Contribuţii Botanice – 2017, LII: 119-131 DOI: 10.24193/Contrib.Bot.52.8
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A CASE STUDY IN THE MOLDAVIAN CENTRAL PLATEAU, ROMANIA - HABITAT DISTRIBUTION, CONSERVATION STATUS AND HUMAN IMPACT IN A PROTECTED AREA

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Abstract: The paper presents the results of the studies performed in the Natura 2000 site Pădurea Bârnova-Repedea (ROSCI0135), in order to identify and map habitat types and plant species of community interest. Palynological and archaeo-botanical studies in the region were reviewed, in order to assess the presence of the ancient forests. This protected area was designed to preserve forests from two habitats types of community interest, namely *Asperulo-Fagetum* beech forests and Dacian oak-hornbeam forests, and to shelter a species of wild and endangered orchid, *Cypripedium calceolus* L. During the field work other Natura 2000 habitats of community interest have been identified: mountain hay meadows, Ponto-Sarmatic steppes and Ponto-Sarmatic deciduous thickets. The information obtained provided new data on the habitats and plant species distribution. Field data were correlated with existing topographic maps and aerial photography. The use of the Geographic Information System allowed translating the field distribution of the species and habitat types into accurate maps, which can be used in the future by the managers of this site for implementing adaptive conservation measures. The human activities with potential impact on this Natura 2000 site have been recorded. The map of current pressures on the site was generated based on these impact categories.

Keywords: Pădurea Bârnova-Repedea SCI, Natura 2000 ecological network, mapping, *Cypripedium calceolus*, Romanian habitat classification system, vegetation history

Introduction

The Natura 2000 European ecological network includes Special Protected Areas (SPAs) classified under the Birds Directive [51] and Sites of Community Importance (SCIs) under the Habitats Directive [49], both designed for the conservation of species and habitats of community interest. Their protection and conservation in Romania is guaranteed by the Government Emergency Ordinance no. 57/2007 [53], approved by the Law 49/2011 [55], which transposes into national law the EU Council Directive 92/43/EEC on the conservation of natural habitats and wild fauna and flora [50]. With the implementation of the Habitats Directive, EU member states committed themselves to protect a range of highly threatened habitats within their territory.

Monitoring and reporting on the status of the Natura 2000 habitats is an essential part of an effective conservation, and an important obligation under the Habitats Directive. Every six years, member states have to report on the actual area, range, quality and future prospects, considering human activities for each habitat type [42].

In order to meet these requirements the Geographic Information System (GIS) is used worldwide. It allows the accurate map positioning of the species, habitats and human impact that is translating their spatial distribution from the field. These data may be used in the future by the managers of each site for implementing adaptive conservation measures to preserve biodiversity and the cultural heritage that are strongly connected [47, 44].

The Natura 2000 Barometer of December 2013, which monitors progress in the implementation of both the Habitats and the Birds Directives [57], provides the following information as regards the SCIs and the SPAs in Romania, that cover together 22.56% of the national territory:

- 383 SCIs, having a total surface of 41.468,65 km^2, cca. 16.68% of the national territory;
- 148 SPAs, having a total surface of 36.977,72 km^2, cca. 14.83% of the national territory.

The species and habitats for which these 531 protected areas were designed require rigorous and actual scientific documentation of their spatial distribution, conservation status and future perspectives within each Natura 2000 site from Romania. In this context, the overarching goal of this study is to contribute to the efficacy of the Romanian Natura 2000 network in conserving biodiversity at the site ROSCI0135 Pădurea Bârnova-Repedea. Specifically, the research objectives are: (1) to document and map the spatial distribution of the plant species and habitat types enlisted in the Natura 2000 Standard Data Form of this site; (2) to register and map the potential human impact on the protected area.

Material and Methods

Study site

The limits for the Natura 2000 site ROSCI0135 Pădurea Bârnova-Repedea (47º1′27″N, 27º38′50″E) have been drawn in conformity with the Order of the Minister for Environment and Forests no. 2387/2011 [56] on an area of 12216 ha; the elevation within the site varies between 103 and 419 m a.s.l. (Fig. 1). The climate is characterized by an annual average temperature of 9.5°C and a yearly average rainfall of 585 mm.

