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CLASSIFICATION OF BROAD-LEAVED FORESTS OF THE TRASCĂU MOUNTAINS (CARPATHIANS, ROMANIA) THROUGH OPTIMAL PARTITIONING

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Abstract: To date, the classification of broad-leaved forests of the Trascău Mountains (in the Apuseni Mountains) has been poorly developed, despite a variety of phytosociological studies. We have aimed to classify and interpret these communities ecologically. We constructed a database of 161 relevés, many of them published but partly comprising our own relevés. We constructed its dissimilarity matrix and, further, the dendrogram using the average method. It was cut at different levels in order to extract from to 2 to 10 clusters. Based on the criterion of the OptimClass 2 variant, we chose the partitioning solution comprising 7 clusters. We have used the indicator species approach for extracting a set of the diagnostic species for clusters. We discuss the ecological characteristics of these clusters. Furthermore, we examine the similarities between the clusters and possible phytosociological associations. In addition, we have checked for the syntaxa that have already been described in the study area.

Keywords: clustering, diagnostic species, Romania, OptimClass, species indicator value

Introduction

The main challenge in vegetation classification is to obtain units that satisfactorily correspond to the particular objectives of studies, such as validating phytosociological syntaxa [12], or distinguishing ecological species groups [18]. Therefore, it is often difficult to choose the optimal number of clusters in which a relevé matrix may be partitioned.

Tichý *et al*. (2010) introduced the method called OptimClass. Its great potential relies on the fact that the optimal partition is chosen to have as many diagnostic species as possible.

To date, no comprehensive classification of the broad-leaved forests of the Trascău Mountains has been carried out. Existing descriptions have focused only on restricted areas. For instance, researches were carried out in the southern [15], northern [7], western [22] and central-eastern parts [8] of these mountains. Moreover, we are not aware of any modern analytical studies. For this purpose, we have applied the 2nd variant of the OptimClass method [24].

Applying this procedure to a matrix comprising relevés of broad-leaved forests in the Trascău Mountains, we addressed the following questions: (i) what is the optimal number of clusters? (ii) what ecological characteristics are revealed by the clusters?, and (iii) to what extent are the clusters similar to existing phytosociological associations, especially those already described in the study area?

Materials and Methods

Study area

The Trascău Mountains (Fig. 1) form a subdivision of the Apuseni Mountains (South-Eastern Carpathians, Romania). Most of their land surface lies below 1000 m a.s.l. The climate is temperate-continental. Mean daily temperatures range from *c*. 4.5 °C in January to 16 °C in July [13]. Mean annual precipitation is 900–1000 mm. The bedrock mostly consists of ophiolites, flysches, crystalline schists, and limestones [16].

A mosaic of broad-leaved forests and secondary meadows characterizes the landscape. The potential natural vegetation is displayed in the maps of Bohn *et al*. (2004) [3]. The units are F126 (i.e. South-Eastern Carpathian hornbeam forests of *Fagus sylvatica* and *Carpinus betulus*, with *Melampyrum bihariense*), and F125 (i.e. Pre-Carpathian beech forests of *F. sylvatica*, *C. betulus*, and/or *Abies alba*, with *Cardamine glanduligera*, *Symphytum tuberosum*, and to a lesser extent *S. cordatum*).

Vegetation data

We compiled a database of 161 relevés. Of these, 47 were recorded by ourselves in 2010, covering nearly the whole range of the study area (Fig. 1); the remainder of the relevés were gathered from the literature of the 9-year period 1962–1971. The selection criterion for relevés was to have a tree cover of at least 30%. The Braun-Blanquet cover-abundance scale in the published relevés was converted into presence/absence data, whereas our own records were already in this form.

Species nomenclature follows the online version of *Flora Europaea* (Royal Botanic Gardens, Edinburgh, 2011).

