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HABITAT CONDITIONS OF *SISYMBRIO-STIPETUM CAPILLATE* AND *KOELERIO-FESTUCETUM SULCATAE* STEPPE PLANT ASSOCIATIONS IN THE OSTOJA NIDZIAŃSKA SPECIALLY PROTECTED AREA

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Summary

Vascular flora of the investigated plant associations is characterized by a considerable biodiversity, unique character and occurrence of protected and threatened species, therefore playing an important role in the natural environment and being an important element of shaping the natural landscape. The assessment of the requirements of edaphic species of the investigated associations allowed for a characterization of the soil habitat as soils with granulometric composition from rubble, scree and gravel to sandy loams and silt deposits. These are mainly moderately poor (mesotrophic) to poor (oligotrophic) soils, prevailingly alkaline (pH>7), dry or to a lesser extend fresh. Climatic conditions in the presented habitat are characterized by full or moderate insolation. They are thermally privileged areas or moderately warm.

Key words*:* the Nida wildlife sanctuary, steppe vegetation, habitat conditions

INTRODUCTION

The Nida Nature Reserve (Ostoja Nidziańska), with the area of 26515.64 ha, which is a part of Special Protection Area, code PLH260003, is situated within the Pińczów and Jędrzejów districts administrative boundaries. The area comprises the natural Nida valley and fragments of the adjoining plateaus with greatly diversified landscapes. In the central part of its course, strongly meandering

Nida river formed a vast complex of wet and waterlogged meadows, marshes and old river beds. Loessial, slightly undulating plateau terrains are cut by numerous gorges, ravines and dry valleys. In the Ponidzie centre we observe typical karstic features associated with the occurrence of gypsum deposits. It is characterized by the presence of numerous caves, paleocrasts, karst springs and blind valleys. Lime and gypsum hills and gorge slopes are overgrown by xerothermic grasslands, whereas valleys are covered by meadow communities. The reserve area is poorly wooded. The forest communities occurring here comprise primarily fresh forests with fragments of coniferous and alder habitats. The site of Community importance (SCI), also situated in this area, occupies ca. 2% of the terrain.

One of the main values of the reserve is gypsum karst forming a substratum for rare, xerothermic gypsophyllic grasslands. Sites of numerous rarest species of Polish vascular flora are connected with them. The only one in Poland site of *Serratula lycopifolia* and one of the strongest populations of *Carlina onopordifolia* are to be found in this place. Numerous salt springs occur in this area, around which halophilic grasslands are developing. The total of 18 habitats included in the Annex 1 to the Council Directive 92/43/EEC and 20 species stated in Annex 2 have been identified on this terrain. Moreover, it is the breeding site of many bird species, especially waterfowl and an important point on the bird migration route strictly connected with the bird sanctuary of the European significance (E62), i.e. the Natura 2000 PLB260001 area – the Nida River Valley.

MATERIAL AND METHODS

The characteristics of the flora of investigated associations in the Nida Nature reserve was conducted on the basis of phytosociological relevés made in 2013 using Braun-Blanquet's method (1967) and ecological indicator numbers determining the number of sites, life forms and continentality. Ecological requirements of individual species considering the natural environment conditions were stated synthetically on the basis of ecological indicator numbers (Zarzycki *et al*. 2002), allowing for the description of the habitat conditions most typical for a given species. The characteristics of edaphic requirements was based on the soil granulometric indicator, soil acidity indicator, trophic state index and soil moisture index. Climatic requirements were characterized by determining the light and thermal index (Roo-Zielińska 2004). The nomenclature of species and plant communities taxonomy were stated after Mirek *et al*. (2002).

RESULTS AND DISCUSSION

Sisymbrio-Stipetum capillatae **association** is quite often encountered in the investigated area, although it does not cover any bigger areas. It is a phyto-

sociological unit regarded as the most pioneer steppe plant association occurring in company of gypsum rocks present in the substratum covered by loess soils.

