

**Muchiile Cernei-Iaila Nature Reserve  
(Tulcea County, Romania)  
a New Site for *Krascheninnikovia ceratoides* in Europe**

*Rezervația naturală Muchiile Cernei-Iaila  
(jud. Tulcea, România)  
un nou site pentru *Krascheninnikovia ceratoides* în Europa*

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**Abstract**

Besides the previous inventories, within the Muchiile Cernei-Iaila Nature Reserve, in 2017-2018, there were identified three priority community interest habitats and the very rare threatened species *Krascheninnikovia ceratoides*. Most of the 10 plant communities framed in these habitats are endangered (four coenotaxa), followed by rare (two coenotaxa), vulnerable or frequent (one coenotaxon) ones. The ruderal species invasive tendency is low for most plant communities. Exceptions are the medium disturbed coenotaxa (*Agropyro-Thymetum zygoidi*, *Paeonio peregrinae-Carpinetum orientalis*, *Agropyro cristati-Krascheninnikovietum ceratoidis*), or those with a high perturbation due to ruderal species (*Artemisio austriacae-Poëtum bulbosae*). The richest in threatened species is considered *Agropyro-Thymetum zygoidi* (seven species), followed by *Medicagini minimae-Festucetum valesiacae* (five species), *Botriochloetum ischaemi* (three species), *Agropyro cristati-Krascheninnikovietum ceratoidis* and *Galio dasypodi-Quercetum pubescentis* (two species), respectively *Thymio pannonic-Chrysopogonetum grylli* (one species). Most of the threatened species are endangered locally, at least within the respective plant communities. *Krascheninnikovia ceratoides* is considered a relict of the „cold mammoth-steppe”, this reserve being a new location and the only one in Dobrogea confirmed by recent inventories. Similar to the phytocenoses inventoried by the author in Alfambra/ Spain, also in Dobrogea *Krascheninnikovia ceratoides* plant communities are present in the disturbed/ ruderal areas of steppe meadows. In Dobrogea these plant communities are located in more continental microclimates than the general cold (continental) steppe macroclimate of the region. In Alfambra/ Spain *Krascheninnikovia ceratoides* occurs in a warm (Mediterranean) steppe, with a more continental influence than the overall Mediterranean climate of Spain. As probably Spain was colonised by *Krascheninnikovia ceratoides* through a preglacial migration through the *Stipa capillata* steppes of the Danube valley, some of the oldest

populations from this natural corridor could be these phytocoenoses from Muchiile Cernei-Iaila Nature Reserve. In this reserve our proper studies frame *Krascheninnikovia ceratoides* as an endangered species, while in the Alfambra area it could be estimated as „vulnerable”. Still, in both regions, this rare species should be protected through adequate management measures, within its habitats.

**Keywords:** Muchiile Cernei-Iaila Nature Reserve new site, *Krascheninnikovia ceratoides*, relict of the „cold mammoth-steppe”, Dobrogea/ Romania, Alfambra/ Spain

## Introduction

In this paper are presented preliminary own data, updated in 2017-2018, on habitats and species of higher plants of community or national interest, following the inventories presented in previous works (*Danube Delta IV, V*). The main aim of this study is to present unedited data on *Krascheninnikovia ceratoides* plant communities, for which this reserve is a new site, also in comparison with other phytocoenosis dominated by this species in Aragon-Spain, where it was also observed by the author. The methodology used in field studies for the expeditious, preliminary inventory of habitats and species of conservation interest is presented also. On this basis, the conservation status of habitats/ species in relation to the intensity of anthropogenic disturbances was also preliminarily estimated.

## Materials and methods

The complex landscape of the Muchiile Cernei-Iaila Nature Reserve (1,891.00 ha), framed within the site of community interest Podișul Nord Dobrogean, includes one of the largest steppe and wooded steppe areas in Dobrogea, the vegetation mosaic consisting of three major habitat types, all of which are priority ones, of community interest:

- **Ponto-Sarmatic steppes** (62C0\*/ 34.92), found on almost all forms of relief, especially in the west of the reserve. Eastwards the steppe meadows appear mainly on peaks, southern slopes or on shallow soils. In areas with humidity higher than average, the steppes intertwine with wooded steppe vistas, or appear only in the clearings of compact forests;
- **Sub-Mediterranean and wooded steppe forests** (91AA\*/ 71.73723, 71.73724) consist of more or less compact forests, all of which are located on slopes with different exposures, but predominantly northern ones, less on the peaks, or on the southern frame of the hills;

- **Continental wooded steppe forests** (91I0\*/ 41.7A221) form isolated clusters of continental forest-steppe forests, which occupy mainly the upper part of some northern slopes.

In Spain, which is the extreme western location in Europe of this species, it was observed by the author in the Aragon region, Teruel province, at Alfambra, where two plots were inventoried. In this Spanish province, the species is quoted in two sites, respectively Zaragoza, where it is located at about 200-300 m (similar with the coenotaxa from Dobrogea) in the meso-Mediterranean layer, respectively in Alfambra, in the supra-Mediterranean layer, at 1000-1200 m.

