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Vegetation Changes and Rare Plant Species in Grasslands in the Middle Wieprz Valley (PLH060005)

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1. Introduction

Middle Wieprz Valley comprises a mosaic of land and water habitats. The steep slopes of this valley are covered by remnants of xerothermic grasslands and shrubs while the lower terraces – mainly by meadows (Janiec & Rederowa 1992). Such a pattern of natural environment conditions favours the occurrence of varied plant associations (Stamirowska-Krzaczek 2008, Warda et al. 2013). However, similarly to other meadow sites in the Lublin Region (Baryła & Urban 1999, Kulik et al. 2016, Mosek & Miazga 2006), changes in the way of utilization or abandonment of use, and changes in the humidity of habitats, result in changes in the properties of the habitat and species composition of the plant communities (Czyż et al. 2013, Grzegorczyk et al. 1999, Kulik et al. 2017) occurring there as well as in the progressing succession (Kotańska et al. 2016, Stypiński & Grobelna 2000). These changes lead to decreasing floristic diversity of meadow communities (Klarzyńska & Kryszak 2015, Kryszak et al. 2010, Warda et al. 2013), reduced numbers or disappearance of characteristic species of typical plant communities (Myśliwy & Bosiacka 2009, Ratyńska 1997) as well as increased presence of species that previously occurred sporadically but are now appearing in greater numbers in transitional communities (Ratyńska et al. 2007, Stamirowska-Krzaczek 2015). The number of dicotyledon species is also

increasing, and grassy communities with a lower value score are spreading (Korzeniak 2012, Kozłowska & Burs 2013).

The basic objective of this study was to investigate the condition of the grassland vegetation, including the presence of rare and endangered plant species in the Middle Wieprz Valley (PLH060005**)**. The investigation concerned the vegetation of rush meadows (*Mag/Phrag*), wet meadows (*Mol*) and fresh meadows (*Arr*), and the presence of characteristic and rare species in the communities under study, in the years 2005 and 2017.

2. Material and methods

2.1. The study area

The Wieprz Middle Valley is situated in the Nadwieprzański Landscape Park (Lublin Region). The Wieprz River is a right-hand tributary of the Vistula, and in its middle reaches is a natural, highly meandering river. Its valley has the character of a floodplain (Janiec & Rederowa 1992). In order to protect the natural values of the meadows and slopes of the Wieprz valley within the Park, a Natura 2000 area (PLH060005) was established in 2008. The meadow complex covers approximately 25% of the park area (Stamirowska-Krzaczek 2008).

2.2. Field study

The previous phytosociological studies were conducted in the years 2005–2007 (Stamirowska-Krzaczek 2008), using the Braun-Blanquet method (1964), while the previously investigated rush communities as well as wet meadow and fresh meadows communities are currently monitored (2017). Phytosociological relevés were made of an area of 25 m^2, representative of meadow phytocoenoses (Dzwonko 2007). In this study, 30 phytosociological relevés (*Molinio-Arrhenatheretea* class) were analysed. The adopted nomenclature of species was according to Mirek et al. (2002) while the taxonomy and nomenclature of communities according to Matuszkiewicz (2008).

2.3. Data analysis

The results of the phytosociological studies carried out in 2017 indicate trends in the species composition dynamics of investigated plant communities and let us locate all rare species occurring within a specified

habitat type in the Middle Wieprz Valley area. Rare plants are represented by species with low number of individuals or in very restricted areas (Lancaster 2000). Some plants are naturally rare while others have become rare or endangered through a loss or change in habitat affected by human practises. Thus, human actions towards biodiversity protection are needed to ensure continued existence of threatened plants.

