Contribuții Botanice - 2009, *XLIV*: 57-66
Grădina Botanică "Alexandru Borza"
Cluj-Napoca

WILDFLOWER SPECIES INDICATORS FOR LOWLAND GRASSLAND HABITAT CONSERVATION IN TRANSYLVANIA (ROMANIA)

Andrew JONES
Fundația Adept, c/o Boite 6, 385 Avenue Louise, **B-1050 Brussels, Belgium**
e-mail: llanllawddog@gmail.com

Summary: Romania has some of the most diverse and extensive lowland grassland habitat resources surviving in Europe maintained by traditional farming practices. A key issue for future conservation of these grasslands is an understanding of their status and whether they are being maintained in good condition or are being damaged. We have been developing wildflower indicators for sensitivity to changes in grassland status in terms of land-use, in particular to nitrogenous fertilizer inputs and over or under grazing. However, another aspect of potential significance for grassland conservation is habitat fragmentation and this may be more difficult to measure through indicators. Studies round the world of the effects of fragmentation on habitat have examined fauna, including butterflies and birds, which tend to be more sensitive to short term changes in habitat quality and availability than plants. We are looking at a suite of plants which may be associated with large open landscapes and non-intensive land-use which could disappear if fragmentation occurs, an early warning which will inform us of the need to develop and implement habitat management strategies as a solution. In another study, we are identifying localized areas of very high grassland diversity that occur in the project area and we describe the distribution and ecology of these botanical 'hotspots'.

Keywords: grasslands, ecology, indicators, management, agri-environment, conservation

Introduction

Romania has probably the best wildflower-rich grasslands still remaining in Europe. In terms of area, it has possibly the largest extent of diverse lowland grassland surviving, within [16] 34 grassland habitat plant communities or associations. It is too the most biogeographically diverse member state of the European Union, a meeting ground of Pannonic, steppic, continental, Pontic and Alpine floristic elements represented in and around the Carpathians and with more Mediterranean elements in the flora towards the Black Sea coast.

The grasslands, which in southern Transylvania cover a third of the land surface, along with a third forest and a third arable, are notable for high species diversity (alpha diversity) and variability in species composition (beta and gamma diversity). Within the grassland matrix, unique botanical hotspots exist in slumping hill terrain, containing unusual combinations of rare steppic and montane species. Enclaves of montane plant species, more typical of the Carpathians, are found on north-facing slopes and on exposed ridges.

The grasslands of Romania and of Transylvania in particular, represent some of the most intact traditional farming systems that remain in lowland Europe in equilibrium with the valuable legacy of high biodiversity that they contain. These traditional systems have developed over centuries as part of what can be described as a sustainable system of land utilization developed within the Saxon villages area (Akeroyd 2006).

The extensive nature of these traditional farming systems is reflected in recent stocking levels of both cattle and sheep that have been some of the lowest in Europe (Romanian Agricultural Census, 2005). However, changes under entry into the European Union, and economic modernization of the country along with the agriculture sector, mean inevitable changes that will affect the pattern and methods of farming and threaten the associated dependant biodiversity.

Romania can be considered to have one of the most valuable and extensive grassland resources surviving in Europe when considered under the title of High Nature Value (HNV) farmland (definition in [4]) or in terms of the survival of critical groups (Romanian Red-data list) of plants and animals. Studies of the grassland systems that are found in Transylvania ([17], A. Jones and J.R. Akeroyd, unpublished) have shown that they have high botanical diversity (for review of grassland biodiversity see [14]) and are in general more so than other remaining grasslands in Central and Eastern Europe. It is believed that this HNV grassland resource extends to 2.6 million ha, about 11% of the national territory, though 50% of this has been affected by economic activities [16] such as being periodically ploughed up for arable crops.

Romanian grasslands are managed by both grazing and hay cutting. Large areas of ground are within pastoral systems of shepherded sheep/goats and with associated pigs at the milking points (*stăne).* There is pendulation (daily movement) of peasants' cattle between grazing lands and village. Stocking densities are generally very low (<1 LU/ha), as are yields of hay (<2 tonnes/ha). One to three cuts of hay are made, in many cases by hand cutting with scythes. Low levels of fertilizers are used and often only on arable land. Scrub is cut and burned to maintain the grasslands.

All these management practices are beneficial to wildlife, including farmland birds and grassland plant and insect species. The agricultural systems can be described as low input-low output, working below modern agricultural capacities, and so are unstressed and sustainable with a buffer for disturbance events such as drought.