The on-site research consisted in observations on itineraries and inventories generally in 100 square meters plots, according to the Braun-Blanquet method. The identification and framing of the plant species, coenotaxa and habitats are based on PHYSIS database, the EUR 27 and 28 versions of the *Interpretation Manual of the European Union Habitats* (\*\* 2007, \*\* 2013) and other papers or field guides (BLAMEY, GREY-WILSON, 1998; CIOCÂRLAN, 2009; DEVILLIERS *et alii*, 1996; DIHORU, DONIȚĂ, 1970; HOREANU, 1976a; HOREANU, 1976b; IVAN, 1979; OLTEAN *et alii*, 1994; PETRESCU 2007; PRODAN, 1934-1935; PRODAN, 1935-1936; PRODAN, 1938-1939; SANDA, ARCUȘ, 1999; SANDA *et alii*, 2008; SĂVULESCU *et alii*, 1952-1976; SÂRBU *et alii*, 2013).

The preliminary assessment of the importance and conservation status of threatened species or habitats/ coenotaxa was made by using a scale, as shown in Table 1.

Table1. The correspondence between the dominance, habitat frequency and the threat categories for species and habitats/ coenotaxa

*Tabel 1. Corespondența dintre dominanță, frecvența habitatului și categoriile de amenințare pentru specii și habitate/ coenotaxa*

Dominance indices (species)	Threat category	Habitat frequency in the studied area (% of the route)
– <5 individuals/ plot, with negligible dominance	critically endangered	-
<b>+</b> – ≤ 1 % dominance	endangered	<b>+</b> – ≤ 1 %
<b>1</b> – 1-10 % dominance	vulnerable	<b>I</b> – 1-10 %
<b>2</b> – 10-25 % dominance	rare	<b>II</b> – 10-25 %
<b>3</b> – 25-50 % dominance	sporadic	<b>III</b> – 25-50 %
<b>4</b> – 50-75 % dominance	frequent	<b>IV</b> – 50-75 %
<b>5</b> – 75-100 % dominance	very frequent	<b>V</b> – 75-100 %

The field data were collected in plots according to the Braun-Blanquet methodology. The preliminary assessment of the importance and conservation status of threatened species or habitats/ coenotaxa, as a basis for the evaluation of the conservation priorities, was based upon their framing into several local threat

categories, within the analyzed coenotaxa (for the species), by using the scale presented in Table 1. For the species the first three gradations correspond to the IUCN threat categories (endangered, vulnerable, rare), to which the "*critically endangered*" category was added. For the next three gradations that correspond to the "*not threatened*" IUCN category, the following frequency categories were used: sporadic, frequent and very frequent. A correspondence was also set between these categories and the Braun-Blanquet scale for the assessment of the dominance within the plots. For the preliminary assessment of the habitat threat categories an adapted form of the previous scale was used, based on the estimation of the percentage limits in the research route within which the habitat/coenotaxa was noticed. If a species or habitat is framed into a high threat category (endangered, vulnerable) its local conservation status can be considered low, closer to an unfavorable status and vice versa. In the case of habitats/ plant communities, the higher is their threatened species number, the better can be considered their conservation value and status, taking into account that these taxa, sensitive to human activities, are in general considered as environment indicators.

Wherever data allowed also the conservation status of the plant communities/ habitats induced by the intensity of human activities was assessed. A simple scale which estimates a high, medium, low or null level of disturbance was used, taking into account the dominance indices and the number of ruderal and/ or non-native species identified in the plots located in plant communities, in the studied habitats. Within the species list, for each plant community the ruderal species are underlined, while the non-native ones are mentioned in the description of the respective coenotaxa.

Within each shrub or herbaceous plant community the presence of at least one ruderal/ non-native species with a certain dominance index corresponds to a level of disturbance, respectively: r – very low; + – low, 1 – medium; 2-5 – high. If the number of recorded ruderal or non-native species is equal or exceeds 50% of the total number of species, even if these kind of taxa have low dominance indices, (like for example + - low), there can be considered that the respective plant community has a level of disturbance that corresponds to the next higher level (such as in this case 1- medium).

For the oak forests, if the oak species proportion is: higher or equal to 2 (20%) – low disturbance; between (or equal to) 1(10%) and 2 (20%) – medium disturbance; no oaks – high disturbance. The highest disturbance level in the canopy or shrub/ grasses layer is considered representative for the overall plant community.

## Results and Discussions

Nearly all the area of Muchiile Cernei-Iaila Nature Reserve is covered in habitats of community importance, typical for the Stepic Bioregion, as described below.

**62C0\* Ponto-Sarmatic steppes****34.92 Ponto-Sarmatic steppes**

**Medicagini minimae-Festucetum valesiaca** **Wagner 1941** can be estimated as a vulnerable cenotaxa in the reserve. In this association were observed five rare taxa, threatened on a national scale, which can be considered endangered, at least at the level of this plant community. The low degree of ruderal species invasive trend is indicated by the reduced abundance-dominance indices of the five such species.

**Plot MF1-12-04-18**

Key species: *Festuca valesiaca* (3), *Medicago minima* (+).

Threatened species: *Koeleria lobata* (+), *Pimpinella tragi* subsp. *lithophila* (+), *Potentilla bornmuelleri* (+), *Thymus zygioides* (+).

Other species: *Astragalus vesicarius* subsp. *pseudoglaucus* (+), *Cichorium intybus* (+), *Dichanthium ischaemum* (1), *Erophila verna* (+), *Euphorbia agraria* (+), *Euphorbia glareosa* (+), *Helichrysum arenarium* (+), *Marrubium vulgare* (+), *Plantago lanceolata* (+), *Poa bulbosa* (1), *Sanguisorba minor* (+), *Teucrium chamaedrys* (+), *Teucrium polium* subsp. *capitatum* (+).

