Steciana

2014, Vol. 18(2): 95–117
doi:10.12657/steciana.018.012

www.up.poznan.pl/steciana

ISSN 1689-653X

VEGETATION CHARACTERISTICS OF THE MORYŃSKIE HILLS (NW POLAND)

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(Received: September 19, 2013. Accepted: November 14, 2013)

ABSTRACT. The aim of this study was to characterise the flora and plant communities in the Moryńskie Hills, Poland. A total of 45 transects and 23 phytosociological relevés were established. Plant communities were identified based on the description of the test patch of the vegetation cover. The paper presents floristic analyses of vascular plants, which includes the taxonomic affiliation of species, their life forms according to Raunkiaer, and the species share in the geographical and historical groups. The results have been compiled and presented in tables and graphs, with a brief discussion. The non-forest communities occupy the largest area: xerothermic swards, meadows and pastures and to a lesser extent, scrub communities. Forests are represented by a riparian slope elm-ash wood *Violo odoratae-Ulmetum minoris*.

KEY WORDS: Moryńskie Hills, xerothermic grasslands, flora, plant communities

INTRODUCTION

The areas around the Moryńskie Hills have been utilised by agriculture for centuries. The Hills are a series of morains of the Myślibórz stage of the Würm glaciation with relatively steep slopes and considerable insolation, running from Kostrzynek/Oder through Myślibórz to Barlinek. In the past the vegetation cover was influenced only by natural factors, with all changes occurring in nature being long-term and slow. Since the time when human activity started to seriously affect the environment, the changes in nature have been drastically accelerated. Interest in xerothermic vegetation in Poland has been observed for years. Examples of such research include e.g. a publication by Czeczotowa (1948), Sławiński (1952), Celiński (1953 a, b, 1954, 1957), Fijałkowski (1957), Celiński & Filipek (1958), Ceynowa (1968), Filipek (1974) as well as numerous contemporary studies. The basic practical information concerning xerothermic grasslands, their distribution, environmental requirements, characteristic species, identified plant associations as well as threats and protection measures are presented in "Poradnik Ochrony Siedlisk" [Habitat Protection Guidelines] (Perzanowska & Kujawa-Pawlaczyk 2004 and literature cited therein).

The aim of this study was to characterise flora in terms of plant communities in the Moryńskie Hills. Moreover, the study focuses on the identification of threats to flora and vegetation and presents recommendations for natural management of the discussed communities.

THE AREA CHARACTERISTIC

The study area is located in north-western Poland (Fig. 1) in the Gryfino county, in the Moryńskie Hills, constituting a section of the terminal Trzciński morain. This area extends along the subglacial valley from the village of Mętno in the north to the town of Moryń in the south and is distinctly elongated over a distance of approx. 4 km.

According to the physico-geographical division of Poland (Kondracki 2002), the Moryńskie Hills are located in the macroregion of Pojezierze Zachodniopomorskie (314.4), mesoregion of Pojezierze Myśliborskie (314.41). A characteristic feature of the area around Moryń is a series of morains of the Myślibórz stage, running from Kostrzynek/Oder

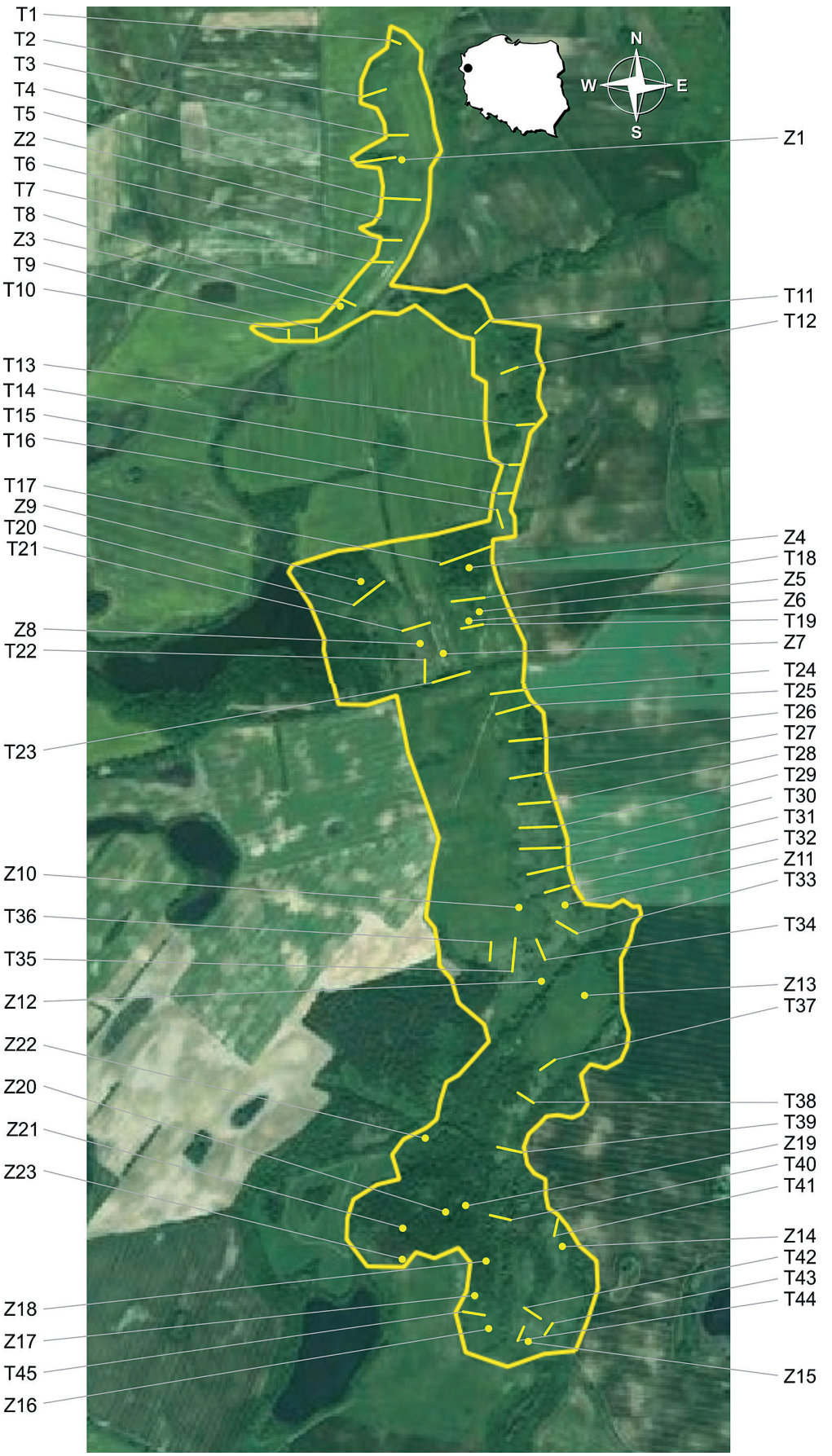

Fig. 1. Distribution of transects and phytosociological relevés of the Moryńskie Hills (transects are marked in yellow, phytosociological records in green, boundaries of the study area in red)

through Myślibórz to Barlinek. As a consequence of the entire glaciation process, diverse land forms were created (Borówka et al. 2004). The land relief is very rich, with predominant hilly and undulating morain plateaux (Kondracki 2002).

The Moryń Morain in very few places exceeds the height of 90 m a.s.l., on average reaching from 60 m to 70 m a.s.l. Altitudes above ground levels range from 20 m to over 40 m and such a diversification in altitude results in an impressive variation of landscape. West of Moryń in the area of Cedynia the morain hills reach much greater altitudes of up to 160 m a.s.l. (Kondracki 2002), with the highest hill in the area, Zwierzyniec in the Puszcza Piaskowa forest, reaching 167 m a.s.l.

Soils found in the Moryńskie Hills are young deposits. They are highly diverse, which results mainly from the variation in the land relief, moisture content and lithogenic conditions. In the study area the predominant soils are glacial tills, their decayed deposits as well as glacial sands and gravels. On these morain sediments mainly brown and podzolic soils were formed, while slight depressions are filled with water-logged soils (Mieczyński 1947).

The investigated area has a specific topoclimate. Slopes and hillsides of the terminal morain hills, as well as the bottom of the subglacial valley form a microregion. In these locations the diurnal temperature ranges are considerable. Slopes with southern exposure are locations reached by the greatest amounts of sunshine, thus air temperature is much higher here. Also the microclimate is more arid than on slopes with northern exposure. These conditions are typical of steppe regions, i.e. these areas are suitable places for the development and growth of xerothermic vegetation. In the morain hill zone precipitation ranges from 600 to 650 mm/year (Borówka et al. 2004).

The Moryńskie Hills are areas of very attractive landscapes (Phot. 1). They comprise a mosaic of fields, grasslands, scrubs, forests and lakes. They are habitats for numerous animal species. They also provide favourable conditions for the development of a great number of plant taxa. Such an extensive richness of animate and inanimate nature resulted in a decision to include the area into the Cedyński Landscape Park, established in 1993.

The Moryńskie Hills, due to their natural value, were included into the Special Bird Refuge Ostoja Cedyńska (PLB320017) and Special Habitat Protection Area the Moryńskie Hills (PLH320055). The Hills are also elements of the ECONET network and serve the function of an international node area (Liro 1998).

