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Dry grassland and thermophilous forest margin species in the flora of gravel pits of the Wysoczyzna Siedlecka plateau

Gatunki muraw i termofilnych okrajków we florze żwirowni Wysoczyzny Siedleckiej

SUMMARY

Gravel pits belong to the most poorly investigated marginal habitats. They are anthropogenic objects distinguishable by specific habitat features – a result of differentiation of soil conditions, relief and intensity of human activity. Floristic studies were carried out in 65 selected gravel pits of the Wysoczyzna Siedlecka plateau between 2001 and 2010, differing in area, intensity of use and type of surrounding vegetation. In total, 90 dry grassland species were noted (15% of the whole flora). The commonest xerothermic species were *Medicago falcata, Centaurea stoebe*, *Coronilla varia* and *Centaurea scabiosa*. The domination of hemicryptophytes (62%) and therophytes (18%) over the remaining life forms as well as anemochoric taxa (56%) was observed in the studied group of plants. Xerothermic vegetation usually develops on sunny slopes of southern and south-western exposure. Psammophilous species prefer initial soils in the relatively recently exploited fragments of gravel pits. Such factors, as intensity of exploitation of gravel pits, their surrounding and size affect the diversity of dry grassland species. Gravel pits are refuges for numerous protected and endangered species, including thermophilous plants, e.g, *Silene tatarica, Verbascum phoeniceum, Teesdalea nudicaulis, Astragalus arenarius, Thalictrum minus, Stachys recta.*

STRESZCZENIE

Żwirownie należą do najsłabiej zbadanych marginesów ekologicznych. Są to obiekty antropogeniczne wyróżniające się specyficznymi cechami siedliskowymi, w wyniku zróżnicowanych warunków glebowych, rzeźby terenu i intensywności działalności człowieka. Badania florystycz-

ne przeprowadzono w latach 2001–2010 w 65 wybranych żwirowniach Wysoczyzny Siedleckiej, różniących się powierzchnią, intensywnością użytkowania i typem otaczającej roślinności. W sumie odnotowano 90 gatunków murawowych (15% całej flory). Najczęściej notowanymi gatunkami kserotermicznymi były: *Medicago falcata, Centaurea stoebe, Coronilla varia* i *Centaurea scabiosa*. W badanej grupie roślin zanotowano dominację hemikryptofitów (62%) i terofitów (18%) nad innymi formami życiowymi oraz taksonów anemochorycznych (56%). Roślinność kserotermiczna zazwyczaj rozwija się na słonecznych zboczach o ekspozycji południowej i południowo-zachodniej. Psammofilne gatunki preferują gleby inicjalne w stosunkowo niedawno eksploatowanych fragmentach żwirowni. Takie czynniki, jak intensywność eksploatacji żwirowni, ich otoczenie i wielkość powierzchni mają wpływ na różnorodność gatunków murawowych. Żwirownie są ostoją dla wielu chronionych i zagrożonych gatunków, w tym roślin ciepłolubnych, np. *Silene tatarica, Verbascum phoeniceum, Teesdalea nudicaulis, Astragalus arenarius, Thalictrum minus, Stachys recta*.

Keywords: vascular flora, gravel pits, Wysoczyzna Siedlecka plateau

INTRODUCTION

Excavations formed as a result of mineral resources mining (loamy sand, gravel), also called gravel pits, belong to the less investigated floristically marginal habitats. Their detailed floristic and phytosociological studies were carried out in Silesia (1, 2, 6, 7, 9) and Pomerania region (14). Gravel pits from the area of Wysoczyzna Siedlecka plateau were studied by Głowacki (8) and Bzdon (3, 4, 5).

A large habitat diversity in spite of relatively small area of excavations (on average about 1 ha) is a result of various soil properties, lay of the land and human pressure. Human activity significantly affects the species composition of plant communities and their internal organization (14). All that factors contribute to the large floristic biodiversity of these objects. It seems that the gravel and sand pits provide excellent conditions for the development of interesting psammophilous, grasslands and wetlands communities. In their composition, we can find a number of rare and endangered plant species.