**Plot MF2-12-04-18**

Key species: *Festuca valesiaca* (3).

Threatened species: *Echinops ritro* subsp. *ruthenicus* (+).

Other species: *Astragalus vesicarius* subsp. *pseudoglaucus* (+), *Cichorium intybus* (+), *Crataegus monogyna* (+), *Dichanthium ischaemum* (1), *Helichrysum arenarium* (+), *Potentilla argentea* (+), *Sanguisorba minor* (+), *Stipa capillata* (+), *Teucrium chamaedrys* (+), *Thymus pannonicus* (+), *Verbascum phoeniceum* (+).

**Botriochloetum (Andropogonetum) ischaemi** **Pop 1977**, a frequent coenotaxa, is the most common in the reserve, especially in its west side, where it occurs on deep to shallow soils. In the plots four threatened species were identified, of which *Pimpinella tragi* subsp. *lithophila*, *Satureja coerulea*, *Tanacetum millefolium* are rare at national level, and *Krascheninnikovia ceratoides* (*Ceratoides latens*) is considered insufficiently known (OLTEAN *et alii*, 1994), respectively very rare (CIOCÂRLAN, 2009). The latter species shows a certain fidelity to this association, similar to the situation in Transylvania (KOVÁCS, 2011). Within the association, the first two taxa are estimated to be locally endangered, while the third species is considered between endangered and vulnerable. A low level of ruderalization is indicated by predominantly low abundance-dominance indices of 14 such species.

**Plot Bi1-13-11-17**

Key species: *Dichanthium ischaemum* (4).

Threatened species: *Krascheninnikovia ceratoides* (1).

Other species: *Agropyron cristatum* (+), *Convolvulus cantabricus* (+), *Cynodon dactylon* (+), *Eryngium campestre* (+), *Euphorbia glareosa* (+), *Linum austriacum* (+), *Stipa capillata* (+), *Thymus pannonicus* (+).

#### **Plot Bi1-4-10-18**

Key species: *Dichanthium ischaemum* (4).

Threatened species: *Pimpinella tragi* subsp. *lithophila* (+), *Satureja caerulea* (+).

Other species: *Agrimonia eupatoria* (+), *Artemisia austriaca* (+), *Chrysopogon gryllus* (1), *Cichorium intybus* (+), *Eryngium campestre* (+), *Euphorbia glareosa* (+), *Festuca valesiaca* (1), *Fragaria viridis* (+), *Marrubium peregrium* (+), *Stachys recta* (+), *Stipa capillata* (+), *Teucrium chamaedrys* (+), *Teucrium polium* subsp. *capitatum* (+), *Thalictrum minus* (+).

#### **Plot Bi2-12-04-18**

Key species: *Dichanthium ischaemum* (4).

Threatened species: *Krascheninnikovia ceratoides* (1).

Other species: *Achillea setacea* (+), *Erodium cicutarium* (+), *Eryngium campestre* (+), *Euphorbia glareosa* (+), *Galium aparine* (+), *Lamium amplexicaule* (+), *Marrubium peregrium* (1), *Ranunculus oxyspermus* (+), *Thlaspi perfoliatum* (+), *Viola arvensis* (+).

#### **Plot Bi3-12-04-18**

Key species: *Dichanthium ischaemum* (4).

Threatened species: *Tanacetum millefolium* (+).

Other species: *Crataegus monogyna* (+), *Euphorbia agraria* (+), *Euphorbia glareosa* (+), *Euphorbia seguieriana* (+), *Lamium amplexicaule* (+), *Marrubium peregrium* (+), *Orlaya grandiflora* (+), *Teucrium chamaedrys* (+), *Thlaspi perfoliatum* (+), *Thymus pannonicus* (+).

#### **Plot Bi4-12-04-18**

Key species: *Dichanthium ischaemum* (5).

Threatened species: *Krascheninnikovia ceratoides* (1), *Tanacetum millefolium* (+).

Other species: *Achillea setacea* (+), *Ajuga chamaeptytis* (+), *Agropyron cristatum* (+), *Falcaria vulgaris* (+), *Lamium amplexicaule* (+), *Marrubium vulgare* (+), *Orlaya grandiflora* (+), *Thymus pannonicus* (+), *Thlaspi perfoliatum* (+).

**Artemisia austriacae-Poëtum bulbosae Pop 1970** can be estimated as an endangered plant community in the reserve. No nationally threatened taxa were observed in this association. The high degree of ruderalization is indicated by significant abundance-dominance indices (+ - 3) of the five indicator species.

#### **Plot AP1-4-10-18:**

Key species: *Artemisia austriaca* (3), *Poa bulbosa* (1).

Other species: *Achillea setacea* (1), *Agrimonia eupatoria* (+), *Carduus thoermeri* (+), *Carthamus lanatus* (+), *Chrysopogon gryllus* (+), *Eryngium campestre* (+), *Festuca valesiaca* (1), *Fragaria viridis* (+), *Melica ciliata* (+), *Phlomis tuberosa* (+), *Plantago lanceolata* (+), *Potentilla argentea* (+), *Quercus pubescens* (1), *Stipa capillata* (+), *Teucrium chamaedrys* (+).

***Thymio pannonici-Chrysopogonetum grylli* Doniță et al. 1992** plant community is considered endangered, only one rare threatened species being identified, estimated as endangered within the respective phytocoenosis. There can be deduced a low disturbance due to presence of three ruderal species with a reduced dominance.