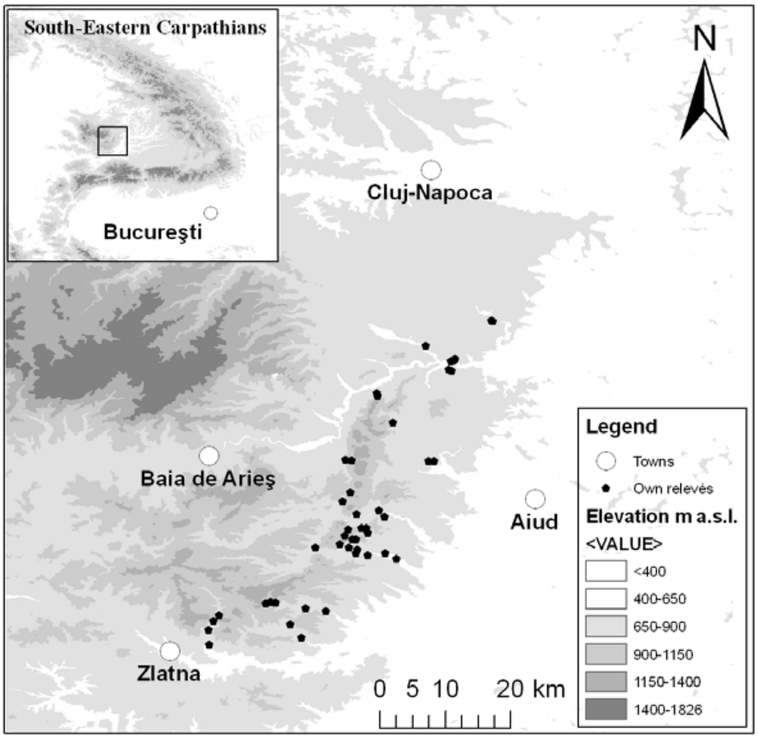

Fig. 1: Location of our own relevés (*n* = 47) recorded within the Trascău Mountains

Cluster analysis

We first computed the Bray-Curtis distance matrix, and then used it to construct the hierarchical dendrogram by the *average* linkage method.

Then, we basically followed the OptimClass 2 variant [24] as follows. This gives priority to the partitioning with the maximum number of clusters that contain a minimum predefined number of diagnostic species, and are thus more distinguishable and ecologically meaningful. Instead of employing Fisher's exact test, as in the original method, for identifying the diagnostic species, we used the indicator values [6], since this approach has been much more used in vegetation classifications [4, 10, 25]. The hierarchical dendrogram was successively cut at different levels in order to obtain 9 partitioning solutions, containing from 2 to 10 clusters. For each partitioning, we calculated the indicator values of the species to the clusters. Then, the criteria for a species to be validated as a diagnostic for a particular cluster were the following, that: (i) its indicator value be >= 0.2 for that cluster only, and (ii) the *p*–value of the Monte Carlo randomization procedure with 1000 iterations be <= 0.05.

Thereafter, for each partitioning solution we counted the clusters that had at least five validated diagnostic species. The result was subsequently used in the selection of the optimal partitioning, i.e. the one having the highest number of clusters that fulfilled the above condition.

The numerical computations were carried out in the open-source software R. We used the ‘vegan’ package [14] to construct the distance matrix, ‘stats’ [17] for hierarchical clustering, and ‘labdsv’ [19] to obtain the indicator values.