Climate, relief and soil types of the Wysoczyzna Siedlecka plateau do not favour xerothermic communities and species. Enclaves of such vegetation occur only on slopes of the Bug river valley and sunny margins of forest communities. Therefore, gravel pits are considered to be an important reservoir of dry grassland species (psammophilous and xerothermic) in that part of Poland. They play the role of habitat islands in the agricultural landscape, acting as refugees of plant and animal species associated with natural and semi-natural ecosystems.

The aim of the present paper was to investigate dry grassland flora of the selected gravel pits of the Wysoczyzna Siedlecka plateau. The relationships between the share of grassland species and selected factors (size of gravel pit, type of surrounding environment, intensity of exploitation, presence of pond) were also studied.

AREA OF STUDIES

Wysoczyzna Siedlecka plateau is situated in mid-eastern Poland and covers an area of 2,502 km^2. According to the physiographic division (10) the study area belongs to the sub-province of Mid-Poland Lowlands and South-Podlasie Lowland macroregion. In the geobotanical division of Poland (11) it is a part of South-Podlasie subregion and South-Podlasie–Masovian region. The study area is situated within the administrative borders of the Masovia voivodeship.

The relief of the Wysoczyzna Siedlecka plateau is a result of geological processes from the central-Polish glaciation period, especially of the Warta Stadial. The northern, younger part of the plateau is hilly and undulating due to occurrence of moraine hills, while its southern part is flat, that corresponds to the area of old glacial plains (15). Gravel pits are usually located among post-glacial forms of relief, like frontal moraines, kames and eskers. A well-developed belt of frontal moraines is observed south of Siedlce and north of Sokołów Podlaski. Near Rozbity Kamień village they reach the height of 213 m a.s.l. The largest relative heights 50–60 m are also noted there. Eskers are visible as meridionally arranged series of hills, mainly along river valleys. Their relative height does not exceed 15 m. A fairly symmetrical, kame hills occur in the form of isolated elevations (15). Parabolic sand dunes and areas of aeolian sands are also frequently observed (Maliszewo, Lipki Stare, Opole Nowe, Białki). In this region podsols, lessive and brown soils are dominating.

METHODS

Floristic studies were carried out in 65 selected gravel pits of the Wysoczyzna Siedlecka plateau in the years 2001–2010. The excavations differed in size, intensity of use and type of surrounding environment. Therefore, gravel pits were divided into several groups, the following parameters being taken into account:

a) the area of excavation: small (≤ 0.25 ha – 18 sites), medium (from 0.26 to 1 ha – 25 sites), large (≥ 1 ha – 22 objects),

b) the type of surrounding communities: homogeneous – forest (12 sites) and cropland (25 objects); heterogeneous (a combination of several types of habitats – 28 objects),

c) the manner and intensity of the mining: unexploited (21 objects), partially exploited (≤ 50% of the excavation area – 34 gravel pits), intensively exploited (> 50% of the excavation area – 10 objects),

d) occurrence of periodic or stable pond at the bottom of gravel pit (lack – 25 objects, periodic – 21, stable – 19).

The characteristics of all studied excavations is presented in Table 1. In each object floristic lists were made in various periods of vegetation season. The floristic records were also taken from nearby vegetation, to determine the specificity of

Table 1. Characteristics of the studied gravel pits (Wysoczyzna Siedlecka plateau)