**Plot TCg1-4-10-18:**

Key species: *Chrysopogon gryllus* (3).

Threatened species: *Thymus zygioides* (+).

Other species: *Allium rotundum* (+), *Asperula tenella* (+), *Bromus tectorum* (+), *Dichanthium ischaemum* (2), *Euphorbia glareosa* (+), *Euphorbia seguieriana* (+), *Eryngium campestre* (+), *Sanguisorba minor* (+), *Teucrium polium* subsp. *capitatum* (+).

**Plot TCg2-4-10-18:**

Key species: *Chrysopogon gryllus* (4).

Other species: *Agrimonia eupatoria* (+), *Carpinus orientalis* (+), *Clinopodium vulgare* (+), *Dichanthium ischaemum* (1), *Euphorbia glareosa* (+), *Origanum vulgare* (+), *Quercus pubescens* (+), *Teucrium chamaedrys* (+), *Teucrium polium* subsp. *capitatum* (+).

***Stipetum capillatae* (Hueck 1931) Krausch 1961** plant community is an endangered coenotaxa that occurs on restricted areas, low grazed. In these phytocoenoses there was observed only one rare threatened taxa *Pimpinella tragi* subsp. *lithophila*, endangered within the plant community. A low level of the ruderal species invasive tendencies was observed, as shown by the reduced dominance indices of four such species.

**Plot Sc1-4-10-18:**

Key species: *Stipa capillata* (3).

Threatened species: *Pimpinella tragi* subsp. *lithophila* (+).

Other species: *Cephalaria uralensis* (+), *Chondrilla juncea* (+), *Cichorium intybus* (+), *Chrysopogon gryllus* (+), *Dichanthium ischaemum* (1), *Festuca valesiaca* (1), *Fragaria viridis* (+), *Galium humifusum* (+), *Marrubium peregrinum* (+), *Pimpinella tragi* subsp. *lithophila*, *Reseda lutea* (+), *Stachys recta* (+), *Teucrium polium* subsp. *capitatum* (+), *Thalictrum minus* (+).

***Agropyro cristati-Krascheninnikovietum ceratoidis* J. A. Kovács 2011** is an endangered cenotaxon, found in small areas, medium grazed. The

phytocoenoses, dominated by the very rare threatened species *Krascheninnikovia ceratoides*, are extremely rare in the reserve, where the species can be considered critically endangered. Another threatened species at the national level is *Salvia aethiopis*, critically endangered in these phytocoenoses. The degree of ruderalization is medium, attested by the abundance-dominance indices (+-1) of the nine such species. This is similar to the situations in Transilvania (KOVÁCS, 2011) and Spain (TENORIO *et alii*, 2000), where the association appears especially in the disturbed steppes.

The phytocoenoses dominated by *Krascheninnikovia ceratoides* in the reserve have been included, at least temporarily, in the only coenotaxa dominated by this species, described so far in Romania, the association *Agropyro cristati-Krascheninnikovietum ceratoidis* J. A. Kovács 2011, recently described from Transilvania (KOVÁCS, 2011), similar to those in Dobrogea.

The inclusion of this association in the *Artemisio-Kochion* alliance indicates the framing of these phytocoenoses from Dobrogea within the habitat 34.92 Ponto-Sarmatic steppes, within which are located the small clusters of *Krascheninnikovia ceratoides*, most of the plots being of 50 square meters, unlike the plots for other plant communities, due to the very restricted areas where *Agropyro cristati-Krascheninnikovietum ceratoidis* occurs. Some differences in the inventory of species compared to the surveys in Transilvania attest to the fact that the Dobrogean phytocoenosis could possibly be considered regional variants.

*Krascheninnikovia ceratoides* is a relict species, which could attest to the existence also in Dobrogea of the “mammoth cold steppe” mentioned for Transilvania (KOVÁCS 2011). Similar to the phytocoenoses in Transilvania, it is very probable that *Krascheninnikovia ceratoides* has been continuously maintained in Dobrogea, at least in the area of the Muchiile Cernei-laila Nature Reserve, since the beginning of the Holocene. This could attest to the continuous existence of steppe meadow habitats until now, being unlikely its survival in a forest environment, in the shade of trees, being a heliophil species. This nature reserve is a new recorded site in Romania, and consequently in Europe, for *Krascheninnikovia ceratoides*.

*Krascheninnikovia ceratoides* could be considered to be located in the Muchiile Cernei-laila nature reserve in its only site in Dobrogea, if its presence is not confirmed in other areas of the province. Thus, the only area from which it was cited (BRÂNDZĂ, 1898; GRECESCU, 1898; PRODAN, 1934-1935) in the past (1898-1935), quotations also used within later works (NEGREAN, 2012), is located between Satu Nou (Ienikioi) and Mircea-Vodă (Akpunar), Constanța County. In that site the species was not found by the author in 2018. In later references it is quoted from Dobrogea in a single work (BORZA, 1947-1949) but without indicating the locality/ location, after which in subsequent works



(CIOCÂRLAN, 2009; KOVÁCS, 2011; SÂRBU *et alii*, 2013; SĂVULESCU, 1952-1976) the species is mentioned only from Transilvania. Given this limited location, possibly in a single Dobrogean site, it can be considered that the species *Krascheninnikovia ceratoides* is more exposed to extinction in Dobrogea than other taxa inventoried in this study, which are also found in other sites in the region.