The threat to this rich legacy of grassland biodiversity, dependent on continued traditional farming, is mounting despite entry of Romania into the EU [5]. Rural areas have low economic growth with the threat of rural depopulation [11], relocation of potential young farmers to adjacent cities under pressures for employment, and collapse of the existing pattern of small farms that includes subsistence and semi-subsistence systems, with depressed agricultural commodity prices, e.g. for meat or milk and possible negative effects of food hygiene legislation. This may affect the continued management of these habitats, with the likelihood of abandonment increasing. An equally and opposite threat exists of increased intensification of land-use and possible conversion of grassland to arable farming or intensive grassland farming. Such goals of productive, efficient and competitive farming are linked to an increase in funding for farm investment and development through European Fund for Agriculture and Rural Development Axis 1 that also may attract farmers from other countries to seek opportunities within Romania.

This paper describes some of the wildlife grassland resources in the Târnava Mare Site of Community Interest (SCI) and Saxon Villages cultural area and the challenges for designing a system of conservation measures. The research to develop a system of wildflower indicator species to determine grassland condition and management is described. The study of possible indictors of large pastoral systems, so called 'fugitive species', is also mentioned. The ecology of hotspots of plant diversity including slumping hills and montane enclaves are described.

Research programme

The study (Fundația-ADEPT Târnava Mare grassland survey) has focused on a botanical analysis of sites covering a range of grassland management systems, from more intensively farmed areas in the valley bottoms to the most diverse wildflower-rich slopes. The kinds of grassland plant communities in the survey include Daco-Sarmatic steppes with *Carex humilis, Stipa joannis* and *Brachypodium pinnatum*; rupicolous Pannonic grasslands with *Festuca pallens* and *Melica ciliata*; Ponto-Pannonic grasslands with *Festuca rupicola* and *Koeleria macrantha*; Daco-balcanic grasslands with *Chrysopogon gryllus* and *Festuca rupicola*; Ponto-pannonic grasslands with *Festuca valesiaca*; and Dacian grasslands with *Molinia caerulea*. This was initially part of a study facilitating the design of a grassland agri-environment scheme under SAPARD, the European Community support programme for pre-accession measures for

agriculture and rural development (European Commission Council regulation 1268/1999). This programme has been carried out within the Târnava Mare SCI, Saxon Villages, south of Sighişoara in Braşov county (Buneşti commune – Viscri and Buneşti), Mureş county (Saschiz commune – Saschiz, Mihai Viteazu and Archita) and Sibiu county (Laslea commune – Mălâncrav). Detailed survey and analysis of the composition of the vegetation has been carried out by 0.25 m^2 relevés, in total 152, and an analysis of the nutrient status of the soil has been carried out by a contracted soil chemistry laboratory for nitrogen, potassium, phosphorus, magnesium, electro-conductivity and pH. In addition, valuable information on the farming systems has been gathered from interviews with village farmers and agronomists, and state agronomists in the regional agricultural extension offices.

Results and Discussion

Grassland characteristics

Characteristically, the grasslands exhibit extreme patchiness in terms of composition of wildflower species and habitat or sub-habitat type at a range of scales across landscapes. This feature is sometimes called 'gamma diversity', as opposed to 'alpha' and 'beta' diversity which measure numbers of species packed into small unit areas, typically 1 m^2 and diversity changes over small scale, e.g. 5 m respectively [8; 10] that are not necessarily always explained by gradients in ecological conditions. Gamma diversity is an undervalued aspect of biodiversity that has been under threat from moves towards agricultural intensification, narrowing of farming methods and a polarization of farming systems into arable or grassland, which has resulted in uniform species composition and habitat-poor environments. Gamma diversity can be considered an attribute or indicator of High Nature Value traditionally farmed landscapes and its reduction associated with loss of ecological function such as the processes of species colonization and gene flow.

The grasslands in the study area have a large potential plant species pool (i.e. the species area curve does not plateau rapidly) being at the crossroads of several bio-geographical zones, including Pannonic, Continental, Pontic, Mediterranean, Alpine (Carpathian) and their associated floras [16]. This contributes to botanical diversity at all spatial levels and allows the presence of species 'hot-spots'.

