THE SEMI-NATURAL GRASSLANDS IN DIFFERENT SUCCESSIONAL STAGES OF ABANDONMENT

Anca PLEŞA[1], Ioan ROTAR[1], Florin PĂCURAR[1], Roxana VIDICAN[1]

e-mail: ancadorinabogdan@yahoo.com

Abstract

All over in the world is known that abandonment shows a heavy impact on grasslands biodiversity. It is important to realize that abandonment has gone and still go with the disappearance of low input traditional farms. This kind of situation is also found in Apuseni Mountains, Romania. The aim of our study was to follow the successional stages of *Agrostis capillaris* L. – *Festuca rubra* L. grassland type, as a result of abandonment. The study included 27 grasslands with similar site conditions. There were three different categories of abandoned grasslands: abandoned up to 5 years, abandoned between 6 and 10 years, abandoned more than 10 years. The categories of abandonment caused changes at the level of phytocenoses, registering a degradation of the vegetation from both, agronomic and ecologic point of view. Without developing the analysis any further we will not realizes that the abandon is a major problem at European level. It takes strong efforts to maintain grassland and dairy farming in less favored areas and to keep the landscape open because different strategies have to be considered and adapted to the special conditions and requirements.

Key words: abandonment, agronomic value, phytodiversity, semi-natural grasslands.

The abandonment of semi-natural grasslands in the mountain areas become a major threat and raise a series of questions and situations, which have to be solved in the whole Europe (Osterburg *et al*., 2010). Grasslands in the mountain areas are very vulnerable habitats, losing their conservation value very quickly after the abandonment (Fischer and Wipf, 2002). In these areas secondary succession takes place, which could be found in the first stage as changes in specific floristic composition of the canopy (Habel *et al.*, 2013). Changes can be sometimes so obvious, that threaten the integrity of the grassland ecosystem (Kryszak *et al*., 2012). Restoration of the grassland ecosystem to the original stage could be a very long process and almost impossible (Galvanek and Leps, 2012). Romania's pastoral area is covering over 4.8 million ha and has been influenced over the last decades by natural factors and human activities, which have been affected the normal functioning of the grassland ecosystems (Vîntu *et al.,* 2011). From these grasslands, more than a half is located in upland areas (Vîntu *et al*., 2011). In addition, the secondary grasslands from Apuseni Mountains and their high diversity are endangered by the land use's changes, caused by the direct and indirect influence of socio economic changes (Gârda N., 2011). Even if the phenomenon in general is well known in other European countries, is needed a thorough understanding of the mechanisms, which occur at the phytocoenoses level because of the abandonment (Kahmen *et al*., 2002; Bilz *et al*., 2011; Habel *et al.,* 2013; Halada *et al*., 2011; Socher *et al.,* 2013).

The aim of our study was to follow the successional stages of *Agrostis capillaris* L. – *Festuca rubra* L. grassland type, as a result of abandonment.

MATERIAL AND METHOD

The study included the floristic composition's determination of certain secondary grasslands in different successional stages as a result of abandonment. The plots were chosen so they have about the same site conditions. The length of plots' abandonment was divided in three categories, as follows: abandoned grasslands up to 5 years (F1), abandoned grasslands between 6 and 10 years (F2), abandoned grasslands more than 10 years (F3). The length of abandonment was determined by questionnaires applied to the owners. Also, the length of abandonment was assessed following the age of the present woody species. The floristic composition was determined by Bran-Blanquet method, when *Poaceae* were in flower. Floristic data processing was performed with PC-ORD, version 6, which use the multivariate analysis of the ecological data entered into the spreadsheet. This program focuses on nonparametric tools, on graphics, randomization tests, bootstrapped confidence intervals for

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[1] University of Agricultural Sciences and Vererinary Medicine Cluj-Napoca

analysis of community data (McCune and Grace, 2011). For data processing and interpretation we used multidimensional scaling (NMS), which is well suited to data coordination that are not normal or stairs arbitrary, discontinuous, or otherwise questionable (Peck, 2010). Also, we used the MRPP (Multi Response Permutation Procedure) and Summary for the Shannon-Wiener index (H) and the number of species (S) and the average abundance and dominance of the species. Based on the Shannon-Wiener index and the number of species, we compared the diversity of different abandonment categories. To evaluate the effects of abandonment on vegetation, from statistical point of view, we used STATISTICA by StatSoft. The analysis of variance was performed by Breakdown and One-Way ANOVA type. Based on F and p values was determined species on which, the different abandonment categories had the highest effect, using the average abundance-dominance of the species. To analyze in detail the effect of abandonment we used a comparative analysis, Post-hoc, the Fisher LSD type. The choice of this test was based on the ability to highlight significant differences between the categories of abandonment and between the

average abundance-dominance of dominant species, economic groups of plants and phytodiversity.