#### **Plot AKr1-12-04-18**

Key species: *Agropyron cristatum* (+), *Krascheninnikovia ceratoides* (3).

Threatened species: *Krascheninnikovia ceratoides* (3).

Other species: *Achillea setacea* (+), *Agrimonia eupatoria* (+), *Dichanthium ischaemum* (1), *Erodium cicutarium* (+), *Euphorbia glareosa* (+), *Galium aparine* (+), *Lamium amplexicaule* (+), *Sanguisorba minor* (+), *Stellaria media* (1), *Thlaspi perfoliatum* (+), *Viola arvensis* (+).

#### **Plot AKr2-12-04-18**

Key species: *Krascheninnikovia ceratoides* (4).

Threatened species: *Krascheninnikovia ceratoides* (4), *Salvia aethiopis* (r).

Other species: *Agrimonia eupatoria* (+), *Artemisia austriaca* (+), *Dichanthium ischaemum* (2), *Eryngium campestre* (+), *Fragaria viridis* (+), *Galium aparine* (+), *Lamium amplexicaule* (+), *Stellaria media* (+), *Teucrium chamaedrys* (+), *Thlaspi perfoliatum* (+), *Veronica chamaedrys* (+), *Viola arvensis* (+).

#### **Plot AKr3-12-04-18**

Key species: *Krascheninnikovia ceratoides* (3).

Threatened species: *Krascheninnikovia ceratoides* (3).

Other species: *Achillea setacea* (+), *Agrimonia eupatoria* (+), *Artemisia austriaca* (+), *Dichanthium ischaemum* (2), *Galium aparine* (+), *Lamium amplexicaule* (+), *Marrubium vulgare* (1), *Orlaya grandiflora* (+), *Salvia nemorosa* (+), *Stellaria media* (+), *Xeranthemum annuum* (+).

### **34.9211 Western Pontic thyme steppes**

***Agropyro-Thymetum zygoidi* Dihoru (1969) 1970**, a coenotaxa assessed as rare within the site, is the richest in threatened species. The seven threatened taxa are framed within the “rare” category at the national level, but within this plant community they are mostly endangered, except the dominant *Thymus zygoides* and the vulnerable *Koeleria lobata*. There was recorded a medium level of disturbance due to grazing, as indicated by the dominance indices of the four ruderal species.

#### **Plot AT1-12-04-18:**

Key species: *Agropyron ponticum* (1), *Thymus zygoides* (3).

Threatened species: *Euphorbia glareosa* subsp. *dobrogeensis* (+), *Koeleria lobata* (1), *Pimpinella tragi* subsp. *lithophila* (+), *Potentilla bornmuelleri* (+), *Thymus zygoides* (3).

Other species: *Astragalus vesicarius* subsp. *pseudoglaucus* (+), *Cichorium intybus* (+), *Dichanthium ischaemum* (+), *Erophila verna* (+), *Poa bulbosa* (1), *Reseda lutea* (+), *Sanguisorba minor* (+), *Scorzonera austriaca* (+), *Scleranthus perennis* (+), *Sedum urvillei* subsp. *hillebrandtii* (+), *Teucrium polium* subsp. *capitatum* (+).

**Plot AT1-4-10-18:**

Key species: *Thymus zygioides* (3).

Threatened species: *Koeleria lobata* (1), *Pimpinella tragi* subsp. *lithophila* (+), *Satureja caerulea* (+), *Scutellaria orientalis* (+), *Thymus zygioides* (3).

Other species: *Cleistogenes bulgarica* (+), *Dichanthium ischaemum* (+), *Leontodon crispus* (+), *Medicago falcata* (+), *Poa bulbosa* (+), *Reseda lutea* (+), *Sideritis montana* (+), *Stipa capillata* (+), *Teucrium chamaedrys* (+), *Teucrium polium* subsp. *capitatum* (+).

**91AA\* Eastern white oak woods**

**41.73723 Moesian *Paeonia peregrina* – white oak woods**

*Paeonio peregrinae-Carpinetum orientalis* Doniță 1970 can be considered between rare and sporadic, being the most widespread type of forest in the reserve. No nationally threatened species have been identified. The specific composition of the grass layer can be considered representative of the natural status of this cenotaxa, in which only one ruderal species has been identified. However, the small proportion of *Quercus pubescens* in some surveys plots indicates a partial derivation, respectively a medium level of disturbance due to anthropogenic activities.

**Plot PC1-4-10-18:**

Key species: *Carpinus orientalis* (3), *Quercus pubescens* (2).

Other species:

- trees: *Fraxinus ornus* (+);
- shrubs/ lianas: *Cornus mas* (1), *Crataegus monogyna* (+);
- grasses/ undershrubs: *Agrimonia eupatoria* (+), *Asperula tenella* (+), *Brachypodium sylvaticum* (1), *Fragaria viridis* (+), *Teucrium chamaedrys* (+).

**Plot PC1-12-04-18:**

Key species: *Carpinus orientalis* (3), *Quercus pubescens* (1).

Other species:

- shrubs/ lianas: *Cornus mas* (1), *Crataegus monogyna* (+), *Evonymus verrucosus* (+);
- grasses/ undershrubs: *Adonis vernalis* (+), *Brachypodium sylvaticum* (+), *Festuca valesiaca* (+), *Filipendula vulgaris* (+), *Fragaria viridis* (+), *Marrubium vulgare* (+), *Polygonatum latifolium* (+), *Teucrium chamaedrys* (+), *Thalictrum minus* (+), *Vinca herbacea* (+), *Viola odorata* (+).