Typically grasslands occur in a mosaic with some or all the year's grass crop of hay cut once or twice and grazed. Much of the grassland is on old arable fields, often on narrow man-made terraces cut into the hillsides and there is even evidence of some 'ridge and furrow' in wetter areas. The grasslands occur within an undulating landscape of deep valleys and plateaux with isolated hillocks, banks, small marshes and occasional ponds, and wet slip zones with seepages. The different age of seral stages of grassland recolonization from arable is associated with a range of grassland types, with some stands extremely diverse, containing many species, rare at the European level. Possibly because of the large proportion of extensively managed land, high wildflower species seed rain allows even young grassland fields to accumulate a high number of species that would be of conservation importance if recorded in another European country [15].

At a larger scale, above this rich detail of grassland diversity, the existing patchy spatial pattern of the Transylvanian landscapes and land-use shared by forestry, wood-pasture (such as the extensive Breite landscape near Sighişoara [1, 2], extensive grasslands and arable farming contrast sharply with the uniform and monotonous landscapes produced by intensive land management for farming in much of Western Europe.

Data from the 0.25 m^2 relevés was combined into a species x relevés data matrix. This was then analysed using multivariate analysis techniques based on the generation of correlations between species and between relevés. This can then be represented in several dimensions

mathematically but plotting of the eigenvalues in the first two dimensions are used as a visual aid to understanding species relationships.

Soil analysis results showed that soil nutrient status was low in agricultural terms for all sites with the exception of some flushed wetland sites. Preliminary findings show that the grasslands follow the same models in terms of the relationship between species diversity and soil nutrient status as those in other parts of Europe, with a negative correlation, i.e. increasing nutrient status is correlated with lower species diversity. Canonical correspondence analysis of data using BIPLOT (18) also demonstrated an association between higher soil nitrogen status and low nature value grassland habitats containing species typical of disturbed ground, including weedy species and widespread perennial wildflowers (Figure 1). Definition of valuable grassland by nutrient status was complicated by the fact that some north-facing, sloping wet grassland with montane species such as *Trollius europaeus* had high nutrient status, possibly as a result of flushing of nutrients and their concentration in areas of soil down the slope and associated with late snow lie. However, it must be emphasized that the soils sampled indicated low nutrient status for the majority of the dry grasslands of the study area.