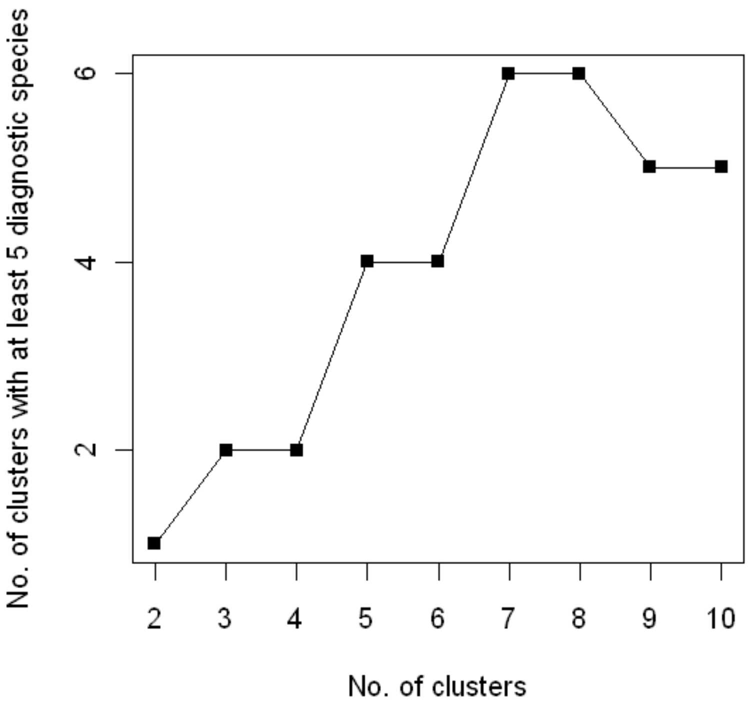

Fig. 2: Distribution of cluster frequency with at least five diagnostic species by the total number of clusters distinguished in each of the nine partitioning solutions

Results

The results are summarised in a diagram that displayed two possible optimal partitionings (Fig. 2). Of these, we chose the first, which divided the relevés into seven clusters. The validated diagnostic species for each cluster are displayed in Table 1.

Cluster 1**:** The tree layer of these communities was formed mainly by *Quercus petraea*, often admixed with *Fagus sylvatica.* In some stands, one of these species was dominant. Occasionally, *Acer campestre*, *Cerasus avium*, *Carpinus betulus*, and *Fraxinus excelsior* occurred at a lower frequency. The diagnostic herbaceous species generally indicated mesotrophic substrates [2, 5]. The altitudinal range was 490–1040 m a.s.l., with a mean of 680 m a.s.l. The sites were relatively variable in terms of slope and aspect.

Cluster 2**:** This cluster represented forests dominated by *Fagus sylvatica*, in some cases admixed with *Carpinus betulus*. Less frequent tree species were *Acer pseudoplatanus*, *A. platanoides*, *Cerasus avium*, *Fraxinus excelsior*, and *Quercus petraea*. The diagnostic herbaceous species, such as *Mercurialis perennis* and *Cardamine bulbifera* [2, 5], mostly indicated mesotrophic substrates, some with mull-type humus. The altitude varied between 590 and 1100 m a.s.l., with a mean of 910 m a.s.l. The aspects were mostly northern.

Cluster 3**:** The stands were dominated by *Fagus sylvatica*. In contrast to the second cluster, *Carpinus betulus* was less frequent here. The trees with a lower frequency were *Acer* *pseudoplatanus*, *A. campestre*, and *Fraxinus excelsior*. In general, the diagnostic herbaceous species, including indicators for mull-type humus (i.e. *Asarum europaeum*, *Pulmonaria rubra*), showed the presence of mesotrophic substrates. *Clematis alpina* and *Valeriana tripteris* indicate shaded rocky and open rocky sites, respectively. *Pulmonaria rubra* is a geographically restricted species that, according to Beldie (1967) is a Dacian element (i.e. occurring in the Carpathians and Balkans only). Additionally, *Cardamine glanduligera* is endemic to the Carpathians [5]. The altitudinal range was 640–1130 m a.s.l., with a mean of 840 m a.s.l. The aspects were mostly northern.

***Cluster 4*:** This cluster represented forests dominated by *Carpinus betulus*, in some places admixed with *Fagus sylvatica*. The other less frequent trees were *Acer campestre, Cerasus avium, Fraxinus excelsior,* and *Tilia cordata.* The diagnostic species generally indicated mesotrophic substrates. Of these, *Melampyrum bihariense* is a Dacian element [5]. The altitude of the relevés varied between 420 and 850 m a.s.l., with a mean of 650 m a.s.l. The sites had high variation in slope, with the aspects being mostly southern.

***Cluster 5*:** This cluster comprised few relevés in our database (Tab. 1). Nevertheless, it had many diagnostic species, which indicated thermophilous open forests of *Quercus pubescens* and *Q. cerris.* The trees with a low frequency were *Acer campestre* and *Q. petraea*. The diagnostic species of the herbaceous layer were mostly xero-mesophilous (e.g. *Carex humilis, Stachys recta*, *Euphorbia polychroma*, *Cornus mas*, *Erysimum odoratum*, *Astragalus glycyphyllos*, *Poa angustifolia*). These are more frequent in the surrounding calcareous grasslands. The altitude was around 550 m a.s.l. The sites had relatively steep slopes and were situated on southern aspects.