#### 41.73724 Moesian *Galium dasypodium* – white oak woods

***Galio dasypodi-Quercetum pubescentis* Doniță 1970** plant community can be considered rare in the reserve, where it appears more in the form of steppe vistas. Only two rare threatened species were identified, endangered in these phytocenoses. The specific composition of the grass layer can be considered as low disturbed with eight ruderal species. The tree layer is non-derived, but often with low coverage, being estimated a low level of disturbance due to human activities.

##### **Plot GQ1-4-10-18:**

Key species: *Quercus pubescens* (4).

Threatened species: *Asparagus verticillatus* (+).

Other species:

- trees: *Fraxinus ornus* (1);
- shrubs/ lianas: *Crataegus monogyna* (+);
- grasses/ undershrubs: *Agrimonia eupatoria* (+), *Asperula tenella* (+), *Brachypodium sylvaticum* (1), *Dichanthium ischaemum* (+), *Galium aparine* (+), *Melica ciliata* (+), *Stipa capillata* (+), *Teucrium polium* subsp. *capitatum* (+).

##### **Plot GQ2-12-04-18:**

Key species: *Quercus pubescens* (3).

Threatened species: *Tanacetum millefolium* (+).

Other species:

- shrubs/ lianas: *Crataegus monogyna* (+);
- grasses/ undershrubs: *Achillea setacea* (+), *Artemisia austriaca* (+), *Erodium cicutarium* (+), *Festuca valesiaca* (1), *Filipendula vulgaris* (+), *Fragaria viridis* (+), *Galium aparine* (+), *Lamium amplexicaule* (+), *Lithospermum arvense* (+), *Poa bulbosa* (+), *Ranunculus illyricus* (+), *Stellaria media* (+), *Teucrium chamaedrys* (+), *Thlaspi perfoliatum* (+), *Viola odorata* (+).

##### **Plot GQ1-12-04-18:**

Key species: *Quercus pubescens* (3).

Other species:

- trees: *Acer campestre* (+), *Fraxinus ornus* (1);
- shrubs/ lianas: *Cornus mas* (1), *Crataegus monogyna* (+);
- grasses/ undershrubs: *Agrimonia eupatoria* (+), *Artemisia absinthium* (+), *Dichanthium ischaemum* (+), *Evonymus verrucosus* (+), *Euphorbia glareosa* (+), *Fragaria viridis* (+), *Marrubium vulgare* (+), *Phlomis tuberosa* (+), *Poa angustifolia* (1), *Salvia nemorosa* (+), *Stipa capillata* (+), *Viola suavis* (+).

#### **9110\* Euro-Siberian stepic woods with *Quercus* spp.**

##### **41.7A221 Pontic *Acer tataricum-Quercus pedunculiflora* oak woods**

***Viola suavis-Quercetum pedunculiflorae* Donita 1970** can be considered an endangered association in the reserve, where it appears

completely isolated. No endangered species have been identified. The specific composition of the grass layer can be considered poorly ruderalised, four indicator species being found, with low coverage. The tree layer is non-derived, being estimated a low general level of disturbance due to anthropogenic activities.

#### **Plot VQ1-12-04-18:**

Key species: *Quercus pedunculiflora* (4).

Other species:

- shrubs/ lianas: *Crataegus monogyna* (1);
- grasses/ undershrubs: *Agrimonia eupatoria* (+), *Dactylis polygama* (+), *Fragaria viridis* (+), *Geum urbanum* (+), *Lamium purpureum* (+), *Scilla bifolia* (+), *Stellaria media* (+), *Urtica dioica* (+), *Veronica hederifolia* (+), *Viola odorata* (+).

#### **Krascheninnikovia ceratoides phytocoenoses from Alfambra, Spain**

***Krascheninnikovia ceratoides* phytocoenoses** from Spain are framed into the *Salsolo-Peganion* alliance, that represents a regressive stage of the Mediterranean thickets known as matorrales, being an ubiquist taxon that occurs several alliances like *Rosmarino-Ericion*, *Gypsophilion*, but mostly *Salsolo-Peganion* (TENORIO *et alii*, 2000), so at least a part of these phytocoenoses could be framed into the habitat of community importance **1430 Halo-nitrophilous scrubs (*Pegano-Salsoletea*)** and its correspondent **15.72 Mediterranean halo-nitrophilous scrubs (*Salsolo-Peganelalia*)** – according to the EUR 28 version of the *Interpretation Manual of the European Union Habitats* (\*\* 2013). In Dobrogea ***Krascheninnikovia ceratoides*** was only recorded in the *Festucion valesiacae* and *Artemisio-Kochion* alliances, both framed into the habitat **62C0\* Ponto-Sarmatic steppes (34.92 Ponto-Sarmatic steppes)**.