Locality	Area (size class)	Exploitation (area in %)	Surrounding type	Pond	Total no. of species	No. of dry grassland species	Share of dry grassland species (%)
Bale	0.5 ha (II)	partial 20%	pine forest	no	90	18	20.0
Bejdy	0.9 ha (II)	no (for 30 yrs)	pine forest	periodic	65	3	4.6
Dąbrówka Stany 1	2 ha (III)	partial 30%	heterogenous	stable	133	16	12.0
Dąbrówka Stany 2	0.6 ha (II)	intensive 80%	heterogenous	no	61	16	26.2
Gołąbek 1	1.0 ha (II)	intensive 70%	pine forest	no	83	19	22.9
Gołąbek 2	0.2 ha (I)	intensive 70%	pine forest	no	56	13	23.2
Gręzów	3.3 ha (III)	intensive 90%	crops	no	63	15	23.8
Guty	3 ha (III)	partial 5%	heterogenous	periodic	153	45	29.4
Kaczory 1	0.9 ha (II)	intensive 60%	crops	stable	93	15	16.1
Kaczory 2	0.7 ha (II)	intensive 70%	crops	no	65	13	20.0
Kamianka	0.2 ha (I)	no (for 10 yrs)	crops	periodic	69	2	2.9
Kisielew-Dębniak	0.2 ha (I)	no (for 10 yrs)	crops	no	64	6	9.4
Klimy	0.8 ha (II)	no (for 20 yrs)	crops	periodic	105	7	6.7
Kolonia Kamianka	0.2 ha (I)	no (for 10 yrs)	crops	no	69	20	29.0
Kolonia Miedzna	3.8 ha (III)	partial 20%	crops	stable	153	18	11.8
Korczówka	0.5 ha (II)	partial 10%	heterogenous	periodic	91	19	20.9
Kupiętyn	0.9 ha (II)	partial 15%	heterogenous	no	78	19	24.4

Cont. Tab. 1

Łuzki I	0.3 ha (II)	no (for 5 yrs)	crops	periodic	96	4	4.2
Łuzki II	1.8 ha (III)	no (for 10 yrs)	crops	stable	130	21	16.2
Międzyleś	0.2 ha (I)	no (for 15 yrs)	crops	no	68	6	8.8
Mołomotki	0.6 ha (II)	partial 40%	pine forest	no	105	27	25.7
Mordy 1	1.0 ha (II)	no (for 10 yrs)	heterogenous	periodic	120	12	10.0
Mordy 2	3.0 ha (III)	intensive 60%	heterogenous	stable	165	20	12.1
Niemirki	2.1 ha (III)	partial 15%	heterogenous	stable	168	21	12.5
Okniny Podzdrój 1	2.6 ha (III)	partial 10%	crops	periodic	110	19	17.3
Okniny Podzdrój 2	1.4 ha (III)	no (for 15 yrs)	heterogenous	periodic	105	14	13.3
Okniny Podzdrój 3	1.0 ha (II)	partial 10%	pine forest	periodic	94	19	20.2
Olszanka 1	0.2 ha (I)	intensive 60%	crops	no	65	12	18.5
Olszanka 2	0.2 ha (I)	partial 30%	crops	no	80	14	17.5
Opole Stare	0.2 ha (I)	partial 40%	heterogenous	no	78	13	16.7
Osiny Dolne	0.8 ha (II)	no (for 10 yrs)	heterogenous	periodic	71	5	7.0
Ostromęczyn	1.4 ha (III)	partial 5%	crops	periodic	132	15	11.4
Ostrowiec	0.9 ha (II)	partial 10%	heterogenous	stable	102	9	8.8
Pióry-Pytki	1.0 (II)	partial 20%	heterogenous	periodic	101	16	15.8
Prochenki	1.9 ha (III)	partial 30%	heterogenous	periodic	97	9	9.3
Przesmyki	0.1 ha (I)	partial 25%	crops	periodic	54	5	9.3
Przeździatka	1.6 ha (III)	no (for 10 yrs)	crops	stable	164	15	9.1

