting High Nature Value Farming in Europe”. 22-25 octombrie 2015, Corofin, County Clare, Irlanda.

Butterfly monitoring in România. Leuphana University, Butterfly Conservation Europe, European Forum on Nature Conservation and Pastoralism. 16-18 noiembrie 2012, Sighișoara, România.

Research grants

Parteneriate în domenii prioritare PN II, derulat cu sprijinul MEN – UEFISCDI, proiect nr. 79/2014.