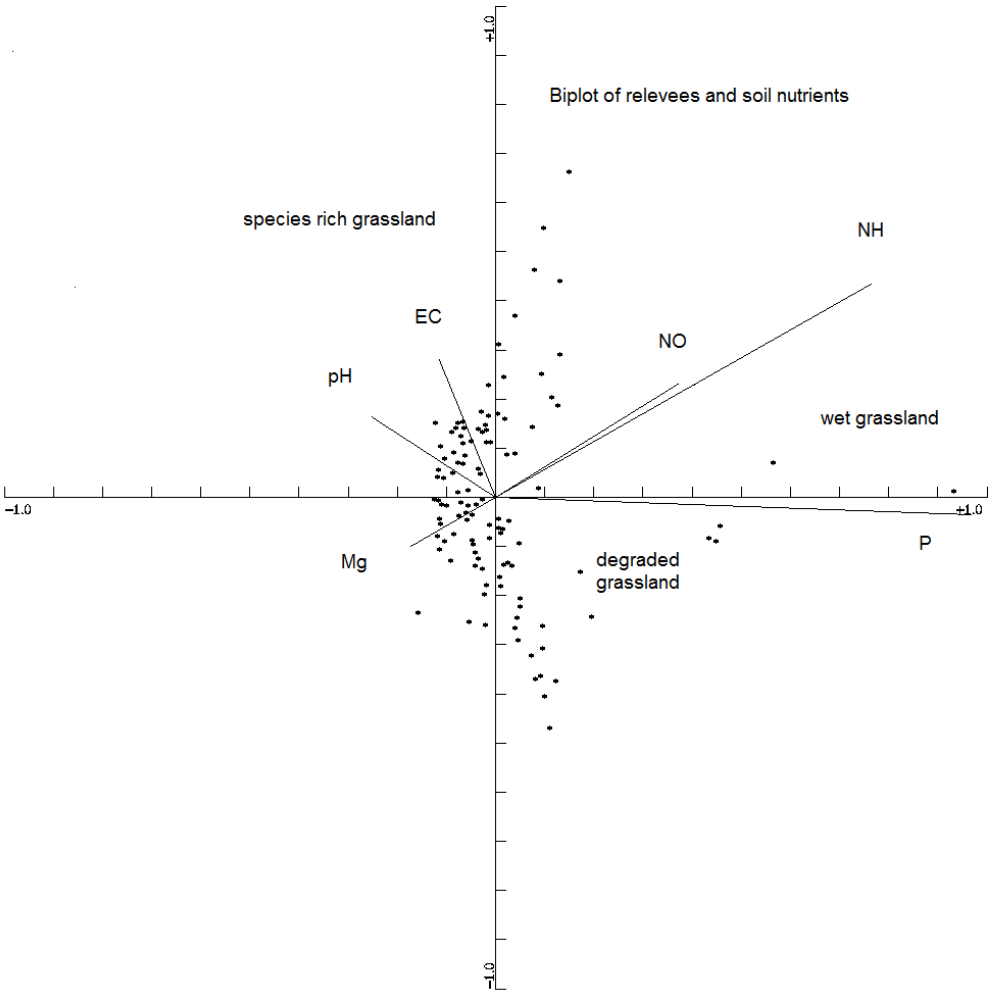

Fig. 1: Biplot of survey samples and soil variables with vectors denoting increasing soil concentration of nutrients and showing relationship between soil nutrient status and broad grassland type.

Note: Increasing NO-nitrates, NH-nitrogen as ammonium ion and P-phosphates to the right of plot associated with grassland degraded through agricultural intensification and also with wet species rich grassland; EC-Electrical conductivity and pH associated with species rich grassland; MG – increasing magnesium-showed no positive correlation with agricultural intensification. Potassium not plotted as soils show uniform concentrations.

The implication of this is that the Transylvanian grasslands are sensitive to the effects of nutrient enrichment equivalent to those HNV grasslands in wider studies on grassland vulnerability to agricultural intensification across Europe (e.g. [6]). These studies suggested that nitrogen application of as little as 50–80 kg per hectare per year would endanger the more sensitive and rare species.

Grassland Habitat protection

Conservation of grasslands ultimately depends on economic imperatives that allow management to be profitable. If such measures are not always possible, then another option is to use habitat protection legislation, but it is a priority to use this if possible in concert with available funding from a range of sources, including the rural development programme. The EU Habitats Directive (Directive 92/43/EEC; 1992) is aimed at conserving the best European examples of habitat and associated species found within the different biogeographical zones. Since December 2008, the ADEPT project area has been designated as a large (85,000 ha) Site of Community Interest, Târnava Mare SIC, under Natura 2000. The focus of the Habitats Directive is to maintain favourable status for the features identified as part of the designation and duly incorporated in management plans. Some features such as steppic slopes and especially the unique heritage of slumping hillocks or 'tumps' will need special investigation to identify existing management and for it to be incorporated into plans designed to maintain favourable conservation status in case farming practices show the shifts under market forces that are expected.

Other national systems of protection are available such as designation as national monuments or national parks, e.g. Law no. 462/2001 regarding the protected natural areas regime, conservation of the natural habitats, the wild flora and fauna. This might solve the problem that large-scale management systems such as shepherded grazing and burning may be difficult to administer if special features such as the hillocks are protected under local designations. Lessons should be learnt from conservation in other parts of Europe where piecemeal conservation for many species and habitats is failing where areas are insufficiently large enough and management fails due to critical mass of livestock or resources. The end of this process is overly prescriptive micro-management for species, a sign that the ecological system has failed and is in collapse. Opportunities still exist in Romania to prevent this.

Wildflower Indicator Species for measuring condition of grasslands

The challenge is to conserve this biodiversity-rich grassland resource using both appropriate national and European systems of government policy and protection (Habitats Directive and agri-environment), while also providing potential for landowners and farmers to benefit from the ownership and management of these areas. Because of the varying nature of grassland in terms of area, different aspects of protection and incentive will be needed.

Whereas some aspects of traditional management can be incorporated into local agri-environment measures such as stocking rate and utilization requirements, other aspects can be more difficult to design within a system of statutory prescriptions, such as the use of fire in burning of encroaching scrub. However this management, for instance, has a highly significant role in maintaining biodiversity allowing steep banks with some of the highest diversity and rarest species to remain as grassland. Other features of management such as the retention of mature trees, folding of livestock and some traditional practices we may yet discover are similar in their importance. Elsewhere in Europe it is the disappearance of such routine manual targeted management that is of equal importance, as intensification in causing habitat and species loss through habitat degradation. Great efforts are made to simulate this management with machinery and other 'fixes' in the absence of traditional skills (e.g. see series of English Nature ENACT publications [3]).