Principal Component Analysis (PCA) (Jolliffe 2002) was used to examine the changes in the percentage share of various characteristic species in three different types of associations in 2005 and in 2017. This enabled the reduction of the number of explanatory variables in the dataset and identification of the characteristic plant species that best portray the changes in the composition of the particular phytosociological units/syntaxa. This method also enabled the identification of the correlations in the co-occurrence of the specific plant groups. Due to the comparable scale of the variables examined, the principal components were determined using the covariance matrix that provides a better image of the proportion of the specific characteristic species in the composition of communities. A MANOVA test was carried out for the determined principal components in order to verify the significance of the differences between the analysed types of plant communities during the period under study. Six categories of observation, i.e. a combination of community type and study year, were examined. Homogeneous groups were determined based on the Tukey's test for multiple comparisons. The significance level used in the test was $\alpha = 0.05$. Statistical analyses were carried out using StatSoft Statistica (version 13).

3. Results and discussion

Phytosociological investigations conducted in the years 2005-2007 revealed diversity of habitats and plant communities in grassland in the Middle Wieprz Valley area. There were distinguished various communities – from *Phragmitetea* class wetland communities to dry and poor habitat communities of the *Koelerio glauca-Corynopheretea canescentis* class, however features of transitional communities were characteristic for some of investigated meadow swards in the study area (Stamirowska-Krzaczek 2015). The results of the currently (2017) conducted phytosociological survey concern condition of the vegetation of rush meadows

(*Mag/Phrag – Magnocaricion/Phragmition*) and some communities of the *Molinio-Arrhenatheretea* class, and the presence of rare and endangered species in the communities under study (Fig. 1).