The vegetation of this association reveals resistance to extremely dry habitat conditions, as observed on the southern exposures of the rocky upheavals on this terrain and on the strongly sunlit and heating up steep loess slopes of ravines (Głazek 1968). The *Sisymbrium polymorphum* and *Stipa capillata* are regarded as characteristic for this association, and regionally also *Festuca valesiaca, Poa bulbosa, Veronica praecox*, as well as *Alyssum montanum* (Kostrowicki, Solon 1994).

The sward in the discussed area is neither too high nor too compact. *Stipa capillata*, forming quite dense clumps is the exception in this respect is mainly whose grass shoots are growing above the other vegetation forming the sward of the discussed association (Table 1).

Table 1. Species composition of the *Sisymbrio-Stipetum capillatae* plant association

Species	Village			
	Bogucice	Wierciszów	Pojałowice	Skowronno
	cover.companionship			
Achillea millefolium L.	+	+	+	+
Achillea setacea Waldst. et Kit.	+	+	+	+
Adonis vernalis L.	+	1.2	+	+
Agrostis capillaris L.	+	+	+	+
Alyssum montanum L.	+	–	+	+
Anthemis tinctoria L.	+	+	–	+
Anthericum ramosum L.	–	+	–	+
Anthylis vulneraria	+	–	2.2	+
Brachypodium pinnatum (L.) P. Beauv.	2.3	3.4	2.3	3.3-4
Bromus erectus Huds.	+	+	+	+
Carex supina L.	+	+	+	+
Carlina acaulis L.	+	+	1.1	–
Carlina onopordifolia Besser	–	+	+	1.1
Cephalanthera longifolia (Huds.) Fritsch.	–	+	–	+
Cerasus fruticosa	+	+	–	–
Coronilla varia L.	1. 2	–	1.2	+
Dianthus carthusianorum L.	2.1-2	–	+	1.1
Elymus hispidus (Opiz) Melderis	+	+	1.1-2	+
Eryngium campestre L.	+	+	+	+

Species	Village			
	Bogucice	Wierciszów	Pojałowice	Skowronno
	cover.companionship			
Euphorbia cyparissias L.	+	+	1.2	+
Falcaria vulgaris Bernh.	+	–	+	+
Festuca ovina L. s. str.	+	+	+	+
Festuca rubra L. s. str.	1. 2	+	+	+
Festuca valesiaca Schleich. Ex Gaudin	+	+	+	+
Fragaria viridis Duchesne	+	+	+	+
Galium verum L. s. str.	1.1-2	1.2	1.1-2	+
Hieracium echinoides Lumm.	+	+	+	+
Inula ensifolia L.	1. 2	1.2	1.2-3	1.2-3
Lotus corniculatus L.	–	+	–	+
Medicago falcate L.	2. 2	1.2	1.2	1.2
Melampyrum arvense L.	+	+	–	+
Orchis militaris L.	+	+	+	+
Orchis pallens L.	+	+	+	+
Orchis ustulata L.	+	–	–	+
Oxytropis pilosa (L.) DC	1.1-2	+	1.1-2	–
Peucedanum cervaria (L.) Lapeyr	1.1	+	+	+
Phleum phleoides (L.) H. Karst.	+	+	–	+
Platanthera bifolia (L.) Rich.	+	–	–	+
Poa angustifolia L.	+	+	–	+
Poa bulbosa L.	+	+	+	–
Potentilla demise Jord.	+	+	+	–
Salvia pratensis L.	+	+	–	1.1
Sanguisorba minor Scop. s. str.	+	+	1.2	1.2
Scabiosa ochroleuca L.	1.1-2	+	+	+
Scorzonera purpurea L.	–	+	–	+
Sisymbrium polymorfum (Murray) Roth	+	+	1.1-2	+
Stipa capillata L.	+	1.2	1.2	1.2
Stipa joannis Čelak. s. str.	–	+	+	+
Thalictrum minus L.	+	+	+	+
Thesium linophyllon L.	–	+	+	+
Thymus sp.	+	1.2	1.2	1.2
Trifolium rubens L.	+	–	+	+

Species	Village			
	Bogucice	Wierciszów	Pojałowice	Skowronno
	cover.companionship			
Veronica spicata L.	+	+	+	+
Vincetoxicum hirundinaria Medik.	–	1.2	+	2.2-3