Within the framework of the geobotanical division of Poland (Matuszkiewicz 1993) the area (Fig. 2) is located in the Pomeranian Divide (A), the Szczecin Region (A.3), the Myślibórz District (A.3.2), in the Lubiechów Sub-district (A.3.2.d). This region comprises lake disticts with the predominance of Pomeranian beech forest landscape. Moreover, there are xerothermic oak forests and steppe grassland communities, beech-oak forests (*Fago-Quercetum* with

Phot. 1. Varied young glacial landscape of the Moryń Morain (phot. M. Kagan)

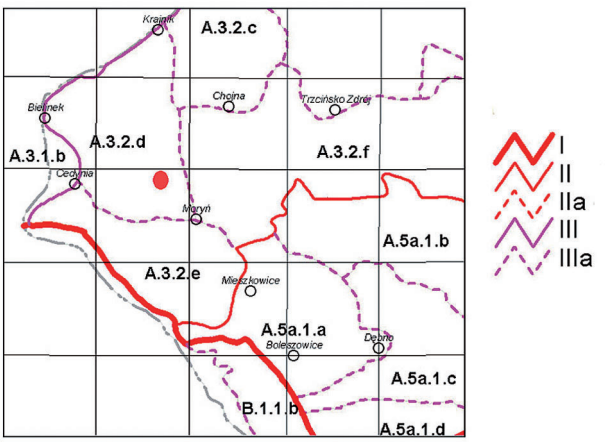

Fig. 2. Location of the Moryńskie Hills within the geobotanical division of Poland (Matuszkiewicz 1993), the red dot denotes the study area; I – divides, II – region, IIa – sub-region, III – district, IIIa – sub-district. Source: http://globus.igipz.pan.pl/geoekoklimat/roslinnosc/regiony_mapa/B1_region.png; 28.03.2013 r.

Lonicera periclymenum) and Atlantic riverside carrs of the association *Carici remotae-Fraxinetum*.

The Moryńskie Hills do not show any considerable variation of the potential natural vegetation. In the study area two cartographic units of potential natural vegetation were distinguished (Matuszkiewicz 2008). The geratest share in the total area is found for the community of potential fertile lowland beech forest *Galio odorati-Fagetum*. A smaller area is covered by non-forest communities of specific habitats, i.e. steppe xerothermic grassland *Festucetalia valesiacae*.

The predominant types of habitats found in the Moryńskie Hills are semi-natural habitats: swards, meadows, pastures, in-field small water bodies and wetlands, as well as multi-species scrubs and forests. Such a considerable variation is a consequence of land relief and to a limited extent – extensive herding. Forests account for 6% area of the Hills, while the rest is unforested area. On steep morain slopes xerothermic grasslands are found most frequently, with ocassional riparian forest *Violo odoratae-Ulmetum minoris*. Xerothermic grasslands frequently border with meadows from the *Arrhenatherion* alliance, usually found in plains of limited slope. Fresh meadows with a high share of xerothermic species occupy 14% area of the Moryńskie Hills. In drainless hollows in the examined area eutrophic small water bodies are frequently found. Associations with water lilies are found in bigger lakes. Xerothermic grasslands cover the area of approx. 50 ha, i.e. 9% area of the study (Natura 2000 SFD). In the region of Mętno and Dolsk the hills are covered with numerous xerothermic grassland communities with *Stipa capillata*, while *Stipa joannis* was found in several localities. Interesting grassland plants of the Moryńskie Hills include also *Campanula sibirica* and *C. bononiensis*, *Melampyrum arvense*, *Anthericum liliago* and *Stachys recta*. On a slope located east of Lake Górka in the spring you may find flowering *Pulsatilla vernalis* (Jermaczek et al. 2005). Grasslands with dominant *Stipa capillata* prefer soils with a proportion of clay and with a greater amounts of humus. They typically cover slopes and hillsides of southern and western exposure, being found rarely on slopes with eastern exposure. Grasslands with dominant *Brachypodium pinnatum* are relatively common (Jermaczek et al. 2005). The Moryńskie Hills have an abundance of grassland phytocenoses with *Brachypodium pinnatum*, frequently accompanied by xerothermic species, e.g. *Campanula sibirica* and *Anthericum liliago*.

MATERIALS AND METHODS

Field studies were conducted in two vegetation seasons in 2012 and 2013. The focus was on forest and scrub communities as well as permanent grassland and to a lesser degree on reed rush communities. In the study area of approx. 4 km in length a total of 45 transects were established. Transects were located at every 100 m, omitting areas covered by arable fields. Outside the transects a total of 23 relevés were established applying the generally adopted method of Braun-Blanquet (1964). Transects and relevés were selected so that they adequately characterised the diversity of plant communities in the study area. A seven-point scale was adopted in order to determine the numbers of taxa found both in floristic lists of the transects and in relevés. The location of each transect and relevé was marked on the map (1:5000 Google Earth map).

The nomenclature of individual plant species was adopted after Mirek et al. (2002), while the phytosociological nomenclature of communities was adopted after Matuszkiewicz (2008).

In order to determine the existing life forms of plants, the system proposed by Raunkiaer (1905) was applied, which classifies plants according to the distribution and manner of protection of dormant buds in the unfavourable season of the year. The study included the following basic units: megaphanerophytes, nanophanerophytes, woody chamaephytes and herbaceous chamaephytes, hemicryptophytes, geophytes, hydrophytes and therophytes. A characteristic of species in terms of the geo-historical classification was conducted according to the concept proposed by Thellung (1915). Species of native plants were distinduished, including non-synanthropic spontanophytes (Sn) and apophytes (Ap) as well as alien species: archeophytes (Ar), kenophytes (Kn) and ephemerophytes (Ef). Flora was also analysed in terms of the share of legally protected species (Rozporządzenie... 2012, Ordinance of the Minister of the Environment of 20 January 2012 on species of wild growing plants covered by legal protection), rare and threatened species (Kaźmierczakowa & Zarzycki

2001, Żukowski & Jackowiak 1995, Attachment II to the Dyrektywa..., Directive of the EEC Council 92/43/EWG) and species of ancient woodlands suggesting long and constant existence of forest sites in this area (Peterken 1974, Dzwonko 2007).

RESULTS

CHARACTERISTICS OF FLORA

In the Moryńskie Hills in patches of relevés and transects (Fig. 1) a total of 186 taxa of vascular plants were found (Attachment Table 6). The recorded species belong to 47 families, of which the most numerously represented are grasses *Poaceae* (29 species). Grasses include 21 genera, of which the genus *Festuca* (4 species) was found most frequently, while the genera *Poa*, *Brachypodium*, *Calamagrostis*, *Deschampsia* and *Phleum* were represented by two species each. Another familiy represented by numerous species was *Asteraceae*, of which 16 genera and 21 species were recorded. The genus *Centaurea* is represented by three species, while three other genera were represented by two species: *Cirsium*, *Chrysanthemum* and *Erigeron*. A rich family comprising 18 species is the family *Fabaceae*. *Trifolium* is a numerous family, represented by five species. The genera *Medicago*, *Melilotus* and *Vicia* have two species each. Another family, rich in species, is the family *Rosaceae* (14 representatives), of which the most numerous genera are *Filipendula*, *Geum* and *Potentilla* (with 2 species each). A relative abundant group comprises species from the family *Lamiaceae*, which two genera *Ajuga* and *Stachys* have two representatives each. Another family represented this time by 10 species is *Caryophyllaceae*. There are seven genera, of which the most numerous are *Silene* (3 species) and *Stellaria* (2 species) (Fig. 3). In the flora of the Hills 20 families are represented by single species.

Analysis of geo-historical groups of species showed that the native taxa are most numerous, accounting for 92% flora. The greatest share in theis groups was reported for apophytes (70%). Non-synathropic spontaneophytes constitute 22% analysed species. Only 8% are alien species, of which the most abundant group is composed of kenophytes (Fig. 4). One taxon was recorded among ephemerophytes. Such a high number of native species indicates a natural character of flora found in the Moryńskie Hills.

It results from the analysis of life forms according to Raunkiaer (Fig. 5) that hemicryptophytes are the dominant group of plants, accouting for 61% flora in the Hills. Annual plants, as therophytes (13%) and geophytes (10%), are less abundant. The other groups do not play any greater role in the study area. Overall they constitute 16% of all species in the study area.