The site partially overlaps with ROSPA0092 Pădurea Bârnova protected area. Within the limits of the SCI, several nature reserves of national interest can be found: *Locul fosilifer Dealul Repedea*, of geological-paleontological type; *Pietrosu-Dobrovăţ*, of forest type; *Poieni-Cărbunăriei*, of forest type; and *Poiana cu Schit*, of botanical type (Fig. 1). All these are included in the Law No. 5/2000 – Section III - Protected Areas [54]. Details of the protected areas within the Natura 2000 site are found in some papers [35, 22, 39, 31]. Previous studies carried out in this region have focused on flora and vegetation synthesis [26, 27, 46], but the current aspects regarding the Natura 2000 habitat types and the conservation issues from this site have not been approached.

The Natura 2000 site ROSCI0135 Pădurea Bârnova-Repedea has been declared for two

habitat types of community interest: 9130 *Asperulo-Fagetum* beech forests and 91Y0 Dacian oak-hornbeam forests. The general description of these habitat types is provided in the Natura 2000 interpretation manuals [52, 28, 30]. According to the Standard Data Form, the habitats of community interest in the Natura 2000 site Pădurea Bârnova-Repedea cover 33% (9130) and respectively 55% (91Y0) from the total surface of the site. These preliminary data on habitat areas were verified in the field, to correct any inconsistencies. The presence of the community interest orchid *Cypripedium calceolus* within the site has also been investigated. Moreover, the sources of human impact were recorded, in order to provide information necessary for biodiversity conservation in this site.

Data collecting and analysis

In order to evaluate the conservation status of species and habitats in this site, in the context of human impact, field surveys were carried out in the year 2012. The Braun-Blanquet [14] method was used for investigating phytocoenoses in the field, combined with the work technique of "itinerary" investigations. The succession of the research phases was as follows:

(1) analytical phase, aiming to identify the qualitative, quantitative and spatial structure of phytocoenosis and habitats, their distribution and spatial extent, along with the intensity of anthropic pressure;

(2) synthetic phase, consisting in analysing the fragments of phytocoenoses in order to assign them to vegetation units (coenotaxonomic units/ habitat types).

Relevés were collected from "key points", along pre-established transects within the Natura 2000 site, in the optimal period for each phytocoenosis type. Transects have focused on the two types of community interest habitats. In order to select transects, several stages have been followed. The existing topographical data (aerial photography 1:5000, topographical maps 1:25000 and 1:50000), as well as polygons with the limits of the Natura 2000 site and nature reserves have been loaded in the Garmin CS60 GPS units. The correlation of all existing data (topographical data, aerial photography, and the Standard Data Form) has allowed drawing optimal transects for the study of habitats of community interest from the site. For *Cypripedium calceolus* investigation, transects have taken into account the ecological requirements of this rare and endangered species [2].

A qualitative and quantitative assessment of the habitats of community interest has been performed, based on information regarding their floristic structure. Habitats which were not mentioned within the Standard Data Form have also been recorded. Conservation status of habitats and plant species of community interest has been assessed. For each habitat type, the distribution was represented as polygon. The identification and mapping of habitats from the site was made at a scale of 1:10000.

In order to identify the major sources of potential human impact on habitats, aerial photographs were used (with 0.5 m pixel resolution), as well as topographical maps at different scales (1:5000, 1:25000, 1:50000). These impact sources have been digitized to a point shapefile, both from the area of the Natura 2000 site, as well as from neighbouring areas, within a 5 km radius around the site. Six different distance classes from the site boundaries, between 500 and 5000 m, have been taken into consideration, in order to reflect the gradual spatial distribution of the most important factors of human impact.

In order to evaluate the real human impact on the protected area, field observations

focused on identification and inventory of impact sources (according to Article 17*: code list of threats and pressures* of the Habitats Directive, 2006) but also on detection and assessment of the degree of damage to habitats and species. Present-day impacts and potential threats have been analysed for each habitat type of community interest and for *Cypripedium calceolus* within the Natura 2000 site, in order to establish the conservation measures.

The delimitation method used both GPS field measurements and the physico-geographical, geomorphological elements of the landscape and ecosystems followed by analysis and processing in ArcGIS software. The coordinate systems used for the maps projection was the Romanian National Coordinate System: Stereo 1970.

Several palynological and archaeobotanical studies were reviewed, in order to assess the status of the ancient forests in the region.

Results

The study of palynological and archaeo-botanical data from 17 sites in Moldova, in the territory of Iaşi and the neighbouring counties of Neamţ, Bacău, Suceava and Botoşani revealed the presence of more or less extensive forests in the studied region, from ancient times.