Cont. Tab. 1

Raczyny	0.4 ha (II)	no (for 10 yrs)	crops	periodic	92	7	7.6
Radzików-Kornica	0.8 ha (II)	no (for 10 yrs)	crops	no	79	7	8.9
Repki	1.2 ha (III)	no (for 20 yrs)	crops	periodic	112	5	4.5
Repki-Skorupki	2 ha (III)	partial 10%	crops	periodic	146	31	21.2
Ruchenka	0.2 ha (I)	no (for 20 yrs)	pine forest	no	74	4	5.4
Ruchna	2.2 ha (III)	partial 20%	heterogenous	stable	172	20	11.6
Rzeszotków	1.0 ha (II)	partial 10%	crops	stable	117	15	12.8
Sawice Kościelne	1.3 ha (III)	no (for 15 yrs)	pine forest	periodic	106	8	7.5
Siedlce-Taradajki	1.6 ha (III)	partial 20%	heterogenous	stable	198	20	10.1
Skwierczyn	1.4 ha (III)	partial 10%	heterogenous	periodic	131	16	12.2
Stasin	0.6 ha (II)	partial 10%	heterogenous	stable	140	17	12.1
Stok Lacki	0.2 ha (I)	no (for 15 yrs)	heterogenous	stable	103	11	10.7
Suchodół Włościański	3.5 ha (III)	intensive 55%	heterogenous	stable	145	29	20.0
Szkopy	1.8 ha (III)	partial 20%	crops	stable	112	18	16.1
Świniary	0.2 ha (I)	no (for 15 yrs)	pine forest	no	60	10	16.7
Telaki	1.8 ha (III)	intensive 65%	heterogenous	no	91	26	28.6
Trebień	0.2 ha (I)	partial 25%	crops	no	70	21	30.0
Ujrzanów	2.2 ha (III)	partial 5%	heterogenous	stable	191	32	16.8
Wiechetki	0.4 ha (II)	partial 20%	crops	stable	92	10	10.9
Władysławów	0.1 ha (I)	no (for 15 yrs)	heterogenous	no	46	2	4.3

Cont. Tab. 1

Wólka Biernaty	0.6 ha (II)	partial 10%	pine forest	periodic	78	4	5.1
Wólka Okrąglik	0.2 ha (I)	no (for 30 yrs)	pine forest	no	63	13	20.6
Wólka Soseńska	0.4 ha (II)	partial 20%	heterogenous	no	120	17	14.2
Wyrąb	0.2 ha (I)	partial 30%	heterogenous	stable	85	13	15.3
Wyrozęby-Podawce	0.2 ha (I)	partial 40%	heterogenous	no	74	4	5.4
Zemły	0.5 ha (II)	partial 15%	heterogenous	no	94	7	7.4
Żeliszew Duży Kol.	0.9 ha (II)	partial 15%	heterogenous	stable	118	18	15.3
Żelków	0.1 ha (I)	partial 25%	pine forest	no	59	9	15.3

their flora. The relationship between the share of dry grassland (classes *Koelerio glaucae-Corynephoretea canescentis* and *Festuco-Brometea*) and thermophilous forest margin species (class *Trifolio-Geranietea sanguinei*) and selected factors (size of gravel pit, type of surrounding environment, intensity of exploitation, presence of pond) were analysed.

Affiliation of species to phytosociological groups was accepted after Matuszkiewicz (12). Species nomenclature (in the alphabetic order) was based on Mirek et al. (13), classification of life forms on Zarzycki et al. (17) and Rutkowski (16).

RESULTS

The flora of the studied 65 post-exploitation excavations of the Wysoczyzna Siedlecka plateau includes 599 vascular plant species belonging to 323 genera and 82 families (see *Alphabetical list of species*). It consists mainly (73%) of native species. Forest and shrub plants (20.7%) and meadow ones (over 16%) play the most important role in its floristic composition. Nevertheless, a large share of xerothermic sward and forest margin species from the classes *Festuco-Brometea* and *Trifolio-Geranietea sanguinei* (50 species – 8.3%) and psammophilous plants from the class *Koelerio glaucae-Corynephoretea canescentis* (40 species – 6.7%) is also noteworthy.

Xerothermic grassland vegetation and forest margin species usually occur on exposed, sunny slopes of southern and south-western exposure. Psammophilous vegetation plays an important role in the first stages of natural succession after mineral resources mining. Therefore, psammophilous species prefer initial soils in the relatively recently exploited fragments of gravel pits, irrespective of the exposure.