In the Moryńskie Hills a total of nine legally protected species were recorded. The group of wild plants found in the area and covered by strict protection (Rozporządzenie... 2012, Ordinance of the Minister of the Environment of 5 January 2012 protection of plant species, the Journal of Law Dziennik Ustaw 2012) comprises four species: *Anthericum liliago*, *Campanula sibirica*, *Centaurium erythraea* and *Stipa capillata*. Among the five species three require active protection: *Campanula sibirica*, *Anthericum liliago* and *Stipa capillata*. *Anthericum liliago* is found only in one locality, which is a slope with western exposure, descending towards the eastern shore of Lake Górka. This site has only several specimens of this species. The four other taxa are found in gretear numbers and in more localities. Four taxa found in the study area have the status of species under partial protection:

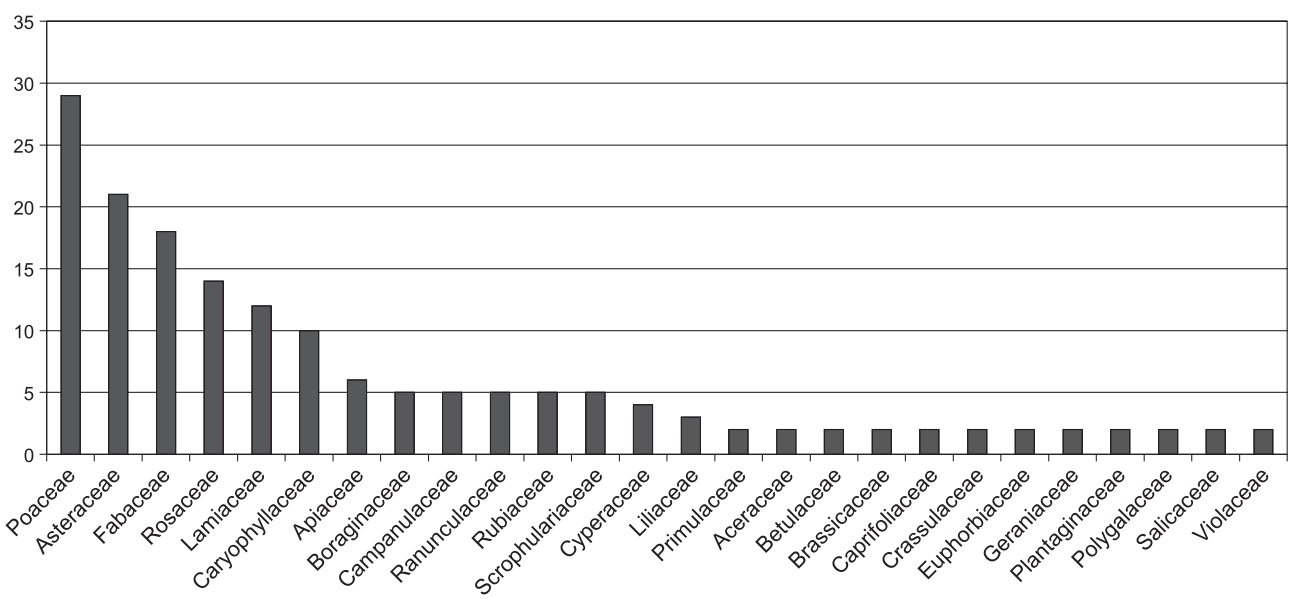

Fig. 3. Numbers of recorded species in individual families

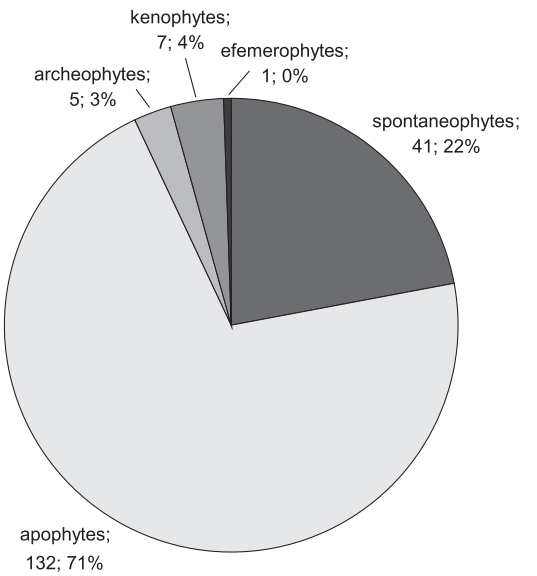

Fig. 4. Spectrum of geo-historical groups of species found in the study area

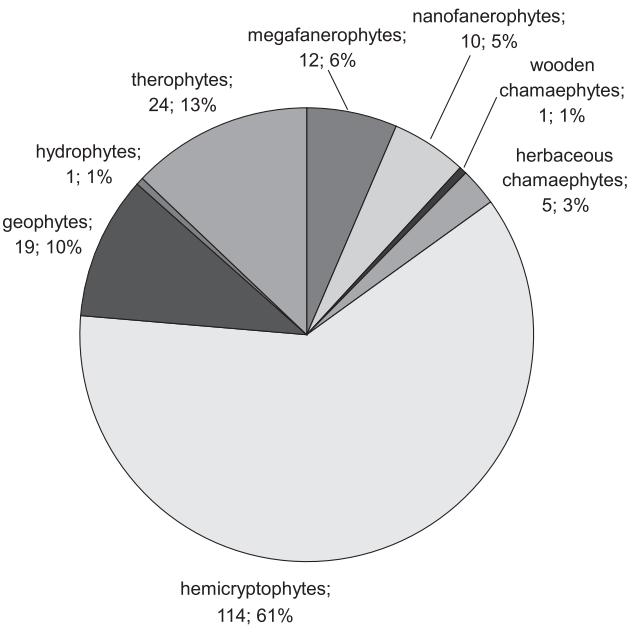

Fig. 5. Spectrum of life forms of species

Helichrysum arenarium, *Primula veris*, *Viburnum opulus* and *Galium odoratum*. In the analysed communities one species from the Polish red book of plants was reported (Kaźmierczakowa & Zarzycki 2001). It is *Anthericum liliago*. This species was classified as vulnerable (VU). Among rare and threatened species in the Western Pomerania (Żukowski & Jackowiak 1995) we have eight taxa, of which *Acer campestre* is classified as a rare species (R) and one, *Thalictrum simplex*, as unspecified (data deficient). The list of vulnerable species (V) in the study area comprises six taxa (*Anthericum liliago*, *Campanula sibirica*, *Laserpitium prutenicum*, *Melampyrum arvense*, *Stachys recta*, *Stipa capillata*). Among all the plants from Attachment II of the Directive of the EECCouncil 92/43/EEC (Dyrektywa... 1992), four taxa were reported in the study area. This group includes *Anthericum liliago*, *Campanula sibirica*, *Stachys recta* and *Stipa capillata*. The analysed flora comprises 11 species of ancient woodlands (Dzwonko 2007). They are found mainly in riparian forests and thickets of the study area (*Aegopodium podagraria*, *Ajuga reptans*, *Brachypodium silvaticum*, *Campanula trachelium*, *Dryopteris filix-mas*, *Euphorbia dulcis*, *Galium odoratum*, *Geum urbanum*, *Impatiens noli-tangere*, *Poa nemoralis*, *Stellaria nemorum*).

CHARACTERISTICS OF COMMUNITIES

Vegetation of the Moryńskie Hills is highly varied. A mosaic of soils, large numbers of dranless small thawed-out water bodies and the varied young glacial land relief all contribute to the fact that within a limited area of the Hills adequate conditions are provided for both forest, shrub as well as different non-forest communities. In the study area four complexes of plant communities are distinguished: forest, shrub, xerothermic grassland, as well as meadows and pastures.

In the Moryńskie Hills, mainly in the southern part, riparian forest habitats are found (Table 1). Their area is relatively large. They are forests overgrowing steep and high slopes. Smaller phytocenoses of riverside carrs are found also in the central part of the Hills, mainly on the slopes adjacent to Lake Górka. Riparian forests grow here on fertile soils formed on glacial tills and to a lesser degree on glacial sands, rich in calcium carbonate. Riparian forests are characterised here by a well developed shrub layer. The vegetation is considerably affected by periodical droughts in the summer period and strong surface runoff of rainwater. The development of the herbaceous layer to a considerable degree depends on light conditions and it mainly comprises hemicryptophytes, with geophytes being much less frequent.

The characteristic species of the *Querco-Fagetea* class found in the Hills include *Acer campestre*, *Aegopodium podagraria*, *Fraxinus excelsior*, *Brachypodium sylvaticum* and *Poa nemoralis*. The upper layer of trees is typically composed of *Ulmus laevis*, while only in phytocenoses in two relevés no. 21 and 22 *Ulmus laevis* was found in the shrub layer. In two phytocenoses (relevés 20 and 19) *Betula pendula* is found in the upper layer, while in the phytocenosis documented by relevé 19 *B. pendula* solely forms the upper layer. The forest floor vegetation cover comprises species associated with the riparian elm association *Violo odoratae-Ulmetum minoris*. These include *Viola odorata* (relevés 4, 9, 18, 22), *Campanula persicifolia* (relevé 4) and *Campanula rapunculoides* (relevés 4, 9, 18). Relatively frequent species in the forest floor cover include *Brachypodium sylvaticum*