RESULTS AND DISCUSSIONS

The statistical analysis of the data highlighted that floristic composition can be separated in three different grassland types (*figure 1*).

The phytocoenosis of abandoned grasslands up to 5 years (F1) is very different from the other categories of abandoned grasslands (T = -6,7861, p<0.001 and T = -6,5185, p< 0.001; Table 1). The analyzed groups are quite heterogeneous (A = 0.1218 and A = 0.1431). The phytocenosis of abandoned grasslands between 6 and 10 years (F2) is different than the phytocenosis of grasslands abandoned more than 10 years (F3), but this two are still overlapped, when are graphically presented (T = - 4.9935, p<0.001; *figure 1, table 1*).
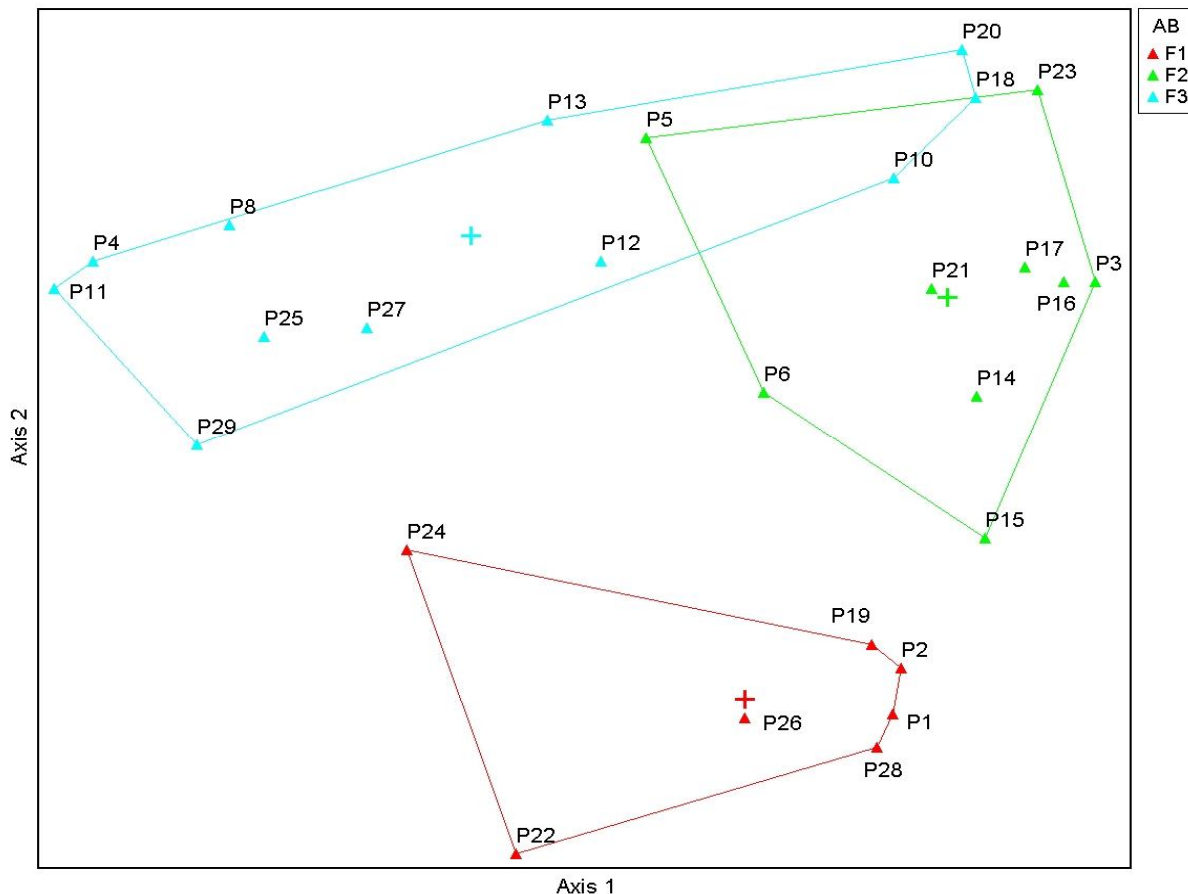