***Cluster 6*:** This cluster was similar to the first one, corresponding to *Quercus petraea* forests. It included a variety of less frequent trees, such as *Acer campestre, Cerasus avium, Carpinus betulus, Fraxinus excelsior, Quercus robur*, and *Q. pubescens*. Many of its diagnostic herbaceous species, such as *Genista tinctoria*, *Festuca heterophylla*, *Potentilla alba* and *Veronica officinalis* [2, 5], were indicators of nutrient-poor or even acidic soils. The available data on altitude were from a single plot only, at 610 m a.s.l, whereas information on slope and aspect was available from each relevé, displaying considerable variation.

***Cluster 7*:** This cluster represented alluvial *Alnus incana* forests. The other trees or shrubs occurring at lower abundance were *Acer campestre*, *Fraxinus excelsior, Salix triandra* and *S. purpurea*. The majority of the diagnostic herbaceous species, such as *Equisetum arvense, Matteuccia struthiopteris, Petasites hybridus, Poa trivialis, Ranunculus repens*, and *Mentha longifolia* are characteristic of substrates with high water content [2, 5]. The available relevés composing this cluster originated from a restricted area (i.e. the central part of the study area). Thus, the altitude had a short range of variation (650–750 m a.s.l.), and the stands were located entirely on flat terrain.

Table 1: Synoptic table of the seven clusters obtained through numerical classification. The validated diagnostic species (in dark-grey) and species with indicator values >= 0.15 (in light-grey) are ranked by their decreasing indicator value. The species with non-significant occurrence (Monte Carlo; *p*<0.05) were not included.

Cluster no. **No. of relevés**	**1** 18	**2** 39	**3** 25	**4** 28	**5** 6	**6** 36	**7** 9	***p*-value**
1. *Luzulo - Quercetum petreae* (Hilitzer 1932) Passarge 1953								
Heracium bifidum	**0.25**	–	–	–	–	–	–	0.002
Melampyrum nemorosum	**0.25**	–	–	–	–	–	–	0.004
Luzula luzuloides	**0.21**	0.02	0.13	0.02	–	0.12	–	0.033
Fallopia dumetorum	**0.19**	0.01	–	–	–	–	–	0.021
Hieracium praealtum subsp. bauhinii	**0.17**	–	–	–	–	–	–	0.019
2. Transitional type between *Symphyto cordati - Fagetum* and *Melampyro bihariense – Carpinetum*								
Lamiastrum galeobdolon	–	**0.32**	0.04	0.04	–	–	–	0.006