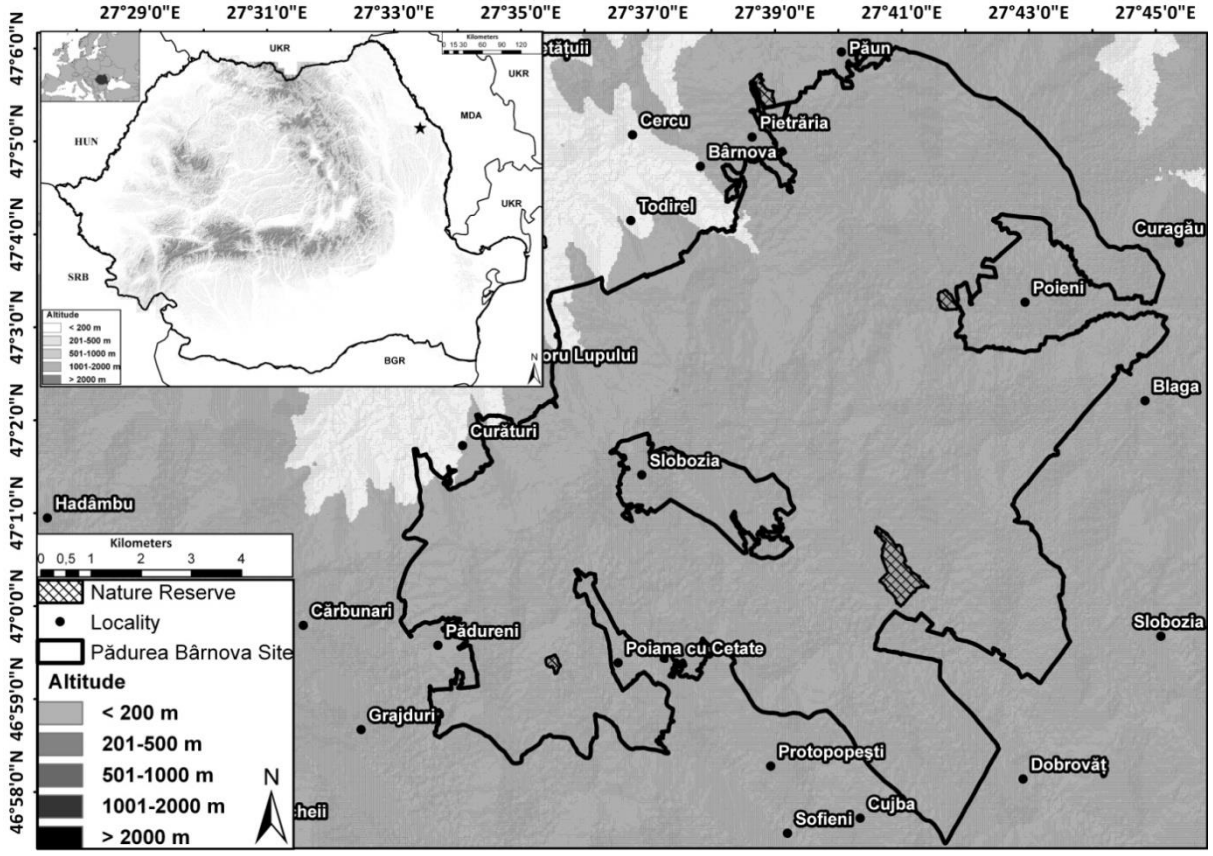

Fig. 1: The boundary of the Pădurea Bârnova-Repedea Natura 2000 site

During field studies in the Natura 2000 site Pădurea Bârnova-Repedea, the distribution of the habitats from the Standard Data Form (**9130** and **91Y0**) has been established. Apart from these types, other habitat types of community/priority interest were mapped in the investigated Natura 2000 site: **6520 Mountain hay meadows, 62C0* Ponto-Sarmatic steppes** and **40C0***

Ponto-Sarmatic deciduous thickets. The information obtained has been used in the laboratory to generate the distribution map for all habitats (of community interest and other types) identified in the site (Fig. 2).