Table 2. Species composition of *Koelerio-Festucetum sulcatae* plant association

Species	Village			
	Gacki	Pińczów	Śladków	Przybysławice
	cover. companionship			
Achillea millefolium L.	+	1.2	+	+
Adonis vernalis L.	–	+	–	+
Agrostis capillaris L.	1.2	+	1.2	+
Anemone sylvestris L.	+	+	+	–
Anthylis vulneraria L.	+	+	+	–
Berteroa incana (L.) DC.	–	+	+	–
Brachypodium pinnatum (L.) P. Beauv.	2.3	+	1.2	2.2-3
Bromus erectus Huds.	+	+	+	–
Campanula rapunculoides L.	+	–	+	+
Carex arenaria L.	+	+	–	–
Carex humilis Leyss.	+	+	+	–
Carlina onopordifolia Besser	–	+	–	+
Carlina vulgaris L.	+	+	+	+
Centaurea scabiosa L.	+	+	+	+
Coronilla varia L.	1.2	+	+	+
Dactylorihiza maculata (L.) Soo	–	+	–	+
Dianthuss carthusianorum L.	–	+	+	+
Elymus hispidus (Opiz) Melderis	+	1.1	+	1.2
Elymus repens (L.) Gould	–	1.1-2	–	+
Euforbia cyparissias L.	1.2	+	1.2	+
Falcaria vulgaris Bernh.	+	–	+	+
Festuca rubra L. s. str.	1.2	1.2	1.2	1.2
Festuca valesiaca Schleich. ex Gaudin	+	+	+	+
Fragaria viridis Duchesne	+	+	1.2	–
Galium verum L. s. str.	–	+	+	1.1-2

Species	Village			
	Gacki	Pińczów	Śladków	Przybysławice
	cover. companionship			
Gymnadenia conopsea (L.) R. Br.	+	+	+	–
Inula ensifolia L.	+	+	+	–
Koeleria glauca (Spreng.) DC.	+	+	–	+
Koeleria grandis Besser ex Gorski	2.2	1.2	+	1.2
Lotus corniculatus L.	+	–	+	+
Medicago falcate L.	1.2	1.2	1.2	1.2
Melampyrum arvense L.	+	–	+	–
Orchis militaris L.	+	+	–	–
Orchis ustulata L.	+	+	–	+
Oxytropis pillosa (L.) DC.	1.2	–	+	–
Peucedanum cervaria (L.) Lapeyr.	+	+	+	+
Phleum phleoides (L.) H. Karst.	+	1.1	+	+
Pimpinella saxifraga L. s. str.	+	+	+	–
Poa angustifolia L.	+	1.2	+	+
Potentilla demissa Jord.	–	+	+	+
Pulsatilla pratensis (L.) Mill.	–	+	+	–
Salvia pratensis L.	+	1.1	+	–
Salvia verticillata L.	+	+	–	1.2
Sanguisorba minor Scop. s. str.	1.2	+	+	+
Stachys arvensis (L.) L.	–	+	+	–
Stipa capillata L.	+	+	–	–
Thymus sp.	2.3	+	1.2	–
Trifolium arvense L.	–	+	+	–
Trifolium medium L.	–	+	–	+
Veronica chamaedrys L.	–	+	+	–
Veronica spicata L.	+	–	+	+
Vicia cracca L.	–	+	+	+
Vicia hirsuta (L.) S.F. Gray	+	–	+	+
Vincetoxicum hirundinaria Medik.	+	–	+	–

***Koelerio-Festucetum rupicolae* association** is more rarely encountered in the discussed area. It may be due to the fact that it prefers lighter and more sandy soils, which are scarce in this area (Medwecka-Kornaś and Kornaś 1972). Apart from *Koeleria macrantha and Festuca rupicola*, its characteristic species in-

clude also *Phleum phleoides*. *Stipa capillata* may also occur scarcely on gypsum substratum. This kind of steppe grasslands thrive best in the conditions where the matrix is formed of lime deposits, usually reaching to the ground surface.