With regard to the potential of rural development programme funding to facilitate grassland conservation, it is important that it is targeted to the most valuable areas of grassland and, if so, to perhaps create large contiguous areas under agri-environment schemes, the most important objective in conserving species and countering the effect of habitat fragmentation [19; 7]. Nationally within Romania this targeting can be at the county level, based on counties with a minimum proportion of land with High Nature Value grassland. At a secondary level or filter this targeting can operate at the level of individual applications. Applications can be potentially scored on the presence of wildflower species indicators, species and habitat diversity, or conversely the absence of significant cover by agricultural species.

The former method using wildflower indicators is gaining more acceptance and support, being used in Germany and Switzerland as part of agri-environment criteria selection [12; 13]. Indicator species are chosen that are easily identified, conspicuous and associated with high quality grassland, supported by pictorial aids allowing farmers to self-assess their grasslands as part of the application process. This method may have potential for use in Romania in the identification of High Nature Value grassland, once awareness of the potential benefits of agri-environment schemes has been achieved and support and training provided by agency field officers or NGOs.

As part of the multivariate analysis of species data conducted as part of our survey study, species have been scored along axes associated with High Nature Value quality and influences of agriculture and these multivariate scores or eigenvalues could be used as an objective method in choosing robust indicators (Table 1). Rare or more ecologically sensitive species with high negative scores would not be suitable, neither would species associated with agricultural intensification with high positive scores. Species should be easily identified and have reasonably long flowering periods.

Table 1: Potential wildflower indicator species in relation to their scores on the first two CCA axes.

Species and attribute	Axis 1	Axis 2
1. Rare and sensitive species		
Linum flavum	-0.38	-1.00
Adonis vernalis	-0.40	-1.10
Teucrium montanum	-0.38	-1.44
Scabiosa ochroleucon	-0.33	-0.92
2. Suitable indicators		
Leontodon hispidus	-0.24	-0.14
Thymus serpyllum	-0.28	-0.29
Veronica austriaca	-0.23	-0.02
Trifolium montanum	-0.27	-0.14
3. Species associated with agricultural intensification		
Daucus carota	-0.08	0.80
Taraxacum agg.	-0.04	0.76
Medicago lupulina	-0.03	0.78
Centaurea phrygia	0.02	0.81

It must be emphasized that currently much of the grassland in the Saxon Villages would meet general application requirements and the need for such a secondary filter, in terms of the scoring of individual applications, will arise in the future when agricultural intensification will have begun to have an impact, reducing quality and extent of semi-natural grassland.

Fugitive species

The ecological analysis of the Târnava Mare SCI area includes an investigation of a suite of plant species that are particularly sensitive to habitat loss and fragmentation and changes in land management, e.g. *Dianthus armeria*. They have all but disappeared from large areas of

Western Europe, including the UK (e.g. [20]). These 'fugitive' species may represent indicators of open landscapes and be associated with large-scale pastoral systems and shepherding, their disappearance indicating loss of functionality and cohesion in grassland ecosystems. These species all have particular life history strategies that may be easily disrupted by shifts in ecological gradients and integrity. They are interesting because they may be dispersed in space and time, i.e. they need to be able to move around a large landscape that is available over long periods of time. They may have short-lived seed-banks, dependant on the occurrence of small patches of particular conditions determining their regeneration niche. They may have potential to be used as a predictive tool in understanding and measuring the relationship between ecological processes and spatial scale and measuring the deterioration of ecologically sensitive habitats and landscape.

These indicators could be useful in designing and evaluating spatial limitations on populations processes which is highly pertinent to the determination of areas required in the designation of nature reserves and the potential of enlarging spatial connectivity in area agri-environment following article 10 of the Habitats Directive. They could also be used to monitor the functionality of nature reserves and also examine whether agri-environment schemes deliver biodiversity benefits.

The 'fugitive' species selected for study include: *Anacamptis morio (*syn. *Orchis morio), Dianthus armeria, Echium russicum, Gentiana cruciata, Gentianella ciliata* and *Melampyrum arvense.* All these species are attractive and potentially iconic. In Transylvania they still appear in intact plant communities and are still reasonably common and may be associated with pastoralism, i.e. in the sense of shepherding livestock across large areas of contiguous land. The project will make use of GIS systems data on land-use, which will allow mapping of populations of these species and evaluation of spatial scale patterns in relation to concomitant pattern and scale of landscape ecological processes and land-use.