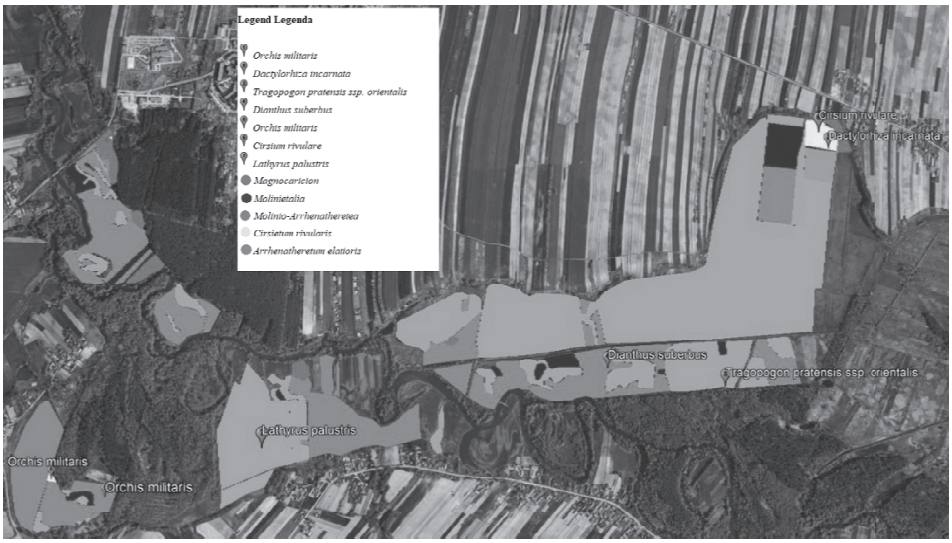


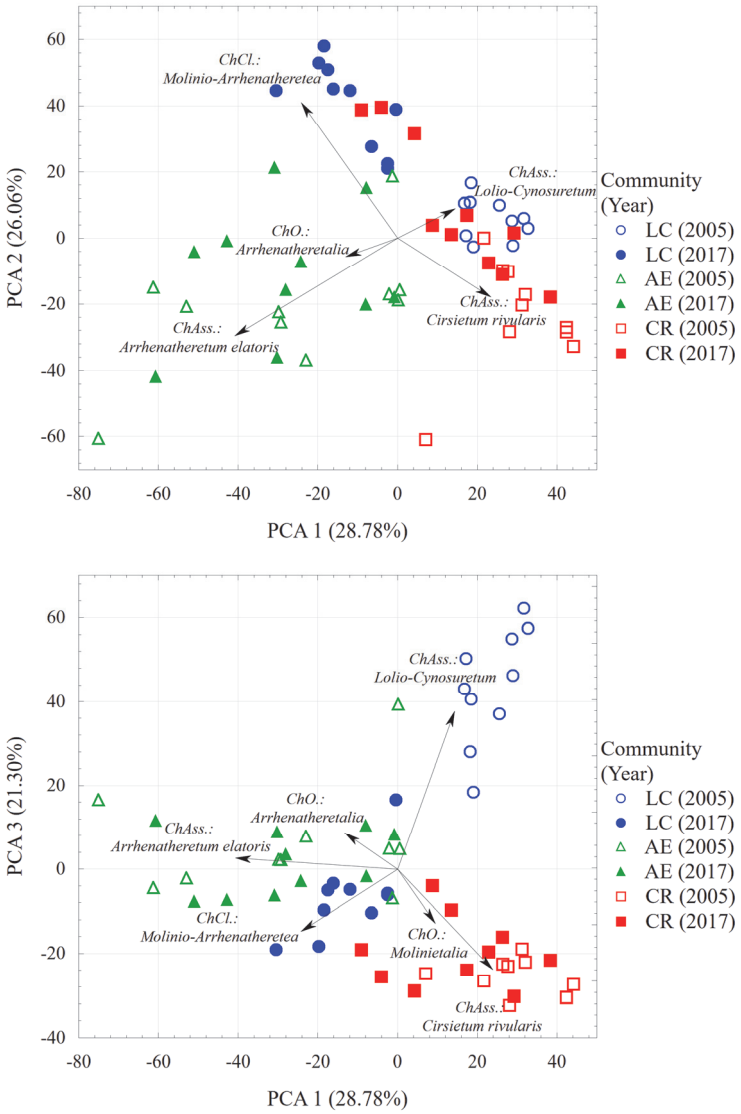
Fig. 1. Distribution of plant communities and rare and endangered species in the grasslands in the Middle Wieprz Valley
Rys. 1. Rozmieszczenie zbiorowisk roślinnych oraz rzadkich i zagrożonych gatunków roślin na użytkach zielonych w Dolinie Środkowego Wieprza

The extensive utilization of meadows or the lack of it pose a serious threat in the Middle Wieprz Valley. The smallest changes in the floristic composition of the sward occur in the rush and wet meadow communities although fluctuations of the number of some plant species can be observed there (unpublished results of own research). The more important changes in the species composition of meadow sward were particularly confirmed in the following associations of the *Molinio-Arrhenatheretea* class: *Lolio-Cynosuretum* R.Tx. 1937, *Cirsietum rivularis* NOWIŃSKI 1927 and *Arrhenatheretum elatioris* BR.-BL. ex SCHERR. 1925.

The Principal Component Analysis enabled the reduction of the plant groups considered in the study. The first three principal components (PCA1, PCA2, PCA3) obtained account for a total of 76.13% (28.78%, 26.06% and 21.30% respectively) of the total variance of the dataset.

The significance of characteristic plant species of the particular syntaxa in the determination of the principal components and their co-occurrence are shown in Fig. 2. The lines with an identical orientation denote a correlated share in the species composition of the syntaxa under study. After determining the principal components identifying the variability of objects to the greatest extent, the species composition for the particular sites was projected to the planes determined by the first three principal components. The sites are shown according to the type of community and study year. The graph shows a clear division of the groups according to type community. Characteristic species of the *Molinio-Arrhenatheretea* class and the *Lolio-Cynosuretum* association are dominant in the *Lolio-Cynosuretum* community, species of the *Arrhenatheretum elatoris* association, the *Arrhenatheretalia* order and the *Molinio-Arrhenatheretea* class are dominant in the *Arrhenatheretum elatoris* community, whereas species characteristic of the *Molinietalia* order and the *Cirsietum rivularis* association are dominant in the *Cirsietum rivularis* community.

Analysing the differences in the species composition of the sward that occurred in the studied communities between 2005 and 2017, it can be concluded that the biggest changes concern the *Lolio-Cynosuretum* association. Decreasing number, stability and cover abundance of characteristic species for association and increasing content of species characteristic for higher phytosociological units give an evidence of plant communities degeneration. A considerably greater presence of species characteristic of the *Molinio-Arrhenatheretea* class was found in the sward of this association in 2017 in comparison with the state of the vegetation cover in 2005. The lack of utilization of the sward for pasturage has probably contributed to the considerably decreased numbers of the characteristic species (Kryszak et al. 2007) and presence of *Cynosurus cristatus*. In the study area, this species can be regarded as very rare, even vulnerable, if the community for this association is not placed under active protection.