Phytocenoses of this association are secondary in nature, because they develop in place of destroyed thermophilic shrubs and even forests growing on this habitat type. The condition of persistence of the vegetation of discussed association is a regular and quite intensive farm animal grazing, which prevents woody vegetation regeneration (Głazek 1968). *Koelerio-Festucetum rupicolae* association is a less colourful community, since it does not feature many flower species having a greater proportion of grasses (Table 2). Therefore it is more useful for farm animal grazing, despite the fact that the main grasses do not have any greater fodder value.

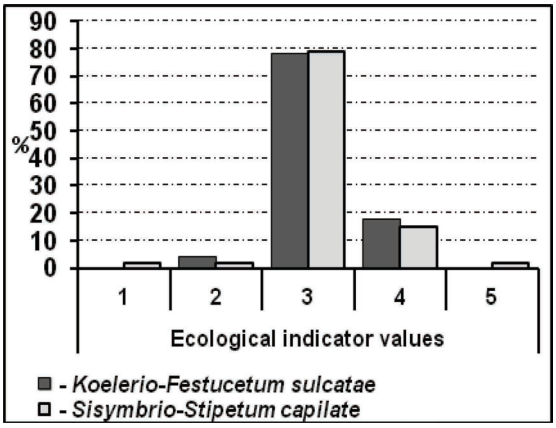

Figure 1. Indicator of continentality. Explanations: 1– Atlantic species; 2 – Sub-Atlantic species, occur mostly in the western part of Poland; 3 – species neutral to continentality; 4 – sub-continental species, occur mostly in the eastern part of Poland; 5 – continental species

Prevalent presence of species neutral to continentality (ca. 80%) was observed in the species composition of the investigated associations (Fig. 1). Discussed associations are composed of species from these forming a small number of sites (up to 100) to those common all over Poland (Fig. 2).

Regarding the preferences of the species composing *Sisymbrio-Stipetum capillatae* association as to their soil granulometric composition, it may be said that ca. 90% of them prefer the soils with grain size composition between the rock rubble, scree, gravel and sandy loam and silt deposits. In case of *Koelerio-Festucetum rupicolae* association, ca. 20% of species preferring rock rubble and scree, sand, sandy loams and silt deposits and heavy loams and clays, each were observed (Fig. 3).

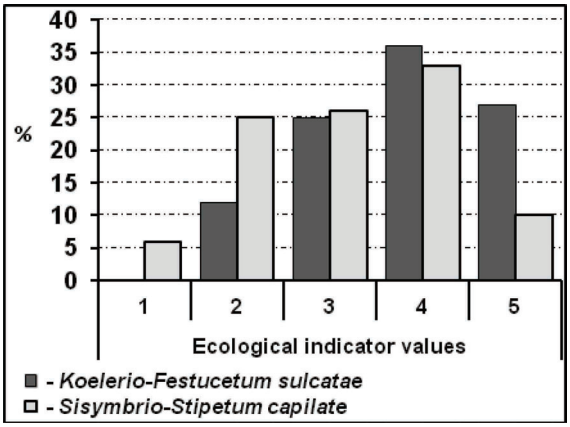

Figure 2 . Number of sites. Explanations: 1 – very small number of sites (to several); 2 – low number of sites (below 100); 3 – high number of sites, grouped mainly in one region; 4 – high number of sites in many regions; 5 – species popular all over Poland

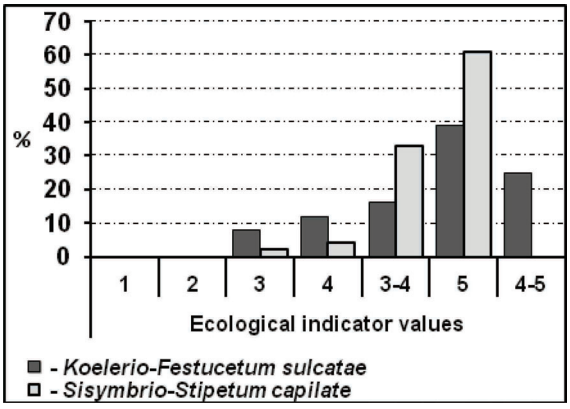

Figure 3. Soil granulometric index. Explanations: 2 – rock debris, colluviums, gravel; 3 – sand; 4 – sandy loams and silt deposits; 5 – heavy loams and clays

In *Sisymbrio-Stipetum capillatae* association prevalent are species preferring alkaline soils (ca. 60%) and soils between moderately acid and neutral (ca. 35%). In *Koelerio-Festucetum rupicolae* association ca. 40% of species prefer alkaline soils and ca. 51% the soils with pH between moderately acid and neutral (Fig. 4).