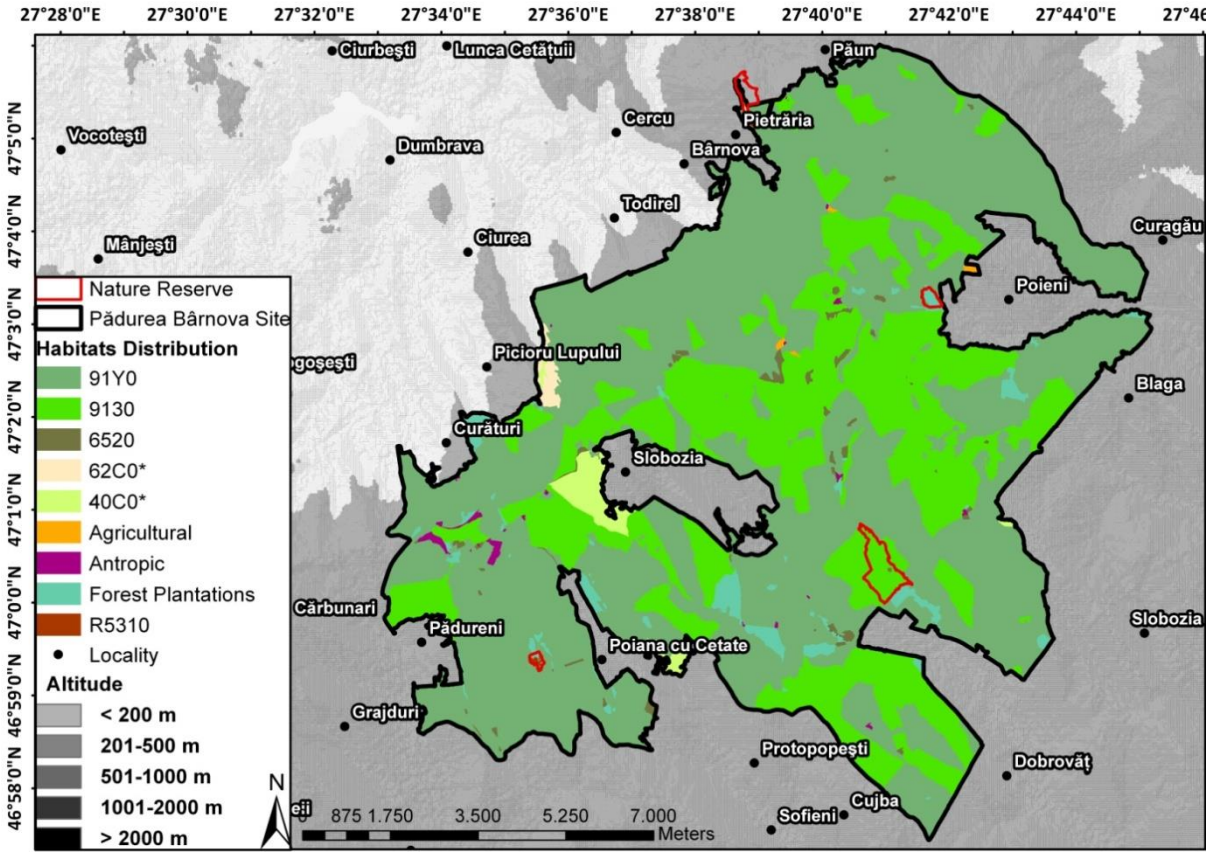

Fig. 2: Habitat types distribution in the Pădurea Bârnova-Repedea Natura 2000 site.

Digitizing the vegetation polygons in ArcGIS [29] allowed us to calculate the surfaces covered by each habitat type (Tab. 1). The dominant habitat type within the site is 91Y0 Dacian oak-hornbeam forests, covering 8137.19 ha (66.61% of the entire surface of the SCI) and distributed in a non-uniform manner.

The map of current pressures, based on the impact categories, is presented in Fig. 3. Several sources of human impact have been identified within the site and in the 5-km buffer zone: 22 sheepfolds, 28 stables, 4 cottages, 6 forestry cottages, 22 farms (livestock farms, vineyards, orchards, and fisheries), 2 hunting lodges, 2 monasteries and 42 villages. Within the site there have also been identified 168 road sections (including two national roads), totaling 137 km in length, and railways (Iaşi-Bucharest), relevant in terms of impacts on habitats and species of community interest.

Discussion

The history of forests in the region

The paleobotanical, palynological, anthracological, and carpological analyses performed both in palynological and archaeological sites, demonstrate the millennial age of forests in the site area, but also at regional level [43].