Mercurialis perennis	–	**0.32**	0.09	–	–	–	–	0.001
Cardamine bulbifera	0.02	**0.29**	0.11	0.01	–	–	–	0.003
Oxalis acetosella	–	**0.27**	0.06	–	–	–	–	0.009
Galium odoratum	0.02	**0.26**	0.12	0.05	–	–	–	0.013
Dryopteris filix–mas	0.01	**0.25**	0.06	0.03	–	0.04	0.05	0.002
Hordelymus europaeus	–	**0.18**	–	–	–	–	–	0.021
3. *Symphyto cordati* -*Fagetum* Vida 1959								
Fagus sylvatica	**0.18**	**0.30**	**0.40**	0.06	–	–	–	0.001
Asarum europaeum	–	0.06	**0.32**	**0.21**	–	0.02	0.01	0.002
Pulmonaria rubra	–	0.01	**0.32**	–	–	–	–	0.002
Clematis alpina	–	0.03	**0.27**	–	–	–	–	0.005
Gentiana asclepiadea	0.01	0.01	**0.26**	–	–	–	–	0.009
Veronica urticifolia	0.02	0.04	**0.24**	0.01	–	–	–	0.009
Cardamine glanduligera	–	0.04	**0.23**	–	–	–	–	0.019
Valeriana tripteris	–	–	**0.22**	–	–	–	–	0.013
Sorbus aucuparia	–	0.06	**0.20**	–	–	–	–	0.024
Hieracium rotundatum	–	–	**0.18**	–	–	–	–	0.026
Hepatica nobilis	–	0.08	**0.17**	0.09	–	0.01	–	0.050
Symphytum cordatum	–	0.03	**0.17**	–	–	–	–	0.050
4. *Melampyro bihariense* - *Carpinetum* Soó 1964								
Carpinus betulus	0.02	0.11	–	**0.62**	–	0.01	–	0.001
Glechoma hirsuta	–	0.03	0.06	**0.28**	–	–	–	0.004
Rosa pendulina	–	0.04	0.01	**0.25**	–	–	–	0.005
Euphorbia amygdaloides	–	0.14	0.03	**0.24**	–	–	0.01	0.006
Pulmonaria officinalis	0.01	0.13	0.01	**0.23**	–	0.01	–	0.008
Melampyrum bihariense	–	0.01	0.05	**0.22**	0.02	0.12	–	0.010
Carex sylvatica	–	0.06	–	**0.19**	–	–	–	0.029
Epipactis atrorubens	–	–	0.01	**0.18**	–	–	–	0.022
5. *Corno* -*Quercetum pubescentis* Jakucs & Zólyomi ex Máthé *et* Kovács 1962								
Quercus pubescens	–	–	–	–	**0.83**	–	–	0.001
Carex muricata subsp. lamprocarpa	0.01	–	–	–	**0.74**	0.02	–	0.001
Clematis vitalba	–	–	–	–	**0.67**	–	–	0.001
Carex humilis	–	–	–	–	**0.50**	–	–	0.001
Stachys recta	–	–	–	–	**0.50**	–	–	0.001
Crataegus monogyna	0.05	0.03	–	**0.17**	**0.34**	0.08	–	0.001
Euphorbia polychroma	–	–	–	–	**0.33**	–	–	0.002
Teucrium chamaedrys	–	–	–	–	**0.31**	–	–	0.004
Quercus cerris	–	–	–	–	**0.30**	0.01	–	0.004
Cornus mas	0.02	0.01	–	0.09	**0.27**	0.03	–	0.005
Coronilla varia	–	0.01	–	–	**0.25**	0.01	–	0.004
Erysimum odoratum	–	–	–	0.03	**0.25**	–	–	0.005
Euphorbia cyparissias	0.03	–	–	–	**0.24**	–	0.11	0.007
Rhamnus catharticus	0.01	–	–	–	**0.23**	0.01	–	0.010
Cruciata glabra	0.10	0.02	–	0.09	**0.23**	**0.23**	–	0.013
Astragalus glycyphyllos	–	–	–	0.03	**0.23**	0.09	–	0.005
Hedera helix	–	0.02	–	0.01	**0.22**	–	–	0.004
Vincetoxicum hirundinaria	0.04	–	0.01	0.04	**0.22**	0.01	–	0.015
Poa angustifolia	0.01	–	–	–	**0.21**	0.04	–	0.013
Galium album subsp. album	–	–	0.05	–	**0.20**	0.01	–	0.019
Cephalanthera rubra	–	–	–	0.13	**0.18**	–	–	0.033
Brachypodium sylvaticum	0.03	–	–	**0.15**	**0.17**	0.02	–	0.031
Melica ciliata	–	–	–	–	**0.17**	–	–	0.040
Campanula sibirica	–	–	–	–	**0.17**	–	–	0.035
Inula ensifolia	–	–	–	–	**0.17**	–	–	0.030
Viola jooi	–	–	–	–	**0.17**	–	–	0.045
Medicago minima	–	–	–	–	**0.17**	–	–	0.031
Leontodon hispidus	–	–	–	–	**0.17**	–	–	0.030
Teucrium montanum	–	–	–	–	**0.17**	–	–	0.039
Verbascum phlomoides	–	–	–	–	**0.17**	–	–	0.033