Botanical hotspots

Slumping hills

As well as the generally diverse grassland habitats that occur on level ground, a striking feature of the ecology of grasslands is the role of aspect, with highly contrasting floras on north and south slopes. Within the same altitudinal ranges, small pockets of steppic (xerophytic) species survive on south-facing, steep, dry banks that exist within the matrix of more mesic (meadow condition) grassland habitats, and conversely on some north-eastern slopes, montane and boreal species are found.

The most extreme example of this relationship occurs on small discrete hillocks, usually less than 100 m in diameter and 30 m high, already identified as floristically rich before the present study [17]. These can have different shapes being very steep or flatter with convex or concave faces and comprising different surface substrates e.g. silt, sand or even gravel. They are probably the products of erosion of a geological sandwich of clay layers inter-bedded with layers of other coarser materials that become saturated with water and slip over the clay. They have two extreme conditions, a south and south–west facing side where temperatures rise to extremes and drought is the norm. A north- and north-east-facing side is cool and shady and often damp, the clay probably providing moisture through capillary action. The rest of the hillock surface provides all conditions between these two extremes. Because of this wide range of conditions, plant species of every possible kind of ecological grouping can be found, from steppic and drought-tolerant plants on the south side through meadow species to woodland, wetland plants or montane/boreal on the north side. Rather than clearly defined species associations determined by mapping of recognized habitats (e.g. under EUNIS habitat classification system), these hillocks can support random assemblages of plants that may represent relicts of a range of climatic

conditions through past millennia, stranded on these ecological islands in a matrix of unsuitable, more mesic, level agricultural land which has been ploughed or grazed more intensely.

One hillock in the Calea Dracului [Dragon's Avenue] complex of hillocks, 2 km south of Saschiz (we have studied other such hillock complexes near Apold, Buneşti and Vânători) has *Prunus frutescens* and *Cephalaria radiata* – steppic plants – on the south side, with *Daphne cneorum, Anemone sylvestris* and *Lilium martagon*, montane plants of the Carpathians and high woodland respectively, on the north side, all within 30 m. Plant species with contrasting ecological requirements can occur in a kind of ecological 'Alice in Wonderland' sward composition. On this particular hillock, *Sanguisorba officinalis* of wet grassland, the presence of which is used to define high priority wet meadow communities, and *Geranium sanguineum*, a xerophyte of dry sunny grassland and woodland margins, were found growing together.

There is also randomness about the plant species that occur within each hillock complex. In particular, hillocks in close proximity (even within 30 m) may not share species that would otherwise have been expected to colonize such short distances. Random or stochastic processes in terms of colonization, catastrophe and associated extinction or population decline, defined by classic models of island biogeography [9], may have resulted in the present distribution of these species, as steepness, size and height of slope and substrate composition are possibly not sufficient alone to explain these distribution patterns.

The ecological events that have shaped these plant species distributions must be related to landscape history. This would include both periods of warmer, drier climate and of colder drier and wetter climate in the past, with reduced tree cover during the Post-glacial period which has allowed some of these species to spread and colonize, making the inter-hillock areas alternately steppic or more boreal. With increasingly discontinuous dispersal over time, the remaining species distribution represents relict populations stranded on even smaller islands of suitable habitat. Some of these relict populations may be thousands of years old.

It is clear that these hillock complexes, which have been studied botanically only in the last 30 or so years [17], represent a botanical wonder of Europe, comparable in some respects with the strange relict plant species assemblages of the Burren in western Ireland or on cliffs of the Canary Islands and some Mediterranean islands. They represent a rich heritage of biodiversity that holds potential for investigation in terms of historical ecology, island biogeography and population genetics and need both to be conserved on scientific grounds and recognized for their value and contribution to grassland biodiversity.

Montane enclaves

In surveying, we have identified two different situations in the landscape associated with montane species: ridge summits covered with residual open woodland/grassland, and late snow hay-meadows on north-facing slopes. The former situation is associated with stands of juniper (*Juniperus communis*) on exposed ridges above 700 m. It may possibly represent an ancient relict of a sub-montane *Pinus sylvestris* forest community with the pine component now having disappeared but with survival of some of the associated species including mosses such as *Hypnum cupressiforme*. These areas must have remained relatively open for thousands of years, possibly aided by factors such as drought, wind damage/tree fall and lightning-strike in order to retain light-demanding relict populations of montane species like juniper. In Romania juniper is often a pioneer species that invades abandoned grasslands, on both siliceous and calcareous substrates, although in the project area it is apparently not a pioneer but a relic, isolated from the nearest major juniper populations.