Table 1: Habitat types and their current areas in the Pădurea Bârnova-Repedea Natura 2000 site

Habitat type	Area (ha)	Percentage in the Natura 2000 site (%)
91Y0	8137.19	66.61
9130	3468.05	28.39
Plantation	266.25	2.17
40C0*	167.66	1.37
6520	82.28	0.67
62C0*	44.07	0.36
Anthropic	35.37	0.28
Agricultural	11.26	0.09
Other	0.52	0.04
R5310	3.30	0.02

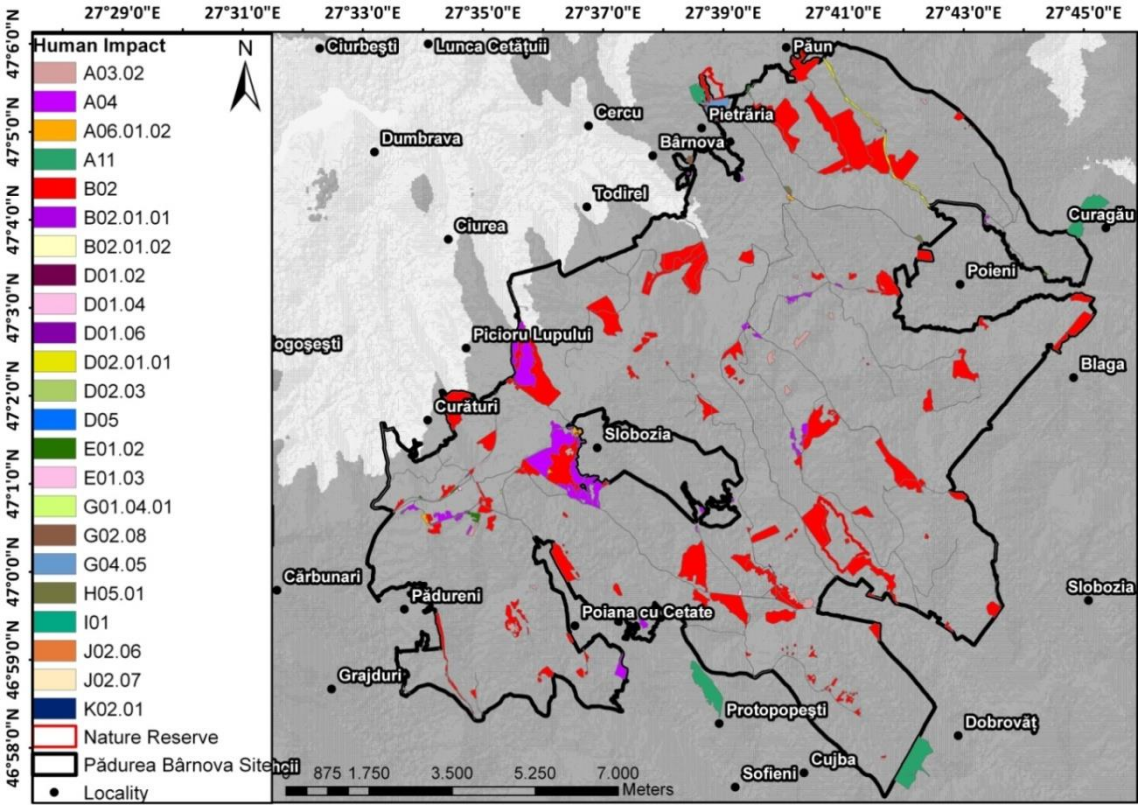

Fig. 3: Distribution of current pressures in the Pădurea Bârnova-Repedea Natura 2000 site

At the Neolithic archaeological site **Isaiia–Balta Popii** [6], the significant percentages of arboreal pollen grains, such as *Fagus*, *Quercus*, *Ulmus*, and *Tilia,* indicate the presence of a nearby forest. At **Costeşti** [4, 8] the authors state that some deciduous trees such as *Tilia* and *Quercus* were present not far from this chalcolithic site assigned to Cucuteni culture. Also, *Quercus*, *Tilia* and *Corylus* were certainly present during the Middle Holocene at the chalcolithic (aeneolithic) site **Hoiseşti**, in the proximity of the archaeological site [3]. At the tardenoisian site **Erbiceni** [17, 18, 19], the existence of deciduous trees (*Ulmus* and *Quercus*) was demonstrated

since the Alleröd climatic oscillation [19]. ^{14}C dating of 7.850±215 B.P. confirms the continuity of the deciduous forest around this site. Older anthracological analyses in this settlement also demonstrated based on macrofossils, the existence of *Quercus* and *Tilia* [17]. At **Topile – Dealul Catargii** [20] the authors estimate that here the habitation can be assigned to the mild climatic oscillations Laugerie – Lascaux, at the termination of the Last Glacial Maximum [25]. Pollen analyses conducted at the site revealed the presence of *Pinus, Betula, Salix, Picea, Tilia, Ulmus* and *Carpinus.*