In Spain, maybe because of this ubiquist character, in the previously mentioned reference (TENORIO *et alii*, 2000), the phytocoenoses dominated by *Krascheninnikovia ceratoides* are not framed in any proper plant community, like the ones identified in Romania that belong to the ***Agropyro cristati-Krascheninnikovietum ceratoidis* J. A. Kovács 2011**. Still it is important to underline that the key species *Agropyron cristatum* of this plant community was also identified within one of the plots from Spain, presented below. In this situation, the two plots recorded by the author from the surroundings of the Alfambra castle, Aragon (Spain), will be just mentioned as ***Krascheninnikovia ceratoides* phytocoenoses**, as no proper plant community denomination was identified in the references on its phytosociology (TENORIO *et alii*, 2000), or anywhere else on the web. These two plots, of 100 square meters each, were inventoried in March 2019, when only a few perennials were visible, mostly in a

vegetative stage, the samples being very poor in species, but this is a general characteristic of the *Krascheninnikovia ceratoides* phytocoenoses, both in Spain and in Dobrogea, Romania. Thus, the number of species per plot is framed between five and eight for the phytocoenoses analyzed in Spain, on plots of 100 square meters area, while in Dobrogea the smaller plots, of 50 square meters, have 12-14 species. The first plot is characteristic for deep terra rossa soils on slopes, while the second is typical for dryer conditions, as it occurs on rocky summits of the hills, being even poorer in species.

A low to medium disturbance can be estimated from the presence of three ruderal species, with coverage of (+-1). *Krascheninnikovia ceratoides* is the only threatened taxon that was identified so far, considered vulnerable in Aragon (Spain). Within the analyzed phytocoenosis it can be considered sporadic, as it is dominant, while in the Alfambra area it can be preliminarily assessed as vulnerable.

#### **1430 Halo-nitrophilous scrubs (Pegano-Salsoletea)**

#### **15.72 Mediterranean halo-nitrophilous scrubs (Salso-Peganelalia)**

*Krascheninnikovia ceratoides* phytocoenoses from Alfambra recorded in two plots have only one threatened species *Krascheninnikovia ceratoides*, dominant within the plant community. A medium level of disturbance is indicated by four ruderal taxa, with a significant variation of abundance-dominance indices.

##### **Plot Kr1-2-03-19:**

Key species: *Krascheninnikovia ceratoides* (3).

Threatened species: *Krascheninnikovia ceratoides* (3).

Other species: *Agropyron cristatum* (1), *Diplotaxis muralis* (+), *Poa bulbosa* (1), *Salsola vermiculata* (+), *Sedum sediforme* (+), *Stipa parviflora* (+), *Veronica hederifolia* (+).

##### **Plot Kr2-2-03-19:**

Key species: *Krascheninnikovia ceratoides* (3).

Threatened species: *Krascheninnikovia ceratoides* (3).

Other species: *Artemisia herba-alba* (+), *Diplotaxis muralis* (+), *Heliotropium europaeum* (+), *Stipa parviflora* (+).

#### **Comparative analysis**

In Spain the species is quoted (DOMINGUEZ *et alii*, 2001) as small populations, especially in the clearings of shrubby vegetation, close to cultivated areas, which indicate ruderal conditions, like in the plant communities from Romania. Similar to the phytocenoses described in Transilvania, also in Dobrogea these are present in the disturbed areas of steppe meadows, usually grazed, including many ruderal species in the specific composition. The analysis of the ruderal species participation within the coenotaxa from Muchiile Cernei-Iaila Nature

Reserve indicates a medium level of disturbance due to human activities, shepherding, trampling, etc., similar to ones from the Transilvania – Romania, while in Spain, at Alfambra, within a typical continental climate, grazing is prohibited, but the soil erosion is active on the steep soils, where the species also occur on barren rocky soils (DOMINGUEZ *et alii*, 2001), unlike Dobrogea.

In Dobrogea *Krascheninnikovia ceratoides* plant communities are located in more continental microclimates than the general steppe macroclimate of the area, being found only on chernozem steppe soils formed on loess, only on the northern slopes of the hills from Muchiile Cernei-Iaila Nature Reserve, in the lower half, towards a large depression, but on all microrelief exposures, not only southern ones as in Transilvania. Even though in Spain, in general this species occurs at the foothill of gentle slopes and within the valley bottom (DOMINGUEZ *et alii*, 2001), in Alfambra-Spain, the *Krascheninnikovia ceratoides* plant communities seem to be better adapted to the general macroclimate than in Romania, still with more continental/ steppic influences than the overall Mediterranean climate of Spain. Thus, it was observed on all exposures of the slopes, and also of plateaux and valleys, on deep to shallow soils. In Spain the species is considered nitrophyllous and halophyllous, similar to the locations within Central Asia (TENORIO *et alii*, 2000). In Dobrogea it occurs on chernozems on loess, so in this case *Krascheninnikovia ceratoides* cannot be considered nitrophyllous nor halophyllous.

This is considered a Mediterranean-Turanian taxa, or Eurasiatic, with a wide range of distribution centered in the Irano-Turanian region, from where it expands eastwards to Mongolia and Northern America, while to the west it has an insular distribution in Russia, in south east Europe, mainly in the Danube Bassin on loess, like in Romania (Dobrogea, Transilvania), Hungary, Austria reaching Spain and Morrocco (TENORIO *et alii*, 2000). The latest two regions were probably colonised through a preglacial migration during the Messinian dry period through the *Stipa capillata* steppes of the Danube valley (JUARISTI, 2003). Taking into account this theory, one of the oldest populations from the Danube valley could be represented by these *Krascheninnikovia ceratoides* phytocoenoses within Muchiile Cernei-Iaila Nature Reserve. Indeed, this site is located at the eastern end of the Danube valley. Still, the distribution area of some saharo-sindian taxa, usually associated with *Krascheninnikovia ceratoides*, like *Stipa tenacissima*, *Artemisia herba-alba*, underlines also the possibility of a south-Mediterranean migration (TENORIO *et alii*, 2000). It is important to notice that *Agropyron cristatum*, a continental species, is associated with *Krascheninnikovia ceratoides* in Dobrogea and Transilvania, but also in the proper plots recorded in Alfambra, which could confirm the theory of a north Mediterranean migration of both species. In this respect it should be taken into account the European distribution of *Agropyron cristatum*.