North-facing slopes where snow may lie late in spring is associated with *Molinia/Nardus/Alopecurus*-dominated grasslands (including EU habitats 6140 *Molinia* meadows, and 6430 hydrophilous tall herb communities and intermediates). *Veratrum album* is often a striking indicator of the presence of these communities, which contain a group of

montane and more calcifuge species, including *Trollius europaeus, Achillea ptarmica, Gentiana pneumonanthe, Dactylorhiza* spp., *Pedicularis comosa, Phyteuma tetramerum* and *Narcissus poeticus* subsp. *radiiflorus.*

Conclusions

The challenge is to conserve these rich grassland resources in the face of inevitable changes resulting from EU accession, but also despite EU accession in terms of technological and societal changes that are occurring everywhere. There is an argument at EU level when considering biodiversity conservation to consider also the European commonwealth of wildlife. If we can conserve the valuable habitats of Transylvania we can do this for Europe rather than just for Romania. This has consequences for the cost of conservation programmes and setting priorities at EU level. A subsequent argument is that it is now more important to provide resources to conserve Romania's grasslands than to restore heavily degraded grasslands in Western Europe, especially as the cost of restoration is at least 20 times that of habitat maintenance, with no certainty of success.

Agri-environmental schemes in the Târnava Mare area need to be more highly developed than the 'broad and shallow' definitions that would mean only limited restrictions on fertilizer application rates. In order to maintain these grasslands and to conserve the patterns of diversity that have been surveyed there would need to be relatively heavy restrictions on the use of fertilizer input, limiting stocking density and hence a lowering of potential production levels and profitability of the farm enterprises. It would essentially be about retaining existing traditional farming management in the face of pressure to change. Furthermore, to conserve bird species such as corncrake and to maintain insect and plant species diversity, mechanical cutting dates would have to also be restricted to the latter half of June or July. The challenge is to impose such restriction with the agreement of farmers under a voluntary agri-environmental scheme that pays sufficient compensation to provide a financial incentive. Indicator species will provide the means of monitoring such schemes and to allow farmers to self-assess their progress.

In terms of threat to the area, the pattern in other countries has been for farming on the poorer, less productive land to be co-financed by agri-environmental schemes or to be included in least favoured area designation or under Natura 2000 with the better land succumbing to pressure to intensify or conversion to arable. Much of the lower land of the Saxon villages may be sufficiently high grade to be profitable if converted to arable farming and this will remain an issue that conservation programmes will have to address.

Beyond the development of indicator species, further ecological research is needed on the habitats and species of the Târnava Mare/Saxons village area. The aim is to develop an integrated conservation strategy that incorporates requirements of EU rural development and Habitats Directive policy (recognizing its SCI status), but goes well beyond these in terms of its remit.

Acknowledgements: The author is grateful to Orange Romania, and the UK Ministry of Agriculture (DEFRA) and the Darwin Initiative, for financial support for the work of ADEPT, including the grassland research. Dr. John Akeroyd collaborated on the fieldwork, and he and the author have discussed many of the conservation issues raised in this paper.

REFERENCES

1. Akeroyd, J, 2006, *The historic countryside of the Saxon Villages of southern Transylvania/Peisajul Istoric al Satelor Sasesti din Sudul Transilvaniei*, Fundația ADEPT, Saschiz.
2. Akeroyd, J., 2003, A Transylvanian wood-pasture, *Plant Talk*, **34**: 34–37.
3. *English Nature* ENACT publications, available from Northminster House, Peterborough PE1 1UA, UK (Tel: +44(0)845 600 3078).