Table 1. Riparian habitat communities

Successive number of relevé	1	2	3	4	5	6	7
Field number of relevé	22	4	9	18	20	19	21
Date	31.05.2013	24.06.2012	24.06.012	01.06.2013	02.06.2013	01.06.2013	02.06.2013
Cover of tree layer a (%)	80	80	90	90	70	60	60
Cover of shrub layer b (%)	5	10	5	10	-	70	50
Cover of herb layer c (%)	70	50	40	50	90	60	70
Area of relevé (m^2)	200	200	200	200	200	200	200
Number of species in relevé	15	18	15	19	15	27	19
ChCl. *Vaccinio-Piceetea*							
Pinus sylvestris a	–	–	–	–	–	5.5	5.5
ChCl. *Querco-Fagetea*							
Ulmus laevis a/b	/+	5.5/	5.5/	3.3/	+	1.1	/3.2
Alnus glutinosa a	5.5	–	–	–	–	–	–
Fraxinus excelsior a/b	–	–	r/	–	–	/4.4	–
Acer pseudoplatanus a	–	3.1	–	–	–	–	–
Brachypodium sylvaticum	2.2	1.2	3.1	5.5	4.4	2.2	–
Viola odorata	2.2	4.5	3.2	2.2	–	–	+
Impatiens noli-tangere	1.2	3.3	+	–	–	–	–
Dryopteris filix-mas	2.1	1.1	–	1.1	–	–	–
Primula veris	–	1.2	–	2.2	–	2.2	1.1
Poa nemoralis	–	–	–	–	–	1.1	3.3
Galium sylvaticum	–	–	–	–	1.1	1.1	–
Campanula persicifolia	–	1.1	–	–	–	–	+
Galium odoratum	–	–	1.2	–	–	–	–
Quercus petraea a	–	–	–	2.1	–	–	–
Quercus petraea	–	–	–	–	+	–	+
Euphorbia dulcis	–	–	–	–	–	+	–
Stellaria nemorum	–	–	–	–	–	–	+
ChCl. *Epilobietea angustifolii*							
Betula pendula a	–	–	–	2.1	5.5	–	–
Sambucus nigra b	+	1.1	+	–	–	–	+
Fragaria vesca	–	–	–	–	–	1.1	–
ChCl. *Rhamno-Prunetea*							
Rosa canina b	–	–	–	–	–	+	+
Acer campestre	–	–	–	+	–	–	–
Crataegus laevigata b	–	–	–	1.1	–	–	+
Berberis vulgaris b	–	–	–	+	–	+	–
Rhamnus cathartictus	–	–	–	1.1	–	–	–
ChCl. *Festuco-Brometea*							
Ajuga genevensis	–	–	–	1.1	1.1	2.2	–
Brachypodium pinnatum	–	–	–	–	–	1.1	–
ChCl. *Koelerio glaucae–Corynephoretea canescentis*							
Rumex acetosella	–	–	–	–	–	–	+
ChCl. *Molinio-Arrhenatheretea*							
Dactylis glomerata	–	–	–	1.1	1.1	3.3	5.5
Laserpitium prutenicum	–	–	–	–	1.1	–	–

Table 1. cont.

Successive number of relevé	1	2	3	4	5	6	7
Ranunculus repens	–	–	–	–	1.1	–	–
Vicia cracca	–	–	–	–	1.1	1.1	–
Plantago major	–	–	–	–	–	2.2	–
Cynosurus cristatus	–	–	–	–	–	1.2	–
Knautia arvensis	–	–	–	–	–	+	–
Plantago lanceolata	–	–	–	–	–	+	–
Ranunculus acris	–	–	–	–	–	+	–
ChCl. *Phragmitetea*							
Peucedanum palustre	1.2	–	–	–	–	–	–
ChCl. *Artimisietea vulgaris*							
Geum urbanum	2.1	2.2	1.2	1.1	3.2	1.1	–
Chaerophyllum temulum	1.1	1.2	1.2	–	1.1	+	1.1
Aegopodium podagraria	1.1	–	–	–	–	–	–
Geranium robertianum	2.2	2.2	2.2	1.1	–	1.1	1.2
Galium aparine	2.2	+	–	–	–	–	–
Alliaria petiolata	–	1.1	+	–	–	–	–
Rubus caesius	–	–	–	3.3	–	3.3	–
Moehringia trinervia	–	1.2	–	–	–	–	–
Urtica dioica	1.1	–	–	–	–	–	–
Lamium maculatum	–	–	–	–	–	–	1.1
ChCl. *Stellarietea mediae*							
Odontites verna	–	+	1.2	–	–	–	–
Lapsana communis	–	–	+	–	–	–	–
ChCl. *Trifolio-Geranietea sanguinei*							
Agrimonia eupatoria	1.1	–	–	1.1	1.1	–	–
Campanula rapunculoides	–	+	1.1	+	–	–	–
Others							
Robinia pseudacacia a/b	–	/+	+/	–	–	–	/+
Lolium multiflorum	–	–	–	–	1.1	1.1	–
Pyrus communis b	–	–	–	1.1	+	1.1	–
Silene chlorantha	–	–	–	–	–	–	1.1
Euphorbia esula	–	–	–	–	–	+	–
Veronica chamaedrys	–	–	–	–	–	–	+

forming large patches (relevés 4, 9, 18, 19, 20, 22) and *Geum urbanum* (relevés 4, 9).

Moreover, deformed phytocenoses were also found, in which the upper tree layer was formed by *Pinus sylvestris*. This form of degeneration, pine overgrowing (pinetyzation), is observed in patches of relevés 19 and 21. They are stands originating from the period after World War II, when intenive afforestation was practiced, frequently using scot pine. In the plot documented by relevé 21 strong regeneration with *Fraxinus excelsior* and typical riparian species are found in the undergrowth.

Mesophilous scrub communities in the study area form relatively large patches (Table 2). They are mostly thickets found in the open spaces, to a lesser extent being shrub communities of forest edges (Phot. 2). Shrubs growing here are formed by communities with domed canopies, in which branches of individual specimens are greatly entangled. Mesophilous thickets comprise primarily shrub species from the *Rhamno-Prunetea* class: *Prunus spinosa*, *Crataegus laevigata*, *Rhamnus cathartica* and *Rosa canina*. The most abundant is *Prunus spinosa*, a species most-frequently forming *Rubo fruticosi-Prunetum spinosae* shrub thickets overgrowing the Moryńskie Hills. *Prunus spinosa* predominated in two patches (relevés 3 and 17). A frequent species found in the mesophilic shrubs is also *Crataegus laevigata*, which in places forms single-species shrub thickets. The structure of *Rubo fruticosi-Prunetum spinosae* is very dense and

Table 2. Communities of the *Rhamno-Prunetea* class

Successive number of relevé	1	2
Field number of relevé	3	17
Date	20.06.2012	01.06.2012
Cover of shrub layer b (%)	60	85
Cover of herb layer c (%)	80	50
Area of relevé (m^2)	150	150
Number of species in relevé	16	14
ChCl. *Rhamno-Prunetea*		
Prunus spinosa b	3.2	5.5
Crataegus laevigata b	2.1	2.2
Rhamnus cathartica b	1.1	–
Rosa canina		r
ChCl. *Querco-Fagetea*		
Quercus petraea b	–	+
Campanula trachelium	r	–
ChCl. *Festuco-Brometea*		
Brachypodium pinnatum	3.2	–
Phleum phleoides	–	2.2
ChCl. *Trifolio-Geranietea sanguinei*		
Agrimonia eupatoria	1.1	–
Galium verum	–	1.1
Coronilla varia	+	–
ChCl. *Molinio-Arrhenatheretea*		
Dactylis glomerata	–	3.3
Achillea millefolium	–	1.1
Knautia arvensis	1.1	–
Tragopogon pratensis	1.1	–
Elymus repens	+	–
Linum catharticum	+	–
ChCl. *Agropyretea intermedio-repentis*		
Falcaria vulgaris	+	+
ChCl. *Artemisietea vulgaris*		
Rubus caesius	1.2	+
Geum urbanum	1.1	–
Hypericum perforatum	+	–
Others		
Silene chlorantha	+	1.1
Lolium multiflorum	–	1.1
Potentilla recta	–	1.1
Pyrus communis b	–	+

forms a strongly compacted shrub community. The composition of the undergrowth vegetation cover is varied, with sward, meadow, ruderal and herbs of forest edge communities species. A considerable effect on the shrubs in the forest floor cover, which is relatively poorly developed, is observed for neighbouring communities, of which plants penetrate to shrub phytocenoses.

Mesophilous shrubs of the Hills are poorer communities in terms of their floristic composition. Two of the analysed plots include total of 25 plant species. Such a small number of species is connected with considerable large coverage of bushes, which reduces the amount of light penetrating to the bottom of the shrub layer. This results in the formation of a low coverage and poor herbaceous layer.

Phot. 2. Blackthorn shrubs, nesting ground for *Lanius collurio* (phot. M. Kagan)

Thickets play a very important role in the landscape, they form in-field wind-break belts, while thickets are refuges and feed bases for animals. In the Moryńskie Hills there is a large population of *Lanius collurio*, which finds nesting space in shrubs and may thrust their prey onto shrub thorns.

A considerable area of the Moryńskie Hills are areas overgrown with xerothermic vegetation (Table 3). Communities of the *Festuco-Brometea* class are found on steep, strongly insolated, rapidly heating slopes. These swards are found most frequently on brown soils formed on glacial sands and glacial tills. Communities of xerothermic grassland have the character of secondary communities, which survived mainly thanks to herding management. At present no agricultural acitivty is conducted there. For this reason in many places grasslands are replaced in the course of secondary succession and are overgrown by shrubs, mainly blackthorn and hawthorns. An example may also be provided by the patches documented by relevé no. 11, where Scot pine seedlings were found. Communities from the *Festuco-Brometea* class are characterised by an extremely rich species composition, with rare and protected species frequently found. Most often they are overgrown by xerothermic species, while mesophilic species are foud very rarely.