Figure 1 **Ordination of floristic composition in function of different abandonment categories;**
P - relevees, F1 - abandoned grassland up to 5 years, F2 - abandoned grassland between 6 and 10 years,
F3 - abandoned grassland more than 10 years

Table1

Comparison between the floristic compositions of different abandonment categories with MRPP

Comparison between variants	T	A	p
F1 vs. F2	-6.786198	0.121860	0.000044
F1 vs. F3	-6.518563	0.143136	0.000229
F2 vs. F3	-4.993546	0.098741	0.002312
Note: T – T test, A – group homogeneity, p – statistical significance			

Abandoned grasslands' phytocoenoses up to 5 years (F1) take part from *Agrostis capillaris* L. - *Festuca rubra* L. grassland type, which has in floristic composition 41.07% of *Poaceae*, 14.11% of *Fabaceae*, 0.14% of *Cyperaceae and Juncaceae* and 41.79% plants from other botanical families (*table 2*).

The phytodiversity of these phytocoenoses have 31.71 species and a Shannon-Wiener index of 2.30. The phytocoenoses of abandoned grasslands between 6 and 10 years (F2) belong to *Festuca rubra* L. type with 18.62% of *Poaceae*, 3.94% *Fabaceae*, 1.11% of *Cyperaceae and Juncaceae* and 54.58% of plants from other botanical families. This phytocoenosis consists from 25.44 species and has a Shannon-Wiener index of 2.30. The abandoned grasslands more than 10 years (F3) belongs to *Nardus stricta* L. types and the floristic composition is composed from 33.09% of *Poaceae*, 2.95% of *Fabaceae*, 5.73% of *Cyperaceae and Juncaceae* and 43.39% of plants from other botanical families. The phytodiversity covers 23.09 species and the Shannon-Wiener index is 2.10. Kącki (2010) evidenced in a study, in the southeastern part of Poland, the fact that *Nardus stricta* L. occurs in abandoned grasslands with a high percentage at the expense of medium and high tolerant species on mowing. Mariott *et al.*, 2004, in an experiment in 20 European countries show that the abandonment of grassland ecosystems causes important changes in the canopy's structure in comparison to the mowed or pastured areas. Changes in the canopy, in their experiment, occurred after different time intervals from an experiment to other. Some changes could be observed after two years, others only after 12 years. They also state that changes strongly depend on site conditions, on original vegetation, on management's history and on vegetation in around.

From agronomic point of view, the phytocoenosis, because of the abandonment, degrades through installation of some less productive and lower quality grassland types. This degradation can be seen by the reduction of *Agrostis capillaris* L. from 21.39 % (F1) to 1.47 % in the case of abandoned grasslands between 6 and 10 years (F2) and to 1.95% in the case of abandoned grasslands more than 10 years (F3; $p < 0.001$; Tab.1). Also, there is a reduction at *Festuca rubra* L. species too, especially for grasslands abandoned more than 10 years (F3), but without statistical assurance ($p > 0.05$). Grassland's degradation is highlighted by the increase of *Nardus stricta* L. cover, from 1.94% to 21.36% ($p < 0.01$), which is a species without forage value.

When pursuing the floristic composition's evolution at the economic groups level, we can find the same canopy degradation, by decreasing the cover of *Poaceae* ($p < 0.01$), reduction of the level of *Fabaceae* ($p < 0.001$; Tab.1). Plants from other botanical families increase slightly, but there is no statistically assurance for their evolution.

Da Ronch et al. (2013) show in a study, carried out in valleys of Val Menera (north-eastern Italy), that abandonment of mountain pastures resulted a significant reduction of agronomic value and forage digestibility, due to a strong installation of *Deschampsia caespitosa* L. species in the canopy. From conservative point of view, we find also a degradation at the grassland vegetation level, because the number of species is reduced in the case of abandoned grasslands up to 5 years (F1) from 31.71 to 23.09 at the abandoned grasslands up to 10 years (F3; $p < 0.01$; *table 1*).