The most commonly noted xerothermic species were, e.g., *Medicago falcata, Centaurea stoebe*, *Coronilla varia*, *Centaurea scabiosa*. Such species as *Corynephorus canescens, Erigeron acris, Jasione montana, Helichrysum arenarium* dominate among psammophilous plants.

Hemicryptophytes (62%) and therophytes (18%) prevail over the other life forms (Fig. 1). The share of therophytes, calculated for the total flora of gravel pits was much larger (28.1%).

A distinct domination of anemochoric taxa among dry grassland flora (56%) was observed. A large share of zoochoric (12%) and anemochoric/zoochoric species (14%) was also noted (Fig. 2). Share of anemochoric plants in the whole flora of gravel pits was much lower (44%).

The diversity of dry grassland species depends on the area of gravel pit. Their largest average number (19.7) as well as the total number of dry grassland species (76) was noted in objects of area over 1 ha (Tab. 2). That tendency was

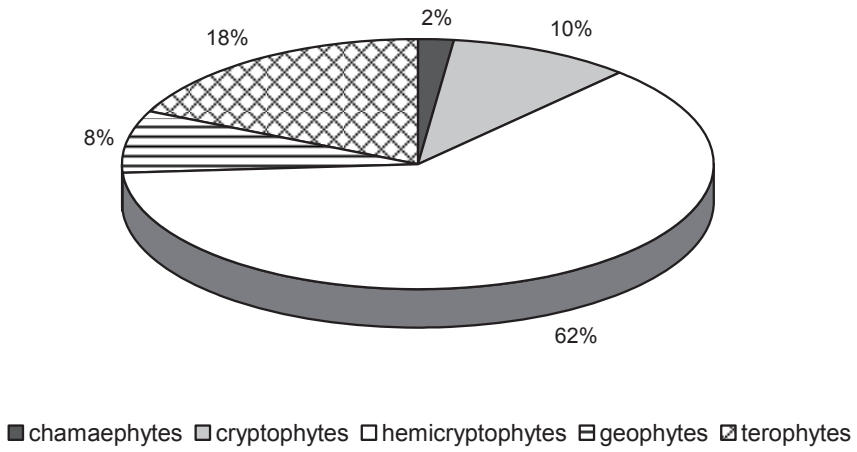

Fig. 1. Share of life forms of dry grassland species in gravel pits of the Wysoczyzna Siedlecka plateau

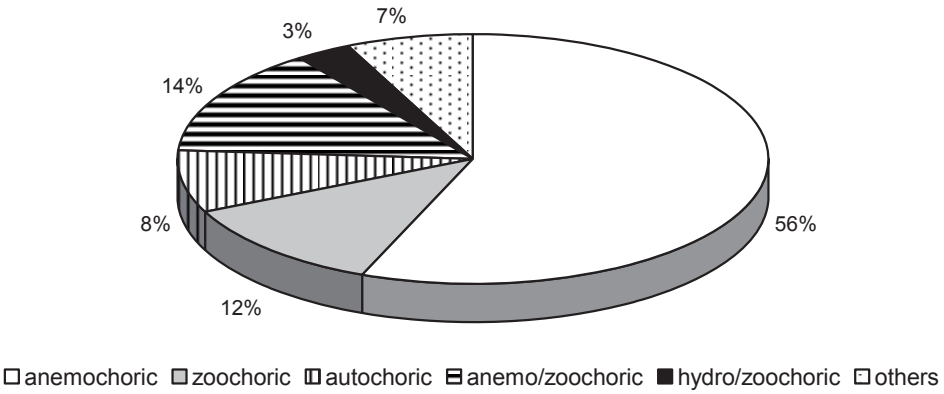

Fig. 2. Share of seed dispersal groups among dry grassland species in gravel pits of the Wysoczyzna Siedlecka plateau

accompanied by the increase in the total number of vascular species. At the same time, no relationships between the size of gravel pit and percentage share of this group of species in the flora were observed.