South of the Natura 2000 site Pădurea Bârnova-Repedea, in the archaeological site of **Poduri – Dealul Ghindari** (chalcolithic site assigned to Cucuteni culture), Monah & Monah [37, 38] identified foliar impressions of *Corylus avellana* and *Tilia plathyphyllos* s. lato, belonging to the Precucuteni culture. The same authors stated in the table regarding the Flora of Eneolithic/Cucuteni culture from western Moldavia the existence of *Acer*, *Alnus*, *Castanea*, *Fagus*, *Fraxinus*, *Juglans*, *Quercus,* and *Salix*. More recently, Bodi *et al*. [7] detailed the results of palynological analyses performed in this archaeological site, certifying the presence of deciduous tree pollen (*Quercus, Tilia, Carpinus, Salix, Fraxinus, Corylus*).

There is also evidence of old deciduous forests from the sites of **Pângărăcior** [11], **Râpa lui Bodai** from Târpeşti [17, 24, 34], **Hălăbutoaia - Ţolici** [23, 24], **Ponoare-Bosanci** [12], Bahna valley near the villages **Dersca and Lozna** [10, 13], **Lunca Zamostei** [36], and **Feteşti - Adâncata** commune [9]. Pollen analyses also certify the early presence of the forests in the sites **Suliţa – Drăcşani** [41], **Drăguşeni** [17], **Mitoc-Valea Izvorului** [5, 19] and **Ripiceni Izvor** [16, 19].

Present-day vegetation within the Natura 2000 site Pădurea Bârnova-Repedea

The main features of the habitats of community interest, identified in the Pădurea Bârnova-Repedea Natura 2000 site as a result of field studies, as well as the issues related to their conservation status and human impact, are presented below.

9130 Asperulo-Fagetum beech forests

The habitat of medio-European and Atlantic areas of Western, Central, and Central Nordic Europe [30], has a natural origin in the site. It includes three types of habitats in the Romanian classification system, according to Doniţă *et al.* [28]: R4118 Dacian forests of beech (*Fagus sylvatica*) and hornbeam (*Carpinus betulus*) with *Dentaria bulbifera*; R4119 Dacian forests of beech (*Fagus sylvatica*) and hornbeam (*Carpinus betulus*) with *Carex pilosa*; R4120 Moldavian mixed forests of beech (*Fagus sylvatica*) and silver lime (*Tilia tomentosa*) with *Carex brevicollis.* Forest associations characteristic to this habitat type are: *Carpino-Fagetum* Paucă 1941 subass. *tilietosum tomentosae* Mititelu *et al.* 1977; *Galio schultesii-Fagetum* Burduja *et al.* 1973, Chifu et Ştefan 1994; *Lathyro veneti-Fagetum (*Dobrescu et Kovács 1973) Chifu 1995 [28, 30].

Its distribution within the site is mostly related to environmental conditions. In terms of topography, it usually occupies the areas from the hilltops - over 300–350 m a.s.l. Nevertheless, one factor that should be taken into account is forest management, the potential distribution of this beech-dominated habitat most likely being wider in the past. This assumption is based on the frequent presence of very old beech individuals within stands of younger trees from other species. These old specimens are considered as remnants of former beech forests. In time,

through the replacement of tree species, in this case of beech by lime and hornbeam, the areas occupied by the habitat 9130 have diminished. On the contrary, the species composition of the herb layer did not change significantly within this relatively small timespan, of 50–100 years.