Considering the trophic requirements, species preferring moderately poor– mesotrophic soils (ca. 60%) and poor – oligotrophic soils (ca. 20%) are dominant in both associations (Fig. 5).

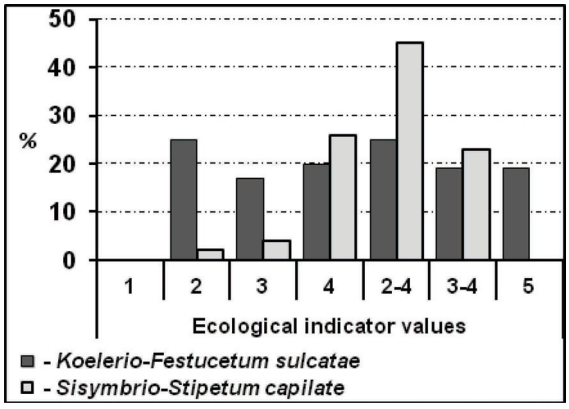

Figure 4. Soil acidity index. Explanations: 1 – strongly acid soil, pH <4; 2 – acid soil, 4≤pH<5; 3 – moderately acid soil, 5 ≤ pH<6; 4 – neutral soil, 6≤pH<7; 5 – alkaline soil, pH >7.

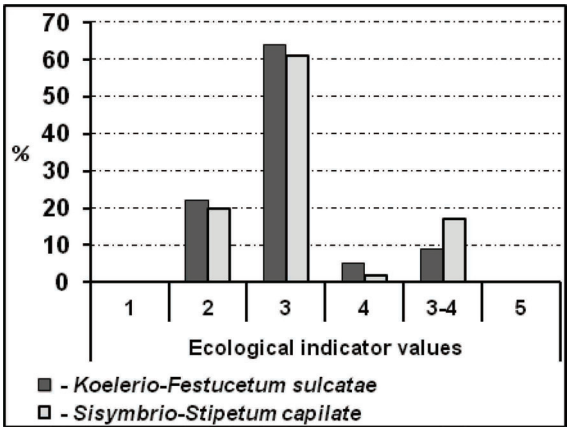

Figure 5. Trophicity indicator. Explanations: 1 – extremely poor (extremely oligotrophic) soil; 2 – poor (oligotrophic) soil; 3 – moderately poor (mesotrophic) soil, acidophilic oak and beech woods; 4 – rich (eutrophic) soil; 5 – soil (water) very rich (extremely fertile)

Hygrophobes prevail both in *Sisymbrio-Stipetum capillatae* and *Koelerio-Festucetum rupicolae* associations (respectively ca. 55% and ca. 45%). The species preferring the sites between dry and fresh constitute ca. 36% of *Sisymbrio-Stipetum capillatae* and ca. 46% of *Koelerio-Festucetum rupicolae* association (Fig. 6).

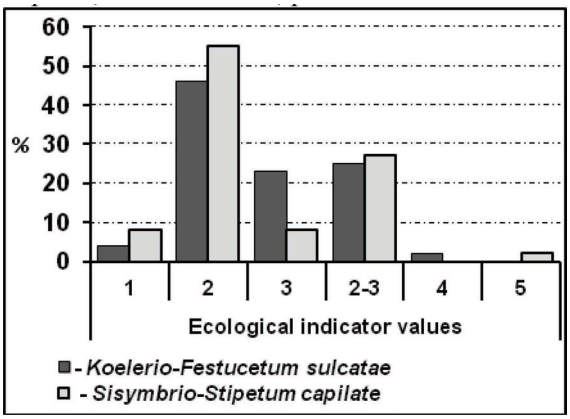

Figure 6. Soil moisture index. Explanations: 1 – very dry; 2 – dry; 3 – alkaline; 4 – moist; 5 – wet