All forms of mining activity resulted in higher dry grassland species diversity – on average 16.8 – 16.9 species in object (8.7 in abandoned ones) (Tab. 2). Partial exploitation has contributed to the increase in the total number of dry grassland species (85), whereas intensive use – to the increase in percentage share of this group of species in the flora (21,6 %). The variability range of these features was relatively narrow.

Tab. 2. Floristic characteristics of the distinguished types of gravel pits (Wysoczyzna Siedlecka plateau)

Feature		Mean number of vascular plant species	Number of dry grassland species			Share of dry grassland species (%)	
			sum for all gravel pits	mean	variability range	mean	variability range
Area	< 0.25ha	68.7	51	9.9	2–21	14.4	2.9–30
	0.26 – 1ha	94.0	68	12.9	4–27	13.9	4.2–26.2
	> 1ha	135.3	76	19.7	6–45	14.9	4.5–29.4
Exploitation	no	88.6	47	8.7	2–21	9.9	2.9–29
	extensive	112.2	85	16.9	4–45	15.1	5.4–29.4
	intensive	78.2	49	16.8	12–29	21.6	16.1–28.6
Surrounding	forest	77.8	56	12.3	3–27	15.6	4.6–25.7
	fields	96.0	67	12.8	2–31	13.8	2.9–30
	heterogenous	115.4	76	16.6	2–45	14.4	4.3–29.4
Pond	no	74.2	62	13.2	2–31	17.7	4.3–30
	periodic	101.3	52	12.2	4–45	11.4	2.9–29.4
	stable	135.8	48	17.8	3–27	13.2	9.1–20

The floristically richest gravel pits, also with respect to thermophilous species were situated in a heterogeneous environment (on average 16.6 species in an object), however, no relationships between percentage share of that group and close surroundings were noted (Tab. 2).

In spite of a high number of termophilous species noted in gravel pits, characterized by occurrence of stable pond (on average 17.8), their percentage share in flora was low due to a large biodiversity of these objects (a large total number of species). The highest participation of dry grassland species (17.7%) was observed in excavations without water basins at the bottom.

Comparing flora of the studied excavations with vegetation in their close surrounding, the former were distinctly richer in xerothermic species (respectively

8.3 and 3.0% of the flora), which proves their floristic separateness and refuge role for xerothermic species. The share of psammophilous plants was similar in gravel pits and in their surroundings.

DISCUSSION

The previous studies on gravel pit vegetation were never focused on dry grassland flora. Therefore, no information regarding relationships between the type of excavation and share of dry grassland species are available. Most studies were related to selected systematic groups of plants, e.g. grasses (2, 3), plant communities and problems of plant succession (6, 7, 9). Psammophilous phytocenoses (particularly association *Spergulo vernalis-Corynephoretum*) are considered among most important plant communities, participating in the process of gravel pits succession (6). The most common species were: *Corynephorus canescens*, *Festuca ovina*, *Jasione montana*, *Rumem acetosella*, *Erigeron acer*, *Sedrum acre*, *Thymus serpyllum* and *Koeleria glauca.* A few other dry grassland species, commonly occurring in pioneer stages of gravel pit succession, e.g., *Plantago indica*, *Viola tricolor*, *Anthyllis vulneralia* and *Herniarnia glabra* were published by Furdyna (7). All these species were also frequently noted in excavations of the Wysoczyzna Siedlecka plateau. More detailed, statistical information on the flora of a large gravel pit in the Silesia region have been published by Bąba and Kompała (1). The most numerous were meadow species from the class *Molinio-Arrhenatheretea* (22%) and synanthropic plants from classes *Artemisietea vulgaris* and *Stellarietea mediae* (19%), whereas the vegetation of selected excavations of the Wysoczyzna Siedlecka plateau is dominated by forest and shrub species (20.7%) and meadow plants (over 16%). The differences are a result of more intensive exploitation of a Silesian excavation. The share of psammophilous species from the class *Koelerio-Corynephoretea* (5%) was slightly lower than in the area of the Wysoczyzna Siedlecka plateau (6.7%). On the contrary, participation of thermophilous forest edge and xerothermic plants (classes *Festuco-Brometea* and *Trifolio-Geranietea sanguinei*) was somewhat higher in the Silesian object (10%) than in the Wysoczyzna Siedlecka plateau (8.3%). Due to insufficient investigation of the flora of excavations, further, more detailed studies on gravel pit vegetation seem to be necessary.