Table 2

Floristic structure of grassland types in function of abandonment's categories

Treatments/Significance/ Grassland type		Dominant and codominant species			Economic groups				Phytodiversity	
		A.c	F.r.	N.s.	P	F	CJ	OBF	S	H
F1 - abandoned grasslands up to 5 years	A.c.-F.r.	21.39	11.01	4.64	41.07	14.11	0.14	41.79	31.71	2.30
Sgf.		Wt.	Wt.	Wt.	Wt.	Wt.	Wt.	Wt.	Wt.	Wt.
F2 - abandoned grasslands between 6 and 10 years	F.r.	1.47	12.53	1.94	18.62	3.94	1.11	54.58	25.44	2.30
Sgf.		000	ns	ns	00	000	ns	ns	0	ns
F3 - abandoned grasslands more than 10 years	N.s.	1.95	4.93	21.36	33.09	2.95	5.73	43.39	23.09	2.10
Sgf.		000	ns	**	ns	000	ns	ns	00	ns

The Shannon-Wiener index shows a decrease of phytodiversity from 2.30 (F1) to 2.10 (F3), but without statistical assurance. In the studies of Zarzycki and Misztal (2010), the abandoned plots had a significantly lower Shannon-Wiener index than it was in the mowed plots. Musiał and Kasperczyk (2013) have the same results with ours in the Polish Carpathians, where the abandonment of permanent grasslands between 600m and 700m caused a significant reduction of the phytodiversity. Da Ronch *et al.* (2010) shows in a study carried out in Treviso (Italia), that abandonment changed significantly the phytodiversity after 12 years, but mowing once per year reduced the woody species participation. Kącki (2010) has shown that for grasslands species, diversity index values were significantly higher on permanently managed grasslands, than on abandoned pastures at least since 5 years. Schrautzer *et al.* (2010) demonstrate that on abandoned grasslands for 9 years, in the region Schleswig-Holstein (Germany) and grazed later with cattle in an extensive system, the phytodiversity increased considerably.

The structure of floristic composition changes according to the categories of abandonment (figure 1). The abandonment up to five years maintains the grassy carpet in addition to dominant species (*Agrostis capillaris* L., *Festuca rubra* L.) as follows: *Leontodon autumnalis* L., *Centaurea pseudophrygia* C. A. Mey, *Lotus corniculatus* L., *Scabiosa columbaria* L., *Campanula patula* L., etc.

The category of abandonment between 6 to 10 years cause a *Festuca rubra* L. type installation and several species as follows: *Thymus pulegiodes* L., *Plantago media* L., *Leontodon autumnalis* L., *Alchemilla vulgaris* L., *Carlina acaulis* L.etc.