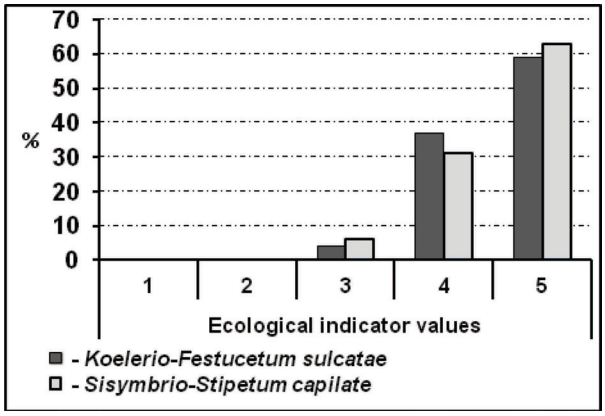

Figure 7. Light indicator. Explanations: 1 – deep shadow; 2 – moderate shadow; 3 – semi shade; 4 – moderate light; 5 – full light

Heliotropic species prevail among the species forming both associations. In *Sisymbrio-Stipetum capillatae* association ca. 62% are the species which require full light and 30% need moderate light, whereas in *Koelerio-Festucetum rupicolae* association ca. 60% of species require full light and 38% need moderate light (Fig. 7).

Species settling the warmest regions and microhabitats prevail among the species composing both plant associations (and mainly in case of *Sisymbrio-Stipetum capillatae*) and areas with moderately warm climatic conditions (Fig. 8).

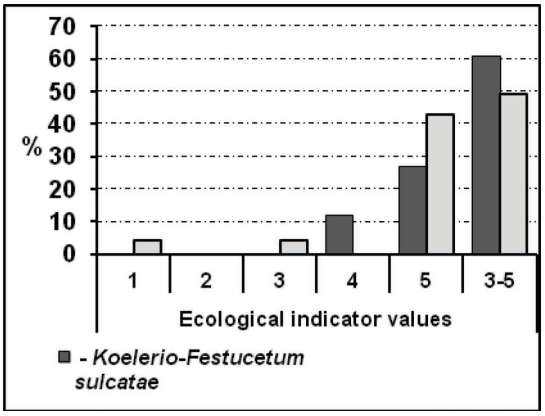

Figure 8. Heat indicator. Explanations: 1 – the coldest areas of Poland; 2 – moderately cold areas; 3 – moderately climatic conditions; 4 – moderately warm; conditions; 5 – the warmest regions and microhabitats

Results presented in this paper are consistent with the reports of other authors (Medwecka-Kornaś, Kornaś 1972, Solon, Roo-Zielińska 2001) who reported a considerable biodiversity of xerothermic grasslands phytocenoses. They are also sanctuaries for rare and protected birds, significantly influencing landscape diversity of the terrains on which they occur.

Like in many other publications (Medwecka-Kornaś, Kornaś 1972, Frey *et al*. 2001, Topwasz, Kotańska 2004, Kostuch, Misztal 2005, Bornkamm 2006, Trąba 2006, Kostuch 2006, Topwasz 2011), the results presented in this paper demonstrate that in case of the discussed plant associations, edaphic conditions and insolation should be regarded as the most important habitat conditions shaping their species composition.

CONCLUSIONS

1. Vascular flora of *Sisymbrio-Stipetum capillatae* and *Koelerio-Festucetum rupicolae* associations in the Nida Nature Reserve (Ostoja Nidziańska) Special Protection Area reveals a great biodiversity and unique character. Protected and endangered species are numerous in the discussed plant associations. Species neutral to continentality definitely prevail in the composition of the discussed plant association.
2. The assessment of edaphic requirements of the investigated associations flora testifies that the habitat they cover are mainly soils with granulometric composition of rock rubble, scree and gravel to sandy

loams and silt deposits. These are mainly moderately poor (mesotrophic) or poor (oligotrophic) soils, mostly alkaline (pH >7), dry or to a lesser degree fresh.

3. Climatic conditions in the habitat covered by the investigated plant associations are characterized by full or moderate insolation. These are thermally privileged or moderately warm areas.

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