Anthericum ramosum	–	–	–	–	**0.17**	–	–	0.039
Pyrus pyraster	–	0.01	–	–	**0.17**	0.07	–	0.016
6. *Quercetum robori - petraeae* Borza 1959								
Quercus petraea	**0.28**	–	–	0.01	0.03	**0.57**	–	0.001
Sedum telephium subsp. maximum	–	–	–	–	0.03	**0.51**	–	0.001
Veronica chamaedrys	0.08	–	–	–	0.02	**0.50**	–	0.001
Hieracium umbellatum	–	–	–	0.01	0.03	**0.39**	–	0.001
Lathyrus niger	0.13	–	–	0.02	–	**0.37**	–	0.001
Genista tinctoria	0.07	–	–	–	0.02	**0.35**	–	0.001
Carex montana	–	–	–	–	–	**0.33**	–	0.002
Galium pseudoaristatum	–	–	–	–	–	**0.31**	–	0.002
Quercus robur	–	–	–	–	–	**0.30**	–	0.007
Malus sylvestris	0.01	–	–	–	–	**0.29**	–	0.004
Potentilla alba	–	–	–	–	–	**0.28**	–	0.002
Festuca heterophylla	0.02	–	–	–	0.04	**0.27**	–	0.005
Trifolium medium	0.07	–	–	0.08	0.02	**0.25**	–	0.007
Hypericum perforatum	0.01	–	–	0.01	–	**0.24**	–	0.009
Hieracium racemosum	–	–	–	–	–	**0.22**	–	0.006
Veronica officinalis	**0.17**	–	–	0.01	–	**0.22**	–	0.010
Origanum vulgare	–	–	0.01	–	–	**0.21**	0.02	0.010
Stachys officinalis	0.03	–	–	–	–	**0.21**	–	0.018
Clinopodium vulgare	0.07	–	–	0.01	0.17	**0.21**	–	0.021
Poa nemoralis	**0.17**	0.06	0.01	0.09	0.08	**0.21**	–	0.029
Campanula persicifolia	0.11	0.01	0.02	0.03	–	**0.20**	–	0.046
Iris graminea	–	–	–	–	–	**0.19**	–	0.021
Sorbus torminalis	0.04	–	–	0.03	–	**0.19**	–	0.032
Chamaecytisus hirsutus	0.14	–	0.04	–	–	**0.18**	–	0.022
7. *Stellario nemori - Alnetum incanae* Oberdorfer 1953 or *Telekio speciosae -Alnetum incanae Coldea (1986) 1991*								
Alnus incana	–	–	–	–	–	–	**1.00**	0.001
Salix purpurea	–	–	–	–	–	–	**0.67**	0.001
Poa trivialis	–	–	–	–	–	–	**0.67**	0.001
Prunella vulgaris	–	–	–	0.01	–	0.01	**0.59**	0.001
Petasites hybridus	–	–	–	–	–	–	**0.56**	0.001
Ranunculus repens	–	–	–	–	–	–	**0.56**	0.001
Lysimachia nummularia	–	–	–	–	–	–	**0.56**	0.001
Urtica dioica	–	0.03	–	0.01	–	–	**0.55**	0.001
Impatiens noli–tangere	–	–	–	0.01	–	–	**0.54**	0.001
Stellaria nemorum	–	–	–	–	–	–	**0.53**	0.001
Matteuccia struthiopteris	–	–	–	–	–	–	**0.44**	0.001
Equisetum arvense	–	–	–	–	–	–	**0.44**	0.001
Polygonum lapathifolium	–	–	–	–	–	–	**0.44**	0.001
Mentha longifolia	–	–	–	–	–	–	**0.44**	0.001
Mentha aquatica	–	–	–	–	–	–	**0.44**	0.001
Anthriscus sylvestris	–	–	–	–	–	–	**0.44**	0.001
Scrophularia nodosa	–	0.01	–	–	–	–	**0.43**	0.001
Chaerophyllum aromaticum	–	–	–	–	–	–	**0.41**	0.001
Salix triandra	–	–	–	–	–	–	**0.33**	0.001
Arctium nemorosum	–	–	–	–	–	–	**0.33**	0.002
Glyceria plicata	–	–	–	–	–	–	**0.33**	0.001
Potentilla anserina	–	–	–	–	–	–	**0.33**	0.001
Cardamine amara	–	–	–	–	–	–	**0.33**	0.001
Solanum dulcamara	–	–	–	–	–	–	**0.33**	0.001
Lamium album	–	–	–	–	–	–	**0.33**	0.002
Geum urbanum	0.01	0.02	–	0.02	0.02	0.01	**0.33**	0.002
Galium aparine	0.04	–	–	–	–	–	**0.28**	0.002
Glechoma hederacea	–	–	–	–	–	–	**0.26**	0.003
Geranium robertianum	–	0.11	–	0.04	–	–	**0.24**	0.011
Equisetum palustre	–	–	–	–	–	–	**0.22**	0.005
Poa pratensis	–	–	–	–	–	–	**0.22**	0.010
Poa annua	–	–	–	–	–	–	**0.22**	0.010