CONCLUSIONS

- Thermophilous plants are an important component of flora of gravel pits of the Wysoczyzna Siedlecka plateau. They build up 15% of the total number of species.
- Xerothermic vegetation usually develops on sunny slopes of southern and south-western exposure. Psammophilous species prefer initial soils in the

relatively recently exploited fragments of gravel pits. They play an important role in the first stage of succession of excavations.

- Such factors as excavation size, intensity of exploitation, and heterogeneity of surroundings affect the share of dry grassland species.
- Gravel pits play a role of refuge for many protected and endangered plants, including thermophilous species, e.g, *Silene tatarica, Verbascum phoeniceum, Teesdalea nudicaulis, Astragalus arenarius, Thalictrum minus, Stachys recta.*

ALPHABETIC LIST OF SPECIES

Numbers following the name of the species denote the number of localities and in brackets – their abundance: sparse, frequent, dominant is given.

Acinos arvensis (LAM.) DANDY – 11 (11, 0, 0), *Agrimonia eupatoria* L. – 14 (13, 1, 0), *Ajuga genevensis* L., 1 (1, 0, 0), *Allium oleraceum* L. – 3 (3, 0, 0), *Allium vineale*L. – 3 (3, 0, 0), *Anthemis tinctoria* L. – 8 (5, 3, 0), *Anthyllis vulneraria* L. – 7 (6, 1, 0), *Arabis glabra* (L.) BERNH. – 1 (1, 0, 0), *Arenaria serpyllifolia* L. – 18 (15, 3, 0), *Armeria maritima* subsp. *elongata* (HOFFM.) BONN. – 3 (3, 0, 0), *Artemisia campestris* L. subsp. *Campestris* – 57 (16, 27, 14), *Asparagus officinalis* L. – 5 (5, 0, 0), *Astragalus arenarius* L. – 2 (1, 1, 0), *Astragalus cicer* L. – 2 (2, 0, 0), *Astragalus glycyphyllos* L. – 4 (3, 1, 0), *Campanula glomerata* L. – 2 (2, 0, 0), *Campanula rapunculoides* L. – 1 (1, 0, 0), *Campanula rotundifolia* L. – 1 (1, 0, 0), *Carex praecox* SCHREB. – 3 (1, 2, 0), *Carlina vulgaris* L. – 1 (1, 0, 0), *Centaurea scabiosa* L. – 18 (11, 7, 0), *Centaurea stoebe* L. – 26 (16, 10, 0), *Cerastium semidecandrum* L. – 3 (3, 0, 0), *Chondrilla juncea* L. – 2 (2, 0, 0), *Clinopodium vulgare* L. – 6 (5, 1, 0), *Coronilla varia* L. – 24 (18, 6, 0), *Corynephorus canescens* (L.) P. BEAUV. – 35 (11, 18, 6), *Dianthus carthusianorum* L. – 3 (2, 1, 0), *Dianthus deltoides* L. – 1 (1, 0, 0), *Elymus hispidus* (OPIZ) MELDERIS – 4 (4, 0, 0), *Erigeron acris* L. – 26 (18, 8, 0), *Erophila verna* (L.) CHEVALL. – 16 (14, 2, 0), *Eryngium planum* L. – 1 (1, 0, 0), *Euphorbia cyparissias* L. – 1 (0, 1, 0), *Euphorbia esula* L. – 2 (2, 0, 0), *Festuca ovina* L. s. l. – 24 (13, 10, 1), *Filago arvensis L.* – 11, (7, 4, 0), *Filago minima* (SM.) PERS. – 2 (2, 0, 0), *Fragaria viridis* DUCHEAPE – 5 (5, 0, 0), *Galium verum* L. s. s. – 17 (13, 4, 0), *Geranium sanguineum L.* – 1 (1, 0, 0), *Helichrysum arenarium* (L.) MOENCH – 22 (11, 10, 1), *Herniaria glabra* L. – 9 (6, 3, 0), *Hypericum perforatum* L. – 49 (18, 31, 0), *Hypochoeris radicata* L. – 18 (16, 2, 0), *Jasione montana* L. – 26 (19, 7, 0), *Koeleria glauca* (SPRENG.) DC. – 3 (0, 3, 0), *Lathyrus sylvestris* L. – 2 (0, 2, 0), *Medicago falcata* L. – 32 (13, 17, 2), *Melampyrum nemorosum* L. – 2 (0, 2, 0), *Myosotis stricta* LINK ex ROEM. & SCHULT. – 5 (3, 2, 0), *Ononis arvensis* L. – 2 (1, 1, 0), *Origanum vulgare* L. – 1 (0, 1, 0), *Peucedanum oreoselinum* (L.) MOENCH – 10 (8, 2, 0), *Phleum*