Xerothermic sward is characterised by a high esthetic value. The colour of grassland changes throughout the vegetation season, with yellow and purple predominating. The characteristic species of the *Festuco-Brometea* class include *Ajuga genevensis*, *Anthericum liliago*, *Anthyllis vulneraria*, *Artemisia campestris*, *Brachypodium pinnatum*, *Carlina vulgaris*, *Dianthus carthusianorum* and *Phleum phleoides*. Xerothermic grasslands were documented on 8 relevés, with an average of 18 species of vascular plants recorded per relevé (from 12 to 23 taxa). Overall in eight phytocenoses a total of 61 plant species were identified.

Phot. 3. Phytocenon of sward with *Stipa capillata* found in the northern part of the study area (phot. M. Kagan)

Table 3. Communities of the *Festuco-Brometea* class

Successive number of relevé	1	2	3	4	5	6	7	8
Field number of relevé	11	2	8	5	23	7	1	6
Date	31.05.2013	14.06.2012	30.06.2012	25.06.2012	01.06.2013	30.06.2012	14.06.2012	25.06.2012
Cover of herb layer c (%)	100	100	90	85	80	75	70	85
Area of relevé (m^2)	25	25	25	25	25	25	25	25
Number of species in relevé	23	18	25	15	16	23	14	12
ChCl. *Festuco-Brometea*								
Brachypodium pinnatum	3.3	3.3	2.2	1.2	–	–	–	–
Stipa capillata	–	–	1.2	2.2	3.3	2.3	–	–
Phleum phleoides	–	–	–	1.2	2.2	3.3	–	3.2
Galium verum	2.2	+	+	–	+	1.2	–	–
Melampyrum arvense	2.2	–	+	–	–	1.2	–	–
Thymus pulegioides	1.2	–	–	–	–	–	1.1	–
Artemisia campestris	–	–	+	–	–	+	2.1	–
Ajuga genevensis	1.2	–	–	–	–	–	–	–
Anthyllis vulneraria	1.2	–	–	–	–	–	–	–
Carlina vulgaris	1.1	–	–	–	–	–	–	–
Anthericum liliago	–	–	r	–	–	–	–	–
Campanula sibirica	r	–	–	–	–	–	–	–
ChCl. *Trifolio-Geranietea sanguinei*								
Coronilla varia	1.2	–	–	–	–	–	1.2	–
ChCl. *Koelerio glaucae-Corynephoretea canescentis*								
Corynephorus canescens	–	1.2	1.1	2.2	2.2	+	–	2.1
Sedum acre	–	–	–	–	–	1.2	+	–
Trifolium arvense	–	–	+	–	2.2	–	–	–
Silene otites	–	–	–	–	+	2.2	–	–
Armeria elongata	–	+	–	–	+	–	+	–
Rumex acetosella	–	+	+	–	–	+	–	–
ChCl. *Molinio-Arrhenatheretea*								
Achillea millefolium	–	+	–	2.2	1.2	2.2	–	2.2
Avenula pubescens	–	1.2	1.1	1.2	–	1.2	–	–
Briza media	2.2	1.2	2.2	–	–	–	+	–
Centaurea jacea	1.1	+	+	+	–	1.1	–	–
Leucanthemum vulgare	1.1	–	–	–	–	–	2.2	1.1
Dianthus carthusianorum	–	+	–	–	3.2	3.2	–	–
Knautia arvensis	1.1	–	+	–	–	+	–	–
Linum catharticum	1.2	–	+	–	–	–	–	–
Lotus corniculatus	1.1	–	+	–	–	–	–	–
Plantago lanceolata	1.2	+	–	–	–	–	–	–
Trifolium montanum	1.2	–	–	–	–	–	+	–
Veronica longifolia	–	–	–	+	+	–	–	–
Vicia cracca	–	–	–	+	–	+	–	–
Festuca rubra	–	–	–	–	–	+	–	–
Tragopogon pratensis	–	–	–	–	–	–	+	–
ChCl. *Epilobietea angustifolii*								
Fragaria vesca	–	1.2	1.2	1.2	–	–	–	2.1

Table 3. cont.

Successive number of relevé	1	2	3	4	5	6	7	8
Calamagrostis epigejos	–	–	–	1.2	–	–	–	–
ChCl. *Agropyretea intermedio-repentis*								
Falcaria vulgaris	–	–	–	–	–	–	4.4	4.4
ChCl. *Betulo-Adenostyletea*								
Calamagrostis arundinacea	–	1.2	1.1	–	–	+	–	–
Leontodon hispidus	1.2	r	–	–	–	–	–	–
ChCl. *Nardo-Callunetea*								
Polygala vulgaris	–	–	–	–	–	–	–	2.2
ChCl. *Artemisietea vulgaris*								
Medicago sativa	+	–	1.2	1.2	–	–	–	–
Hypericum perforatum	–	+	1.2	+	+	–	–	–
Echium vulgare	–	–	–	–	–	+	–	1.2
Potentilla argentea	–	–	–	–	1.2	–	–	–
Rubus caesius	–	–	–	–	–	–	1.1	–
Medicago lupulina	–	–	+	–	–	–	–	–
Chaerophyllum temulum	–	–	–	+	–	–	–	–
Linaria vulgaris	–	r	–	–	–	–	–	–
ChCl. *Stellarietea mediae*								
Orobanche serotina	–	–	2.2	–	–	–	2.2	3.2
Chrysanthemum segetum	–	+	–	–	–	–	–	–
ChCl. *Vaccinio-Piceetea*								
Pinus sylvestris	+	–	–	–	–	–	–	–
ChCl. *Querco-Fagetea*								
Primula veris	2.2	–	+	–	–	–	–	–
Euphorbia dulcis	–	–	–	–	–	–	–	+
Campanula trachelium	r	–	–	–	–	–	–	–
Others								
Salvia pratensis	2.2	–	–	1.1	+	+	1.2	2.2
Potentilla recta	–	–	–	2.2	1.2	3.3	–	–
Sedum maximum	–	4.3	1.2	–	+	+	–	–
Erigeron annuus	–	–	1.2	–	–	–	1.1	1.1
Allium vineale	–	–	–	–	–	1.1	–	–
Petrorhagia prolifera	–	–	–	–	+	+	–	–
Ononis spinosa	–	–	+	–	–	–	–	–

In terms of the covered area *Brachypodium pinnatum*, *Stipa capillata* and *Phleum phleoides* predominated. The most interesting phytocenoses are those covered by large numbers of *S. capillata* (Phot. 3), which sometimes forms uniform light swards swaying in the wind. Patchas with *S. capillata* are most frequently found on very steep, strongly insolated slopes.

Corynephorus canescens and *Salvia pratensis* are permanent elements of the described xerothermic grasslands, which are found in almost every described plots. Species from the *Molinio-Arrhenatheretea* class are also frequent, although they do not cover large areas. Described phytocenoses were characterised by a relatively large herb layer cover, on average the cover amounting to over 85% relevé area. The lowest herb layer cover rate was observed in patches growing on very shallow and dry soils.

Communities from the *Molinio-Arrhenatheretea* class were formed primarily on more fertile habitats (Table 4). They are semi-natural pasture and meadow communities found on soils with various moisture levels. In the Moryńskie Hills they cover the greatest area and have a rich floristic composition (20 species). Characteristic species found in the study area include *Alopecurus pratensis*, *Avenula pubescens*, *Festuca pratensis*, *Holcus lanatus*, *Phleum pratense*, *Plantago lanceolata*, *Poa pratensis*, *Trifolium pratense* and *Vicia cracca*.

Table 4. Communities of the *Molinio-Arrhenatheretea* class

Successive number of relevé`	1	2	3	4
Field number of relevé	13	10	16	12
Date	31.05.2013	31.05.2013	01.06.2013	31.05.2013
Cover of herb layer c (%)	95	85	100	100
Area of relevé (m^2)	25	25	25	25
Number of species in relevé	19	17	23	18
ChCl. *Molinio-Arrhenatheretea*				
Avenula pubescens	4.4	1.1	3.3	4.4
Dactylis glomerata	2.2	1.1	5.5	3.3
Plantago lanceolata	2.1	2.1	1.1	1.1
Festuca pratensis	1.1	1.2	1.1	1.1
Phleum pratense	1.1	1.1	2.2	1.1
Trifolium repens	2.2	–	2.2	2.2
Leucanthemum vulgare	2.2	2.2	–	1.1
Deschampsia caespitosa	2.2	1.2	–	2.2
Trifolium pratense	1.2	–	1.1	1.1
Vicia cracca	1.2	1.2	1.1	–
Alopecurus pratensis	1.2	–	2.2	1.2
Briza media	1.1	3.3	–	–
Holcus lanatus	2.2	3.2	–	–
Plantago major	–	–	1.1	2.1
Ranunculus repens	–	–	1.1	1.1
Taraxacum officinale	1.1	–	1.1	–
Trifolium montanum	–	1.1	1.1	–
Valeriana officinalis	–	–	1.1	1.1
Achillea millefolium	–	–	2.2	–
Laserpitium prutenicum	–	–	+	–
ChCl. *Artemisietea vulgaris*				
Chaerophyllum temulum	–	–	–	2.2
Melilotus officinalis	–	1.1	–	–
Arctium tomentosum	–	–	+	–
Cirsium arvense	–	–	+	–
Medicago lupulina	+	–	–	–
ChCl. *Trifolio-Geranietea sanguinei*				
Galium verum	1.1	1.1	2.2	+
ChCl. *Agropyretea intermedio-repentis*				
Equisetum arvense	–	–	1.2	–
ChCl. *Epilobietea angustifolii*				
Fragaria vesca	2.2	2.2	–	–
ChCl. *Festuco-Brometea*				
Brachypodium pinnatum	–	1.1	1.1	–
ChCl. *Koelerio glaucae-Corynephoretea canescentis*				
Rumex acetosella	+	–	–	+
ChCl. *Stellarietea mediae*				
Aethusa cynapium	–	–	–	1.2
Others				
Lolium multiflorum	1.1	1.1	1.1	1.1
Salvia pratensis	–	1.1	–	–
Silene chlorantha	–	–	+	–