Lycopus europaeus	–	–	–	–	–	–	**0.22**	0.004
Chrysosplenium alternifolium	–	–	–	–	–	–	**0.22**	0.004
Ranunculus acer	–	–	–	–	–	–	**0.22**	0.004
Geranium sylvaticum	–	–	–	–	–	–	**0.22**	0.006
Myosotis sylvatica	0.01	–	–	–	–	0.01	**0.21**	0.005
Stachys sylvatica	–	–	–	0.06	–	–	**0.20**	0.012
Galeopsis speciosa	0.05	–	–	–	–	–	**0.18**	0.027
Plantago media	–	–	–	0.02	–	–	**0.17**	0.017

Sources of relevés, ordered by clusters: **1.** 15 – original, 1 - Gergely (1962), 2 - Gergely (1968); **2.** 16 – original, 4 - Gergely (1962), 8 - Gergely (1968), 4 - Ghişa *et al*. (1965), 1 - Şuteu (1971), 6 - Şuteu (1970); **3.** 4 – original, 10 – Gergely (1968), 11 – Şuteu (1970); **4.** 9 – original, 4 – Gergely (1962), 3 – Gergely (1968), 6 – Şuteu (1971), 6 – Şuteu (1970); **5.** 2 – original, 3 – Gergely (1962), 1 – Gergely (1968); **6.** 1 – original, 15 – Gergely (1962), 20 – Gergely (1968); **7.** 9 - rel. Şuteu (1970).

Discussion

The clusters obtained through our classification do not have a geographical significance as do most of the phytosociological syntaxa. Nevertheless, they indicated particular ecological conditions.

Since *Luzula luzuloides* and *Quercus petraea* were listed among the diagnostic species of Cluster 1 (Tab. 1), we assign this cluster to *Luzulo-Quercetum petreae* (Hilitzer 1932) Passarge 1953. This association, which according to Sanda [20] is synonymous with *Genisto tinctoriae-Quercetum petreae* Klika 1932, was described previously in the eastern side of the study area [13].

Cluster 2 does not obviously correspond to any association. Based on the positive indicator values of the diagnostic species of Cluster 3 and 4 in this cluster, we can only describe this as a transitional type.

Of the diagnostic species of Cluster 3, *Pulmonaria rubra* and *Cardamine glanduligera* have been considered in the phytosociological literature as character species of the *Symphyto-Fagion* Vida 1959 alliance. *Symphytum cordatum* and *Fagus sylvatica* also had high indicator values. Therefore, we assign this cluster to *Symphyto cordati-Fagetum* Vida 1959. This association has been often mentioned in the literature as being present in the Trascău Mountains [9, 11, 22]. Accordingly, we can report this association as being the most widespread in the area.

Since *Carpinus betulus* and *Melampyrum bihariense* are among the diagnostic species of Cluster 4, we assign this to *Melampyro bihariense-Carpinetum* Soó 1964. To our knowledge, this association never been reported in the study area. Instead, *Carpino-Fagetum* Paucă 1971 has frequently been found there [8, 15, 22, 23].

Because of the occurrence of *Quercus pubescens* and *Cornus mas* in the diagnostic species list of Cluster 5, we assign this to *Corno-Quercetum pubescentis* Jakucs et Zólyomi ex Máthé et Kovács 1962. An association called *Quercetum pubescentis-cerris* nomen nudum was reported previously in the southern part of the Trascău Mountains [15].

Due to the presence of *Quercus petraea* and *Q. robur* among the diagnostic species of Cluster 6, we assign this cluster to *Quercetum robori-petraeae* Borza 1959. This is somewhat related to Cluster 1, as *Q. petraea* is a common diagnostic species for both clusters. The most similar association given in the literature to describe the vegetation of the Trascău Mountains is *Quercetum roboris-petraeae dacicum* [8].