phleoides (L.) H. KARST. – 2 (2, 0, 0), *Plantago arenaria* WALDST. & KIT. – 2 (2, 0, 0), *Plantago media* L. – 21 (15, 6, 0), *Potentilla arenaria* BORKH. – 7 (6, 1, 0), *Potentilla argentea* L. s. L. – 38 (21, 17, 0), *Potentilla collina* WIBEL s. s. – 11 (8, 3, 0), *Primula veris* L. – 1 (1, 0, 0), *Ranunculus polyanthemos* L. – 3 (3, 0, 0), *Rumex acetosella* L. – 52 (31, 21, 0), *Scabiosa ochroleuca* L. – 7 (6, 0, 1), *Scleranthus perennis* L. – 12 (9, 3, 0), *Scleranthus polycarpos* L. – 1 (0, 1, 0), *Sedum acre* L. – 19 (13, 5, 1), *Sedum maximum* (L.) HOFFM. – 8 (6, 2, 0), *Sedum sexangulare* L. – 17 (14, 2, 1), *Senecio jacobaea* L. – 12 (11, 1, 0), *Senecio vernalis* WALDST. & KIT. – 16 (14, 2, 0), *Silene nutans* L. s. L. – 1 (1, 0, 0), *Silene otites* (L.) WIBEL – 4 (4, 0, 0), *Silene tatarica* (L.) PERS. – 1 (1, 0, 0), *Spergula morisonii* BOREAU – 2 (2, 0, 0), *Teesdalea nudicaulis* (L.) R. BR. – 2 (2, 0, 0), *Thalictrum minus* L. subsp. *minus* – 1 (1, 0, 0), *Thymus pulegioides* L. – 8 (4, 4, 0), *Thymus serpyllum* L. em. FR. – 14 (10, 3, 1), *Trifolium alpestre* L. – 1 (1, 0, 0), *Trifolium arvense* L. – 43 (17, 26, 0), *Trifolium aureum* POLLICH – 11 (10, 1, 0), *Trifolium campestre* SCHREB. – 2 (2, 0, 0), *Trifolium medium* L. – 22 (16, 6, 0), *Verbascum nigrum* L. – 14 (8, 6, 0), *Verbascum phoeniceum L.* – 2 (2, 0, 0), *Veronica spicata* L. – 7 (5, 2, 0), *Veronica verna* L. – 1 (1, 0, 0), *Vicia sepium* L. – 7 (4, 3, 0), *Vicia tenuifolia* ROTH – 1 (0, 1, 0), *Viscaria vulgaris* RÖHL. – 4 (3, 1, 0).

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