Phot. 4. Meadow from the *Molinio-Arrhenatheretea* class in the foreground, morain hills seen in the background (phot. M. Kagan)

Communities from the *Molinio-Arrhenatheretea* class are most typically semi-natural and anthropogenic communities. They frequently serve the productive functions, providing high quality value of the feed (Phot. 4). In the discussed area all such meadows are utilised. Plots documented in relevés 10, 12 and 13 are cut at least once a year. Relevé no. 16 was established in a location where horses were grazing until 2012. Fresh meadows also play an important natural role in the landscape.

On average in that relevé 19 species were recorded (from 18 to 23). The herbaceous layer was dominated by *Avenula pubescens* and *Dactylis glomerata*. Plants representing other classes were found rarely, e.g. *Artemisietea vulgaris*, *Trifolio-Geranietea sanguinei*, *Agropyretea intermedio-repentis*, *Epilobietea angustifolii*, *Festuco-Brometea*, *Koelerio glaucae-Corynephoretea canescentis* and *Stellarietea mediae*. Totally 34 species of vascular plants were reported in all the relevés established in patches of communities from the *Molinio-Arrhenatheretea* class. The herb layer cover is considerable and on average amounts to 95%.

In the Moryńskie Hills we may presently observe threats for the habitats found there. A dangerous phenomenon for the xerothermic grassland is connected with a lack of extensive land use and the vicinity of arable fields. In this case biogen runoff from field poses a threat, leading to eutrophication of these habitats. Until recently extesive grazing was conducted on grassland, which had a positive impact on this habitat. Grazing on the vegetation and trampling caused microerosion, preveting encroachment of woody species. Grazing was abandoned recently and in this way surface erosion ceased. This leads to an increased accumulation of organic matter, herb vegetation cover increases in the patches, which results in changes in microclimatic conditions within xerothermic grassland. Another important threat is connected with fragmentation and isolation of plots of swards. The Moryńskie Hills are surrounded by arable fields. Such an isolation seriously hinders the spread of xerothermic species. The nearest phytocenoses of xerothermic swards are found only on slopes surrounding the Odra river valley at a distance of around a dozen km to the west. Frequently in the grasslands an intensive process of encroachment by taxa alien for this habitat may be observed. They are usually species of shrub communities: *Prunus spinosa* and *Crataegus laevigata* (Phot. 5). *Rubus caesius* is a very common species, with young *Pinus sylvestris*, or *Pyrus communis* and *Robinia pseudacacia* being found less frequently. In meadows and pastures from the *Molinio-Arrhenatheretea* class a considerable impact of the lowering of groundwater table may be observed (Natura 2000). This problem has been evident for some time now. As a result of changes in water relations we may frequently observe the vegetation preferring more moist and more fertile habitats being elimitaed from this area, while a neg-

Phot. 5. Overgrown xerothermic grassland, *Crataegus laevigata* shrubs seen in the background (phot. M. Kagan)

ative effect is also observed on in-field, thawed-out glacial small water bodies. Many such small water bodies simly diappeared from the landscape, which was followed by the depletion of valuable refuges of fauna and flora.

Blackthorn thickets, while being dangerous for xerothermic swards, may be susceptible to various threats. Communities from the *Rhamno-Prunetea* class are subjected to secondary succession. A considerable share of trees in the thickets (*Quercus petraea* and *Ulmus laevis*) may lead to changes in light conditions, as trees by limiting access to light have a signiifcant influence on shrub vegetation (Matuszkiewicz et al. 2012) and transform it into forest commnities. In the Moryńskie Hills *Robinia pseudacacia* is frequently found in thickets. Ripariam forests with *Viola odorata* growing on slopes are at risk of penetration by alien species. In the Moryńskie Hills *Robinia pseudacacia* is the species encroaching most frequently into riparian forest, with the largest patches with black locust found in the cental and northern parts of the study area. This species highly frequently grows on forest edges and in more strongly isolated sites. Frequently we may also observed the phenomenon of pine encroachment (pinetysation). In many places in the riparian habitats the upper tree layer is composed of *Pinus sylvestris* alone, which was especially evident in the southern part of the study area (relevés 19 and 21). Another very important factor affecting riparian forests is connected with the previously mentioned loweirng of the groundwater table. The deteriorating water relations do not promote fertile riparian forest sites and cause their degeneration.

INDICATIONS FOR MANAGEMENT

The best method to preserve xerothermic swards is to return to extensive grazing management. Grazing is the simplest and cheapest method to maintain and protect grassland. The intensity of grazing determines what type of termophilous grassland will be formed, as on very dry habitats at low intensity of management phytocenoses of *Stipa* sp. are formed. Swards should be cut only once a year, since the later regrowth of green material is strongly limited by the unfavourable water conditions (they are low-producing meadows). Hay from xerothermic grassland is very rarely used due to the problems with its harvest (it is found typically on steep slopes) and the very small amount of produced forage. However, such hay has specific feeding value thanks to the considrable amounts of herbs (Wysocki & Sikorski 2009).

In the case when woody species appear in grassland, grazing alone is not sufficient. In such a situation all woody plants need to be cut down so that they may not produce sprouts in the same vegetation season. Only after such a procedure extensive graz-

ing may be introduced, which will considerably limit growth and spread of the shrub vegetation.

In order to improve the natural value of riparian carr forests with sweet violet *Viola odorata* growing on slopes, alien species have to be eliminated gradually, mainly *Robinia pseudacacia* found in large numbers in the study area. It is highly advisable to transform pine stands found in the riparian forest site. It may be difficult to prevent the lowering of groundwater levels, which has a considerable effect on the occurrence of the specific natural habitats.

CONCLUDING REMARKS

The Moryńskie Hills are characterised by the occurrence of various conditions, both geomorphological and habitat. Thanks to such a diversity, this area is a mosaic of plant communities. In places extremely arid grasslands and fertile riparian forests grow in the nearest vicinity. On steep slopes we find most frequently xerothermic swards and riparian forests with *Viola odorata*. Swamp vegetation grows in numerous post-glacial depressions, while in levelled areas there are meadows and pastures mainly from the *Molinio-Arrhenatheretea* class.

In the study area there are two types of potential natural vegetation (Matuszkiewicz 2008 a): fertile lowland beech forest *Galio odorati-Fagetum* and steppe xerothermic grassland *Festucetalia valesiacae*.

Actual vegetation is first of all the result of human activity. Mainly forested areas were changed and tranformed into farmland.

In the study area a total of 186 taxa of vascular plants were found. Species recorded in that area belong to 47 families, of which the family *Poaceae* is the most numerous with 29 species. Flora of the Hills to a considerable degree is natural in character. Non-synathropic spontaneophytes and apophytes constitute 92% flora. The most numerous group of life forms comprises hemicryptophytes (61%), with numerous representatives of therophytes (12.9%) and geophytes (10.2%), while the other groups account for 15% flora in the study area.

A large group of species found in the Hills comprises taxa covered by various forms of law protection. As many as four species are covered by strict protection (*Anthericum liliago, Campanula sibirica, Centaurium erythraea* and *Stipa capillata*), with three species from this group requiring active protection. The partial protection status has been awarded to four species (*Helichrysum arenarium, Primula veris, Viburnum opulus* and *Galium odoratum*). *Anthericum liliago,* is the only species from that area registered in the Polish red book (species threatened with extinction). From among rare and threatened species in the Western Pomerania (Żukowski & Jackowiak 1995) eight taxa were recorded, i.e. six endagered species, as well as one species with deficient data and unspecific risk, and one rare species. Among all the plants specified in Attachment 2 to Directive no. 92/43/EEC (Dyrektywa... 1992) in the study area five taxa and 11 species classfied as species of ancient woodlands. Plant communities of the Moryńskie Hills belong to nine syntaxonomic classes. The most abundant, i.e. comprising 46 species, was *Molinio-Arrhenatheretea* class, followed by *Artemisietea vulgaris* (28 species), with classes *Festuco-Brometea* and *Querco-Fagetea* comprising 17 taxa each. A relatively numerous gruop was composed of other species, beloging to none of the classes, i.e. the so-called accompanying species.