Dobrogea is considered to have been the refuge of forest species during the last Ice Age (PAȘCOVSCHI, 1967), but it could have been also a refuge for some continental species like *Krascheninnikovia ceratoides*. In this respect some authors (TENORIO *et alii*, 2000) consider that *Krascheninnikovia ceratoides* was spread after the last glaciations from the Mediterranean refuge. It could have spread maybe also from the Dobrogea refuge, probably the northernmost area of the East Mediterranean refuge. Even nowadays, at least the southern seacoast of the Romanian Dobrogea, is considered the Euxinic province of the Mediterranean region (CIOCÂRLAN, 2009).

In the recorded plots in Alfambra-Spain, *Krascheninnikovia ceratoides* is one of the typical steppe species that form a part of the plant communities' inventories, similar to the situation from Dobrogea. The difference is that in Dobrogea the species are mainly characteristic for the cold (continental) steppe, while in Alfambra some taxa confer a distinctive aspect of warm (Mediterranean) steppe. It is considered a Tertiary relict taxa classified as vulnerable in the latest area, according to some references (*Catalogo de especies amenazadas de Aragon – Flora*), but other studies rank it into the not threatened IUCN category (DOMINGUEZ *et alii*, 2001). Within our proper studies in Alfambra, within the two plots *Krascheninnikovia ceratoides* was recorded with a dominance index of 3, which could frame preliminarily it into the "sporadic" category within these phytocoenoses. Still from only two plots this cannot be extrapolated to the whole Alfambra area, where the author estimates it as „vulnerable”, as these populations were observed on the hill around the medieval castle, but also on several valleys southwards of Alfambra village. There, this species can be dominant in some plant communities, respectively codominant or rare in other phytocoenoses.

In the Romanian Dobrogea, while at the country level it is considered insufficiently known (OLTEAN *et alii*, 1994), respectively very rare (CIOCÂRLAN, 2009), the present paper rank it as endangered at the level of the nature reserve, where it was observed with dominance indices of 1-4 within the plots, which could frame it into the vulnerable to frequent within the analyzed phytocoenoses. But the plant communities where *Krascheninnikovia ceratoides* is dominant or codominant are very restricted, so at the level of the nature reserve the species could be considered critically endangered, like also in Dobrogea region, where this is the only site confirmed by recent inventories.

## Conclusions

At the site level, three habitats of community interest were identified, all priority ones, respectively: **62C0\* Ponto-Sarmatic steppes**, **91AA\* Eastern white oak woods** and **91I0\* Euro-Siberian steppe woods with *Quercus* spp.** Of the 10 associations observed, most are endangered (four cenotaxa),

followed by rare (two cenotaxa), vulnerable or frequent syntaxons (one cenotaxon). The degree of ruderalization is low for most associations. Exceptions are the medium disturbed cenotaxa (*Agropyro-Thymetum zygoidi*, *Paeonio peregrinae-Carpinetum orientalis*, *Agropyro cristati-Krascheninnikovietum ceratoidis*), or those with a high level of ruderalization (*Artemisia austriacae-Poëtum bulbosae*).

The richest in endangered species is considered the association *Agropyro-Thymetum zygoidi* (seven species), followed by *Medicagini minimae-Festucetum valesiacae* (five species), *Botriochloetum ischaemi* (three species), *Agropyro cristati-Krascheninnikovietum ceratoidis* and *Galio dasypodi-Quercetum pubescentis* (two species), respectively *Thymio pannonic-Chrysopogonetum grylli* (one species). Most nationally threatened species are endangered locally, at least in the associations that contain them. They are followed by sporadic/ frequent species within the respective phytocenosis, dominant within the plant communities, such as *Thymus zygoides* and *Krascheninnikovia ceratoides*, respectively by those critically endangered like *Salvia aethiopsis*.

*Krascheninnikovia ceratoides* is a relict species, which could attest to the existence also in Dobrogea of the “mammoth cold steppe”. Muchiile Cernei-laila reserve is a new recorded site in Romania, and consequently in Europe, for *Krascheninnikovia ceratoides*. It is also the only site from Dobrogea confirmed by recent inventories.

Similar to the phytocenoses described in Transylvania and Alfambra, also in Dobrogea *Krascheninnikovia ceratoides* plant communities are present in the disturbed/ ruderal areas of steppe meadows. In Dobrogea these plant communities are located in more continental microclimates than the general cold (continental) steppe macroclimate of the region. In Alfambra *Krascheninnikovia ceratoides* occurs in a warm (Mediterranean) steppe, with a more continental climate than the overall Mediterranean climate of Spain. As probably Spain was colonised by *Krascheninnikovia ceratoides* through a preglacial migration through the *Stipa capillata* steppes of the Danube valley, some of the oldest populations from this natural corridor could be these phytocenosis from Muchiile Cernei-laila Nature Reserve. While in the Muchiile Cernei-laila area our proper studies frame *Krascheninnikovia ceratoides* as an endangered species, in the Alfambra area it could be estimated as „vulnerable”, so less threatened. Still, in both regions, this rare relictar species should be protected through adequate management measures, together with the habitats where it occurs.



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