91Y0 Dacian oak-hornbeam forests

The habitat 91Y0 is the best represented within the site, making up most of the forested area. Similarly to the previous one, it is related to the particular environmental conditions. It includes two types of habitats in the Romanian classification system [28]:

1. R4125 Moldavian forests with sessile oak (*Quercus petraea*), beech (*Fagus sylvatica*), lime (*Tilia cordata*) with *Carex pilosa*. This habitat can be found on southern and western aspects and even on northern ones at lower altitude, below 350 m a.s.l., having a more thermophillous character. Its wide distribution within the site is explained by the more continental climate, specific to the Central Moldavian Plateau. In contrast to habitat 9130, this habitat is less fragmented.

2. R4143 Dacian forests of oak (*Quercus robur*) with *Melampyrum bihariense* are usually found on plateaus near large valleys - probably former river terraces. On large sized plateaus, stagnation of rain water occurs frequently, especially in spring, providing mesophillous and sometimes meso-hygrophillous conditions, favourable to this type of habitat. This habitat occupies a wide area in the western part of the site. Most probably, in the past, the forests of *Quercus robur* and *Carpinus betulus* occupied larger areas, currently their surface being on the decrease, because of timber extraction practices that have caused the fragmentation of these communities. However, evidence of natural regeneration and reforestation activities has been observed.

6520 Mountain hay meadows

This comprises the large meadows of the site (*Festuco rubrae - Agrostietum capillaris* Horvat 1951) that are established in forest clearings and provide fodder for game animals. Therefore, the habitat has a scattered distribution, surrounded by forests. In summer the meadows are mowed once or twice for hay production. This habitat is important mainly for its ecosystem services.

62C0* Ponto-Sarmatic steppes

This habitat is present within the site in very small areas, mainly in the natural reserve *Locul fosilifer Dealul Repedea*, of geological and paleontological type. The habitat is represented by xero-mesophillous communities of *Festuca rupicola* and *Festuca valesiaca* (syntaxon *Taraxaco serotinae – Festucetum valesiacae* Burduja *et al.* 1956), specific for sunny areas with low humidity.

40C0* Ponto-Sarmatic deciduous thickets

It is a priority habitat of sub-thermophyllous bushes that occupies small areas on hillsides with various slopes, at forest edges, most often with a patchy distribution. This habitat type appears after abandonment of pastures and represents a successional stage towards climax forests within this area.

The rare and endangered orchid *Cypripedium calceolus* (Lady's Slipper Orchid) was identified in four small areas. In terms of habitat requirements, the species is mesophilous, micro-mesotherm, acidophillous-neutrophillous, helio-sciadophile and calcicole [33, 21]. It grows in shady forests and scrub of sessile oak, up to the boreal belt of the spruce, blooming in

May-June [21]. In Europe, this species has become increasingly rare, having small populations throughout its geographical distribution area, being protected in many countries [15, 45]. Although individuals are long-lived, sometimes up to 60–100 years [32], extinction analysis revealed that in a population of around 20 individuals (as is the case of many European sites), survival chances significantly decrease if more than two shoots are collected over a period of five years [48, 1].

According to Nicolè *et al.* [40], many orchids, including *Cypripedium*, exhibit dormancy in some years, under unfavorable conditions, which further reduces their chance of survival. Since blooming occurs in cycles that sometimes encompass more years, the monitoring process for this orchid requires long-term studies.

In all four points where the species is present within the Natura 2000 site ROSCI0135 Pădurea Bârnova-Repedea, only a few individuals bear flowers. This is a common situation for this species, caused not only by environmental conditions (especially soil), but also due to the physiological characteristics of the species [40]. The species occurs in scattered populations in the site, on calcareous, neutrophyllous soils (rendzinas), on humus-rich substrates. It prefers sheltered stations with a relatively thick layer of litter, vegetating under various degrees of canopy closure 65–90%. Tree species composition of forests in the four stations is quite diverse, the most frequent being *Quercus petraea*, *Fagus sylvatica*, *Prunus avium*, *Tilia cordata*, *Corylus avellana*. The herb layer is dominated by mull humus flora, such as *Asarum europaeum*, *Circaea lutetiana* and *Lamiastrum galeobdolon*.

Conservation Status and Human Impact within the Natura 2000 site Pădurea Bârnova-Repedea

The structure and functions of the habitats 9130 and 91Y0, including typical species, are in good condition, without significant deterioration. Some actions of timber extraction of beech and hornbeam were observed in the field across the 9130 habitat, but there are not major violations to seriously worsen habitat conservation status. The appearance of this type of habitat only in certain areas of the site is almost entirely due to environmental conditions and in very few cases to silvicultural interventions. Referring to the habitat 91Y0, which occupies the largest part of the site, no actions significantly affecting the conservation status were observed, except those which were performed according to forest management. An exception is represented by oak and hornbeam forests with *Melampyrum bihariense* and exceptionally *Euonymus nanus* in the western part of the site, which have suffered considerable losses, but still in relatively small proportion compared with the extent of this type of habitat at the site.