Most plant communities in the study area are non-forest in character. A large area is covered by xerothermic grassland from the *Festuco-Brometea* class, with a slightly smaller area being covered by meadows and pastures from the *Molinio-Arrhenatheretea* class, as well as shrub communities from the *Rhamno-Prunetea* class. Forest vegetation is represented by riparian forests (*Querco-Fagetea* class) covering mainly the southern part of the Hills, while in the central part of the study area found only in the immediate vicinity of Lake Górka. The northern part is overgrown mainly by shrubs (*Rhamno-Prunetea* class) and xerothermic grassland (*Festuco-Brometea* class). Meadows and pastures (*Molinio-Arrhenatheretea* class) grow mostly on the central part of the Hills and are found mainly on flat land.

The greatest threat to xerothermic swards in the discussed area is connected with the decision to cease extensive grazing. This leads as a consequence to overgowing of such plots, which results in a slow change in the habitat conditions. Such grasslands are encroached by vegetation from more fertile communities, and organic matter deposition is enhanced. Frequently the first shrub plants, mainly *Prunus spinosa* and *Crataegus laevigata*, appear in such locations.

A relatively large number of riparian forest phytocenoses underwent various forms of degeneration: pine ecroachment and encroachment by neophytes, due to the encroachment of aline woody species, mainly *Robinia pseudacacia*. Another difficult to eliminate, negative phenomenon is connected with the lowering of groundwater levels.

The most important protection measure which may prove applicable in the Moryńskie Hills is to re-introduce extensive grazing. Such an action would lead to the preservation of existing xerothermic grasslands and reduction of the spread of shrub communities.

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ANNEX

Vascular plants of the Moryńskie Hills occuring in the transects and plots of phytosociological relevés and family, life forms of Raunkiaer (GRRA), geographic-historical group of species (GRHG) and phytosociological class (ChCl)

No.	Species	Family	GRRA	GRHG	ChCl
1	*Acer campestre*	*Aceraceae*	M	Ap	R-P
2	*Acer pseudoplatanus*	*Aceraceae*	M	Ap	Q-F
3	*Achillea millefolium*	*Asteraceae*	H	Ap	M-A
4	*Acinos arvensis*	*Lamiaceae*	TH	Ap	F-B
5	*Aegopodium podagraria*	*Apiaceae*	H	Ap	AV
6	*Aethusa cynapium*	*Apiaceae*	T	Ap/Ar	SM
7	*Agrimonia eupatoria*	*Rosaceae*	H	Ap	T-G
8	*Ajuga genevensis*	*Lamiaceae*	H	Sn	F-B
9	*Ajuga reptans*	*Lamiaceae*	H	Sn	V-P
10	*Alliaria petiolata*	*Brassicaceae*	H	Ap	AV
11	*Allium vineale*	*Liliaceae*	G	Ap	–
12	*Alnus glutinosa*	*Betulaceae*	M	Ap	Q-F
13	*Alopecurus pratensis*	*Poaceae*	H	Ap	M-A
14	*Anchusa officinalis*	*Boraginaceae*	H	Ap	AV
15	*Anthericum liliago*	*Liliaceae*	G	Sn	F-B
16	*Anthoxanthum odoratum*	*Poaceae*	H	Ap	K-C
17	*Anthyllis vulneraria*	*Fabaceae*	H	Ap	F-B
18	*Arctium tomentosum*	*Asteraceae*	H	Ap	AV
19	*Armeria elongata*	*Plumbaginaceae*	H	Ap	K-C
20	*Arrhenatherum elatius*	*Poaceae*	H	Ap	M-A
21	*Artemisia campestris*	*Asteraceae*	Ch	Ap	F-B
22	*Asparagus officinalis*	*Liliaceae*	G	Ap	F-B
23	*Astragalus glycyphyllos*	*Fabaceae*	H	Ap	T-G
24	*Avenula pubescens*	*Poaceae*	H	Ap	M-A
25	*Berberis vulgaris*	*Berberidaceae*	N	Sn	R-P
26	*Berteroa incana*	*Brassicaceae*	HT	Ap	AV
27	*Betonica officinalis*	*Lamiaceae*	H	Sn	M-A
28	*Betula pendula*	*Betulaceae*	M	Ap	EA
29	*Bidens tripartita*	*Asteraceae*	T	Ap	BT
30	*Brachypodium pinnatum*	*Poaceae*	H	Sn	F-B
31	*Brachypodium sylvaticum*	*Poaceae*	H	Sn	Q-F
32	*Briza media*	*Poaceae*	H	Sn	M-A
33	*Calamagrostis arundinacea*	*Poaceae*	H	Sn	B-A
34	*Calamagrostis epigejos*	*Poaceae*	G	Ap	EA
35	*Campanula glomerata*	*Campanulaceae*	H	Ap	F-B
36	*Campanula persicifolia*	*Campanulaceae*	H	Sn	Q-F
37	*Campanula rapunculoides*	*Campanulaceae*	H	Ap	T-G
38	*Campanula sibirica*	*Campanulaceae*	H	Sn	F-B
39	*Campanula trachelium*	*Campanulaceae*	H	Sn	Q-F
40	*Carex acutiformis*	*Cyperaceae*	GHy	Sn	P

No.	Species	Family	GRRA	GRHG	ChCl
41	*Carex fusca*	*Cyperaceae*	G	Sn	P
42	*Carex gracilis*	*Cyperaceae*	GHy	Sn	P
43	*Carex leporina*	*Cyperaceae*	H	Ap	–
44	*Carlina vulgaris*	*Asteraceae*	HT	Ap	F-B
45	*Carpinus betulus*	*Corylaceae*	M	Ap	Q-F
46	*Centaurea jacea*	*Asteraceae*	H	Ap	M-A
47	*Centaurea scabiosa*	*Asteraceae*	H	Ap	F-B
48	*Centaurea stoebe*	*Asteraceae*	H	Ap	-
49	*Centaurium erythraea*	*Gentianaceae*	T	Ap	EA
50	*Chaerophyllum temulum*	*Apiaceae*	TH	Ap	AV
51	*Chrysanthemum segetum*	*Asteraceae*	T	Ar	SM
52	*Cirsium arvense*	*Asteraceae*	G	Ap	AV
53	*Cirsium oleraceum*	*Asteraceae*	H	Ap	M-A
54	*Consolida regalis*	*Ranunculaceae*	T	Ar	SM
55	*Conyza canadensis*	*Asteraceae*	TH	Kn	SM
56	*Coronilla varia*	*Fabaceae*	H	Ap	T-G
57	*Corynephorus canescens*	*Poaceae*	H	Ap	K-C
58	*Crataegus laevigata*	*Rosaceae*	NM	Ap	R-P
59	*Cucubalus baccifer*	*Caryophyllaceae*	H	Sn	AV
60	*Cynoglossum officinale*	*Boraginaceae*	H	Ap	AV
61	*Cynosurus cristatus*	*Poaceae*	H	Sn	M-A
68	*Dactylis glomerata*	*Poaceae*	H	Ap	M-A
63	*Deschampsia caespitosa*	*Poaceae*	H	Ap	M-A
64	*Deschampsia flexuosa*	*Poaceae*	H	Sn	M-A
65	*Dianthus carthusianorum*	*Caryophyllaceae*	C	Ap	M-A
66	*Dryopteris filix-mas*	*Aspidiaceae*	H	Ap	Q-F
67	*Echium vulgare*	*Boraginaceae*	H	Ap	AV
68	*Elymus repens*	*Poaceae*	G	Ap	M-A
69	*Epilobium hirsutum*	*Onagraceae*	H	Ap	AV
70	*Equisetum arvense*	*Equisetaceae*	G	Ap	AI-R
71	*Erigeron annuus*	*Asteraceae*	TH	Kn	–
72	*Euphorbia dulcis*	*Euphorbiaceae*	GH	Kn	Q-F
73	*Euphorbia esula*	*Euphorbiaceae*	H	Ap	–
74	*Falcaria vulgaris*	*Apiaceae*	H	Ap	AI-R
75	*Festuca arundinacea*	*Poaceae*	H	Ap	M-A
76	*Festuca duriuscula*	*Poaceae*	H	Ap	–
77	*Festuca pratensis*	*Poaceae*	H	Ap	M-A
78	*Festuca rubra*	*Poaceae*	H	Ap	M-A
79	*Filipendula ulmaria*	*Rosaceae*	H	Ap	M-A
80	*Filipendula vulgaris*	*Rosaceae*	H	Ap	F-B
81	*Fragaria vesca*	*Rosaceae*	H	Ap	EA
82	*Fraxinus excelsior*	*Oleaceae*	M	Ap	Q-F
83	*Galium aparine*	*Rubiaceae*	T	Ap	AV