4. European Environment Agency, 2004, *High nature value farmland. Characteristics, trends and policy challenges*, EEA report No 1/2004.
5. FAO, 2002, *Database of the UN Food and Agriculture Organization*, FAO, Rome.
6. Gough, M. W., Marrs, R. H., 1990, A comparison of soil fertility between semi-natural and agricultural plant communities: implications for the creation of species-rich grassland on abandoned agricultural land, *Biological Conservation*, **51**: 83–-96.
7. Honnay, O, Roldán-Ruiz, I., Baguette, M., 2006, *Conservation and restoration of fragmented biodiversity hot spots: calcareous grasslands of south Belgium* (BIOCORE report) contract: EV/01/26A, Belgian Science Policy.
8. Lande, 1996, Statistics and partitioning of species diversity and similarity among multiple communities, *Oikos*, **76**: 5-13.
9. MacArthur, R. H., Wilson, E. O., 1967, *The theory of island biogeography*. Princeton Univ. Press, Princeton, New Jersey, USA.
10. Martin, L. M., Moloney, Kirk, A., Wilsey, B. J, 2005, An assessment of grassland restoration success using species diversity components, *Journal of Applied Ecology*, **42**: 327–336.
11. Ministry of Agriculture Forests and Rural Development, Government of Romania, *National strategic plan of rural development* 2007-2013.
12. Oppermann, R. Gujer, H. U., 2003, *Artenreiches Grunland bewerten und forden MEKA und OQV in der Praxis*, Stuttgart.
13. Oppermann, R., Meyerhoff, E., van Elsen, T., 2006, *Naturschutzberatung für die Landwirtschaft. Einführende Beratermaterialien*. BfN-Script 162, Bonn. Bundesamt für Naturschutz (BfN).
14. Partel, M., Bruun, H. H., Sammul, M., 2005, *Biodiversity in temperate European grassland: origin and conservation. Integrating efficient grassland farming and biodiversity*, Proceedings of the 13th International Occasional Symposium of the European Grassland Federation Tartu, Estonia (published by organizing committee).
15. Ruprecht, E., 2005, Secondary succession in old-fields in the Transylvanian Lowland (Romania), *Preslia, Praha*, **77**: 145–157.
16. Sârbu, A., Coldea, G., Negrean, G., Cristea, V., Hanganu, J., Veen, P., 2004, *Grasslands of Romania*. Final report on National Grassland Inventory 2000-2003. University of Bucharest & Royal Dutch Society for Nature Conservation.
17. Schneider-Binder, E., 2007, Xerophilous and xero-mesophilous grasslands on slumping hills around the Saxon villages Apold and Saschiz (Transylvania, Romania), *Transylvanian Review of Systematical and Ecological Research*, **4**: 55-64.
18. Ter Braak, C. J. F., 1990, Interpreting canonical correlation analysis through biplots of structural correlations and weights, *Psychometrika*, **55**: 519-531.
19. Tscharntke, T., Steffan-Dewenter, I., Kruess, A., Thies, C., 2002, Contribution of small habitat fragments to conservation of insect communities of grassland-cropland landscapes, *Ecological Applications*, **12** (2): 354–363.
20. Wilson, P., 2002, *Dianthus armeria* (Deptford Pink) in 2001. Plantlife report no. 210., Plantlife, London.

SPECII SPONTANE INDICATOARE PENTRU CONSERVAREA HABITATELOR DE PAJIŞTI DIN TRANSILVANIA (ROMÂNIA)

(Rezumat)

România deține unele dintre cele mai diverse habitate de pajişte din Europa, care sunt menținute datorită agriculturii tradiționale. Pentru conservarea acestor habitate este foarte important să se stabilească starea lor, dacă sunt menținute în condiții bune sau sunt deteriorate. S-au stabilit specii spontane indicatoare, care sunt sensibile la schimbările din aceste habitate, în ceea ce privește modalitatea de folosire a terenului, mai cu seamă la adaosuri de îngrăşăminte azotate sau la supra şi subpăşunat. Un alt aspect foarte important pentru conservarea pajiştilor este fragmentarea habitatului, fapt care este greu de cuantificat cu ajutorul indicatorilor. Studiile cu privire la fragmentarea habitatului au examinat fauna, inclusiv fluturi şi păsări, care par a fi mult mai sensibili decât plantele la schimbările de scurtă durată ale calității habitatului.

În prezent, se caută o serie de plante care ar putea fi asociate cu habitate deschise şi utilizarea neintensivă a terenului şi care ar putea să dispară în condiții de fragmentare a habitatului, ceea ce ar reprezenta un semnal pentru nevoia de a dezvolta şi implementa strategii de management al habitatului. Într-un alt studiu, au fost identificate suprafețe localizate cu o diversitate foarte crescută a pajiştilor, iar aceste "puncte fierbinți" botanice au fost studiate din punctul de vedere al distribuției şi ecologiei.

Received: 30.06.2009; Accepted: 02.11.2009