Considering the current pressures in the Natura 2000 site Pădurea Bârnova-Repedea, the presence of some large categories can be observed, such as: A – Agriculture, B – Silviculture, D - Communication networks, E – Urbanisation, residential and commercial development, F - Use of biological resources other than agriculture and forestry, G – Intrusions and human imbalances, H – Pollution, I - Invasive species, other problems of species, J – Changes in the natural system, K – Natural biotic and abiotic processes (without catastrophes), M – Global Change. Considering the categories of human impact identified, non-intervention management is recommended for semi-natural habitats, like 9130 and 91Y0, and surrounding areas with self-restoration capacity. Where replanting is necessary, non-native trees must be avoided in order to maintain the characteristic structure of these forest habitats. Generally, it is known that non-intervention

management of protected areas and large Natura 2000 sites significantly improves habitat conservation status and living conditions for species depending on natural dynamic processes (e.g., all primary forest habitats in Central Europe).

Conclusions

Besides the two forest habitats enlisted in the standard data form of the site, three more community interest habitats were mapped. *Asperulo-Fagetum* beech forests have a fragmented distribution in the site, being influenced by both natural and human factors, which have reduced their distribution area within the site. Dacian oak-hornbeam forests are represented within the site by two habitat types (based on the Romanian classification system): Moldavian forests with sessile oak, beech, and lime that are widespread and have a continuous distribution in the site, while Dacian forests of oak have a fragmented distribution, being the most impacted habitat within the site. *Cypripedium calceolus* was recorded at only four isolated points within the site, with a small number of shoots. Sixty-one human impact types have been identified, representing current pressures on the site. In spite of these, the conservation status of the habitats is favourable. The GIS spatial distribution database and the generated maps are useful for designing the management plan of this site and serve to bring in agreement the conservation measures with the forestry management plans, in order to ensure the sustainability of economic activities within this area. The review of palynological and archaeobotanical results from several sites in Moldova revealed the presence of more or less extensive forests from ancient times.

Acknowledgements: This research was supported by Sectoral Operational Programme, Environment Axis 4, Ministry of the Environment and Climate Change, the National Agency for Environmental Protection, SINCRON Project.

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STUDIU DE CAZ ÎN PODIŞUL CENTRAL AL MOLDOVEI, ROMÂNIA – DISTRIBUŢIA HABITATELOR, STAREA DE CONSERVARE ŞI IMPACTUL ANTROPIC DINTR-O ARIE PROTEJATĂ

(Rezumat)

Articolul prezintă rezultatele unor studii realizate în situl Natura 2000 Pădurea Bârnova-Repedea, cu scopul de a identifica și carta habitatele și speciile de plante de interes comunitar. Au fost analizate diverse studii palinologice și arheobotanice, pentru a demonstra prezența milenară a pădurilor de foioase în regiune. Această arie protejată a fost desemnată pentru conservarea pădurilor din două habitate de interes comunitar, păduri de fag de tip *Asperulo-Fagetum* și păduri dacice de stejar și carpen, precum și pentru conservarea unei specii de orhidee periclitată, *Cypripedium calceolus* L. În timpul studiilor de teren au fost identificate şi alte habitate Natura 2000 de interes comunitar: fânețe montane, stepe ponto-sarmatice și tufărișuri foioase ponto-sarmatice. Informațiile obținute au oferit noi date asupra distribuției habitatelor și speciilor de plante din aria protejată. Datele obținute în teren au fost corelate cu hărțile topografice existente, și cu fotografii aeriene. Prin folosirea de Sisteme Informatice Geografice, distribuția speciilor și habitatelor a fost tradusă în hărți precise, ce pot fi utilizate în managementul ariei protejate, pentru implementarea de măsuri conservative adecvate. Activitățile umane cu impact potențial asupra ariei protejate au fost înregistrate. Cu ajutorul acestora, a fost realizată o hartă cu presiunile antropice existente în prezent.

Received: 13.11.2017; Accepted: 22.11.2017