No.	Species	Family	GRRA	GRHG	ChCl
84	*Galium odoratum*	*Rubiaceae*	H	Sn	Q-F
85	*Galium mollugo*	*Rubiaceae*	H	Ap	M-A
86	*Galium sylvaticum*	*Rubiaceae*	G	Sn	Q-F
87	*Galium verum*	*Rubiaceae*	H	Ap	T-G
88	*Geranium pratense*	*Geraniaceae*	H	Ap	M-A
89	*Geranium robertianum*	*Geraniaceae*	TH	Ap	AV
90	*Geum rivale*	*Rosaceae*	H	Ap	M-A
91	*Geum urbanum*	*Rosaceae*	H	Ap	AV
92	*Glechoma hederacea*	*Lamiaceae*	GH	Ap	AV
93	*Glyceria plicata*	*Poaceae*	Hy	Ap	P
94	*Helichrysum arenarium*	*Asteraceae*	H	Ap	K-C
95	*Holcus lanatus*	*Poaceae*	H	Ap	M-A
96	*Hypericum perforatum*	*Hypericaceae*	H	Ap	AV
97	*Impatiens noli-tangere*	*Balsaminaceae*	T	Sn	Q-F
98	*Iris pseudacorus*	*Iridaceae*	HG	Sn	P
99	*Juncus articulatus*	*Juncaceae*	H	Ap	S-CN
100	*Knautia arvensis*	*Dipsacaceae*	H	Ap	M-A
101	*Koeleria glauca*	*Poaceae*	H	Sn	K-C
102	*Lamium maculatum*	*Lamiaceae*	H	Sn	AV
103	*Lapsana communis*	*Asteraceae*	HT	Ap	SM
104	*Laserpitium prutenicum*	*Apiaceae*	H	Sn	M-A
105	*Leontodon hispidus*	*Asteraceae*	H	Ap	B-A
106	*Leucanthemum vulgare*	*Asteraceae*	H	Ap	M-A
107	*Linaria vulgaris*	*Scrophulariaceae*	G	Ap	AV
108	*Linum catharticum*	*Linaceae*	T	Sn	M-A
109	*Lolium multiflorum*	*Poaceae*	HT	Kn	–
110	*Lotus corniculatus*	*Fabaceae*	H	Ap	M-A
111	*Lychnis flos-cuculi*	*Caryophyllaceae*	H	Sn	M-A
112	*Lysimachia vulgaris*	*Primulaceae*	H	Ap	M-A
113	*Medicago lupulina*	*Fabaceae*	TH	Ap	AV
114	*Medicago sativa*	*Fabaceae*	H	Ee	AV
115	*Melampyrum arvense*	*Scrophulariaceae*	Tpp	Sn	F-B
116	*Melilotus albus*	*Fabaceae*	T	Ap	AV
117	*Melilotus officinalis*	*Fabaceae*	T	Ap	AV
118	*Moehringia trinervia*	*Caryophyllaceae*	TH	Ap	AV
119	*Myosotis arvensis*	*Boraginaceae*	TH	Ar	SM
120	*Odontites verna*	*Scrophulariaceae*	Tpp	Ar	SM
121	*Ononis spinosa*	*Fabaceae*	HN	Ap	–
122	*Origanum vulgare*	*Lamiaceae*	HC	Ap	T-G
123	*Orobanche ramosa*	*Orobanchaceae*	G	Kn	SM
124	*Petrorhagia prolifera*	*Caryophyllaceae*	T	Ap	–
125	*Peucedanum palustre*	*Apiaceae*	H	Sn	P
126	*Phleum phleoides*	*Poaceae*	H	Sn	F-B

No.	Species	Family	GRRA	GRHG	ChCl
127	*Phleum pratense*	*Poaceae*	H	Ap	M-A
128	*Phragmites australis*	*Poaceae*	GHy	Ap	P
129	*Pinus sylvestris*	*Pinaceae*	M	Ap	V-P
130	*Plantago lanceolata*	*Plantaginaceae*	H	Ap	M-A
131	*Plantago major*	*Plantaginaceae*	H	Ap	M-A
132	*Poa nemoralis*	*Poaceae*	H	Ap	Q-F
133	*Poa pratensis*	*Poaceae*	H	Ap	M-A
134	*Polygala vulgaris*	*Polygalaceae*	H	Sn	N-C
135	*Potentilla argentea*	*Rosaceae*	H	Ap	AV
136	*Potentilla recta*	*Rosaceae*	H	Ap	–
137	*Primula veris*	*Primulaceae*	H	Ap	Q-F
138	*Prunella vulgaris*	*Lamiaceae*	H	Ap	M-A
139	*Prunus spinosa*	*Rosaceae*	N	Ap	R-P
140	*Pyrus communis*	*Rosaceae*	M	Ap	–
141	*Quercus petraea*	*Fagaceae*	M	Sn	Q-F
142	*Ranunculus acris*	*Ranunculaceae*	H	Ap	M-A
143	*Ranunculus repens*	*Ranunculaceae*	H	Ap	M-A
144	*Rhamnus cathartica*	*Rhamnaceae*	N	Ap	R-P
145	*Robinia pseudacacia*	*Fabaceae*	M	Kn	–
146	*Rosa canina*	*Rosaceae*	N	Ap	R-P
147	*Rubus caesius*	*Rosaceae*	N	Ap	AV
148	*Rumex acetosella*	*Polygonaceae*	GH	Ap	K-C
149	*Salix alba*	*Salicaceae*	M	Ap	SP
150	*Salix aurita*	*Salicaceae*	N	Ap	AG
151	*Salvia pratensis*	*Lamiaceae*	H	Ap	–
152	*Sambucus nigra*	*Caprifoliaceae*	N	Ap	EA
153	*Sedum acre*	*Crassulaceae*	C	Ap	K-C
154	*Sedum maximum*	*Crassulaceae*	HG	Ap	–
155	*Silene chlorantha*	*Caryophyllaceae*	H	Sn	–
156	*Silene otites*	*Caryophyllaceae*	H	Ap	AT
157	*Silene vulgaris*	*Caryophyllaceae*	HC	Ap	SM
158	*Solidago canadensis*	*Asteraceae*	HG	Kn	AV
159	*Sorbus aucuparia*	*Rosaceae*	NM	Ap	T-G
160	*Stachys palustris*	*Lamiaceae*	G	Ap	M-A
161	*Stachys recta*	*Lamiaceae*	H	Sn	F-B
162	*Stellaria media*	*Caryophyllaceae*	T	Ap	SM
163	*Stellaria nemorum*	*Caryophyllaceae*	H	Sn	Q-F
164	*Stipa capillata*	*Poaceae*	H	Sn	F-B
165	*Symphytum officinale*	*Boraginaceae*	HG	Ap	M-A
166	*Taraxacum officinale*	*Asteraceae*	H	Ap	M-A
167	*Thalictrum minus*	*Ranunculaceae*	H	Sn	T-G
168	*Thalictrum simplex*	*Ranunculaceae*	H	Sn	F-B
169	*Thymus pulegioides*	*Lamiaceae*	C	Ap	AT

No.	Species	Family	GRRA	GRHG	ChCl
170	*Tragopogon pratensis*	*Asteraceae*	H	Ap	M-A
171	*Trifolium arvense*	*Fabaceae*	T	Ap	K-C
172	*Trifolium medium*	*Fabaceae*	H	Ap	T-G
173	*Trifolium montanum*	*Fabaceae*	H	Sn	M-A
174	*Trifolium pratense*	*Fabaceae*	H	Ap	M-A
175	*Trifolium repens*	*Fabaceae*	CH	Ap	M-A
176	*Tussilago farfara*	*Asteraceae*	G	Ap	AI-R
177	*Ulmus laevis*	*Ulmaceae*	M	Ap	Q-F
178	*Urtica dioica*	*Urticaceae*	H	Ap	AV
179	*Valeriana officinalis*	*Valerianaceae*	H	Ap	M-A
180	*Veronica chamaedrys*	*Scrophulariaceae*	C	Ap	–
181	*Veronica longifolia*	*Scrophulariaceae*	H	Sn	M-A
182	*Viburnum opulus*	*Caprifoliaceae*	N	Ap	R-P
183	*Vicia cracca*	*Fabaceae*	H	Ap	M-A
184	*Vicia tenuifolia*	*Fabaceae*	HG	Sn	T-G
185	*Viola arvensis*	*Violaceae*	T	Ar	SM
186	*Viola odorata*	*Violaceae*	H	Ap	Q-F

GRRA – life forms of Raunkiaer; GRHG – geographic-historical group of species; ChCl – characteristic species of the class: AG – *Alnetea glutinosae,* AI-R – *Agropyretea intermedio-repentis,* AT – *Asteretea tripolium,* AV – *Artemisietea vulgaris,* B-A – *Betulo-Adenostyletea,* BT – *Bidentetea tripartiti,* EA – *Epilobietea angustifolii,* F-B – *Festuco-Brometea,* K-C – *Koelerio glaucae-Corynephoretea canescentis,* M-A – *Molinio-Arrhenatheretea,* N-C – *Nardo-Callunetea,* P – *Phragmitetea,* Q-F – *Querco-Fagetea,* R-P – *Rhamno-Prunetea,* S-CN – *Scheuchzerio-Caricetea nigrae,* SM – *Stellarietea mediae,* SP – *Salicetea purpureae,* T-G – *Trifolio-Geranietea sanguinei,* V-P – *Vaccinio-Piceetea, "–"* – accompaning species.