Since *Alnus incana* and *Stellaria nemorum* are diagnostic for Cluster 7, we have assigned this to *Stellario nemori-Alnetum incanae* Oberdorfer 1953. Among the remainder of the diagnostic species, some (e.g. *Impatiens noli-tangere*, *Stachys sylvatica*) are character species of the class *Querco-Fagetea* Br.-Bl. et Vlieg. 1937, and others (e.g. *Lamium album*, *Lysimachia nummularia*, *Prunella vulgaris*, *Urtica dioca*) of syntaxa unrelated to the alliance *Alno-Padion* Knapp 1942, to which this association belongs. The assignment of this cluster to the above-mentioned association is questionable since all the available relevés derive from the same source

[20]. Another possibility would be to assign Cluster 7 to *Telekio speciosae-Alnetum incanae* Coldea (1986) 1991 because this is the most widespread association of the *Alnus incana* forests in the Apuseni Mountains – even though our relevés do not include *Telekia speciosa*.

Conclusions

The numerical classification revealed a variety of associations. In short, we identified six associations from a total of seven clusters. *Luzulo-Quercetum petreae*, *Symphyto cordati-Fagetum* and *Quercetum robori-petraeae* were previously reported in the study area, whereas *Melampyro bihariense-Carpinetum*, *Corno-Quercetum pubescentis,* and *Stellario nemori-Alnetum incanae* were not.

As we considered a relatively small region of the Carpathians, the diagnostic species could not have enough geographical discrimination power. Instead, they indicate local ecological conditions.

This study is the first to present a comprehensive numerical classification of the broad-leaved forests at the scale of the Trascău Mountains.

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CLASIFICAREA PĂDURILOR DE FOIOASE DIN MUNŢII TRASCĂU (CARPAŢII SUD – ESTICI) PRIN PARTIŢIONARE OPTIMĂ

(Rezumat)

Până în prezent, clasificările pădurilor din Munţii Trascău au fost inconsistent efectuate, în ciuda variatelor, dar restrânselor, studii fitosociologice. Prin urmare, ne-am propus atât clasificarea acestor comunităţi forestiere, cât şi interpretarea lor sub aspect ecologic şi fitosociologic.

Am realizat o bază de date cuprinzând 161 de relevee, dintre care 47 au fost efectuate de noi. Pentru început, am calculat matricea de disimilaritate a releveelor, iar pe baza acesteia am construit o dendrogramă prin algoritmul legăturii medii. Dendrograma a fost retezată la diferite nivele în vederea extragerii de 2 până la 10 clustere. Urmând varianta 2 a metodei OptimClass, ce are ca scop alegerea soluţiei optime de partiţionare, şi anume aceea cu un număr maxim de clustere care să deţină fiecare cel puţin cinci specii diagnostice, am decis împărţirea releveelor în 7 clustere. Pe baza valorilor indicatoare ale speciilor, am extras un set de specii diagnostice pentru fiecare cluster.

Pe baza indicaţiilor oferite de speciile diagnostice, preluate din literatură, am discutat caracteristicile ecologice ale clusterelor, acestea evidenţiind, în special, o varietate relativ mare în ceea ce priveşte tipul de substrat şi condiţiile fiziografice. Prin urmare, solurile pe care pădurile analizate vegetează pot fi dezvoltate atât pe roci acide, cum ar fi ofiolitele sau şisturile cristaline, cât şi bazice, predominant calcare. Expoziţiile şi pantele variază de asemenea într-un interval relativ larg.

Pe lângă aceasta, am examinat asemănarea floristică dintre clustere şi posibilele asociaţii fitosociologice, verificând totodată şi unităţile descrise deja în literatura cu privire la aria de studiu. În linii mari, din cele 6 asociaţii identificate, 3 au fost deja menţionate (*Luzulo – Quercetum petreae, Symphyto cordati – Fagetum* şi *Quercetum robori – petraeae*), iar 3 (*Melampyro bihariense – Carpinetum, Corno – Quercetum pubescentis* şi *Stellario nemori – Alnetum incanae*) au fost identificate ca noi, în acest masiv muntos. Unul din clustere a fost tranzitoriu.

Considerăm că metoda implementată în acest studiu s-a dovedit a fi o modalitate potrivită de clasificare a vegetaţiei, care deţine, în opinia noastră, un potenţial metodologic şi informativ ridicat.

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