The abandonment over 10 years has the greatest influence leading to the installation *Nardus stricta* L. type and the following species: *Arnica montana* L., *Thymus pulegiodes* L., *Festuca rubra* L., *Potentilla erecta* L., *Lotus corniculatus* L. etc. Plieninger *et al.*, 2014, said also that land abandonment potentially has substantial environmental and socio-economic consequences.
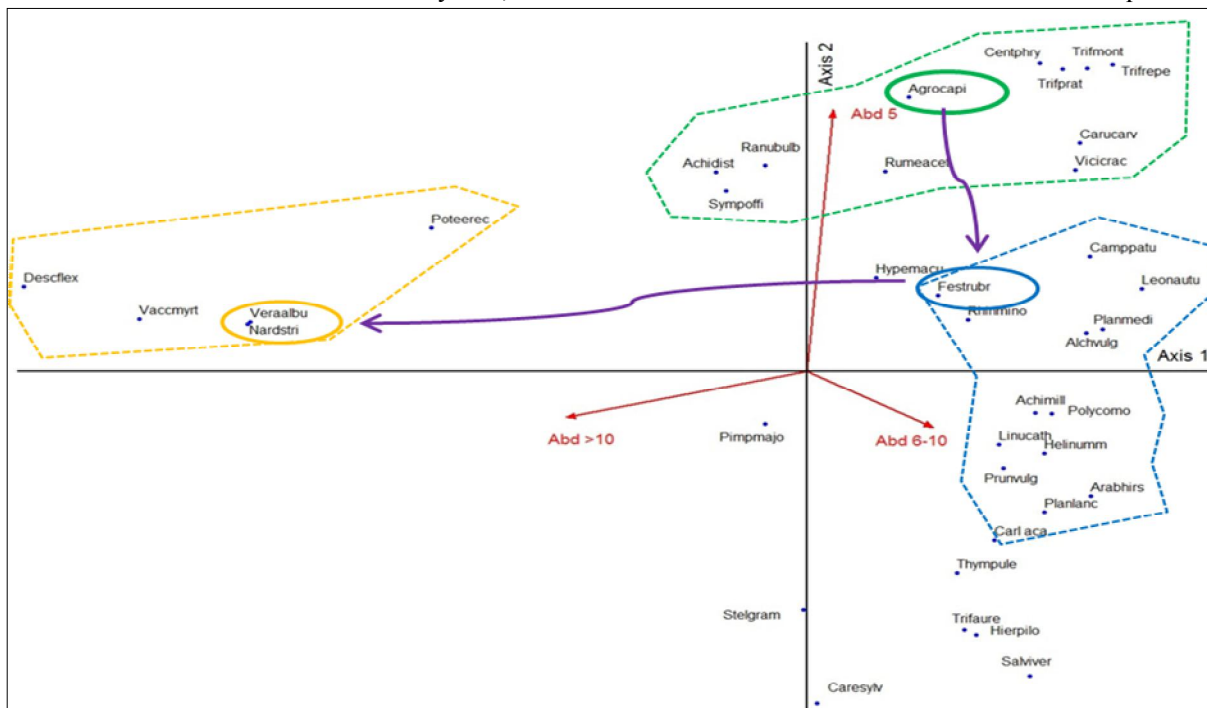

Figure 1 **The influence of abandon upon the floristic composition (are represented only species which shows statistical assurance): Achimill = *Achillea millefolium* L., Achidist = *Achillea distans* Waldst et Kit., Agrocapi= *Agrostis capillaris* L., Alchvulg= *Alchemilla vulgaris* L., Arabhirs = *Arabis hirsuta* L.; Campabie= Camppatu= *Campanula patula* L.; Caresylv= *Carex sylvatica* Huds.; Carlacau = *Carlina acaulis* L;Carucarv=*Carum carvi* L. Centpseu = *Centaurea pseudophrygia* C. A. Mey., Descflex = *Deschampsia flexuosa* L.; Festrubr= *Festuca rubra* L. , Helinumm=*Helianthemum nummularium* L.; Hierpilo=*Hieracium pilosela* Hill*;* Hypemacu= *Hypericum maculatum* Crantz; H Leonautu =*Leontodon autumnalis* L., Linucath= *Linum cathartichum* L.; Nardstri= *Nardus stricta* L.; Pimpmajo = *Pimpinella major* L., Planlanc = *Plantago lanceolata* L., Planmedi = *Plantago media* L*.,* Polycomo= *Polygala comosa* Schkuhr.; Poteerec = *Potentilla erecta* L., Prunvulg = *Prunella vulgaris* L., Ranubulb = *Ranunculus bulbosus* L., Rhinmino = *Rhinanthus minor* L., Rumeacet = *Rumex acetosa* L., *Salvvert* L.= *Salvia verticilata* L.*;* Stelgram = *Stellaria graminea* L.,Sympoffi=*Symphyitum officinale* L.; Thympule .= *Thymus pulegiodes* L.*;*Trifaure=*Trifolium aureum* Pollich.*;* Trifprat = *Trifolium pratense* L., Trifrepe = *Trifolium repens*, L., Trifmont= *Trifolium montanum* L., Veraalbu= *Veratrum album* L.; Vicicrac= *Vicia cracca* L., Vaccmyrt=*Vaccinium myrtillus* L.**

CONCLUSION

The different categories of abandonment caused major changes in the floristic structure of phytocoenoses, determining the canopy's degradation both from agronomic and ecologic point of view. The major changes occur after 6 years of abandonment. The semi-natural grasslands, situated on sites with different disadvantages (improper orography, reduced trophicity, pronounced acidity, etc.) which are on the threshold to be abandoned or are already abandoned, need to be mowed at least once at four or five years, to preserve their specific floristic structure.

ACKNOWLEGMENTS

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