LC – *Lolio-Cynosuretum*, AE – *Arrhenatheretum elatioris*, CR – *Cirsietum rivularis*

Fig. 2. PCA ordination diagram of 60 relevés taken in the same study sites in the vegetation seasons of 2005 and 2017

Rys. 2. Diagram ordynacyjny PCA dla 60 zdjęć fitosocjologicznych wykonanych w tych samych miejscach w sezonie wegetacyjnym 2005 i 2017

A similar trend, but with less distinct changes, can be observed in the *Cirsietum rivularis* association where an increasing proportion of species characteristic for the *Molinio-Arrhenatheretea* class was confirmed. In the Middle Wieprz Valley, similar stability but less cover abundance of *Cirsium rivulare* (Jacq.). All. specimens (Table 1) were found at sites of its previous occurrence even though a clear decline in the number of sites of this species can be observed in Poland (Warda et al. 2014).

In the period under study, no significant changes in the vegetation cover of the *Arrhenatheretum elatoris* association were found, as evidenced by the distribution of points corresponding to the particular sites of this community, covering similar areas in both years compared. However, sward condition of this plant community was not good in the previous study period. According to the study results of Stamirowska-Krzaczek (2015), changes in the species composition of this association as a consequence of abandoned utilization usually lead to the disappearance or reduced presence of typical characteristic species and the development of *Poa pratensis-Festuca rubra* Fijałk. 1962 pro ass. and *Holcus lanatus* associations (Kulik et al. 2016, Myśliwy & Bosiacka 2009, Urban & Grzywna 2003). *Tragopogon pratensis* L. *ssp. orientalis* (L.) Čelak is a species that is very rarely found among characteristic species of typical *Arrhenatheretum* meadows.

In order to confirm significant statistical differences between the communities and years under study, a single-factor multidimensional analysis of variance (MANOVA) was carried out for the obtained principal components; the results of this analysis are shown in Table 1.

The *Lolio-Cynosuretum* R.Tx. 1937 is another association where negative changes in the species composition have been observed. MANOVA analysis confirmed significant changes in the floristic composition of the sward of the *Lolio-Cynosuretum* association in the years 2005–2017. In the case of this association, all principal components for the particular years were assigned to other homogeneous groups according to Tukey's test. In the *Cirsietum rivularis* association, there are groups from different years which were assigned to the same homogeneous groups because of the first and third principal component, and the differences occurred in the second principal component.

Table 1. Mean values of principal components for the groups under study (determinations of communities, same as in PCA)
Tabela 1. Średnie wartości składowych głównych dla rozpatrywanych grup (oznaczenia zbiorowisk jak w PCA)

Group	PCA1 mean	PCA2 mean	PCA3mean
LC (2005)	23.7^{B}	5.9^{B}	43.9^{C}
LC (2017)	-12.6^{A}	40.7^{C}	-6.5^{A}
AE (2005)	-27.4^{A}	-21.3^{A}	6.5^{A}
AE (2017)	-28.5^{A}	-10.6^{AB}	1.8^{A}
CR (2005)	30.2^{B}	-23.4^{A}	-25.8^{B}
CR (2017)	14.7^{B}	8.8^{B}	-19.8^{B}
F(df = 5)	25.05	20.29	61.15
p-value	<0.001	<0.001	<0.001

^{A,B,C} – homogeneous groups within one principal component
^{A,B,C} – grupy jednorodne w obrębie jednej składowej głównej

The statistical analysis did not confirm differences in the condition of the vegetation cover of the *Arrhenatheretum elatoris* association in the particular study years with respect to every principal component.

Among species from studied grassland communities in the Middle Wieprz Valley, the following species were very rarely occurring: *Dactylorhiza incarnata* (L.) SOÓ, *Dactylorhiza majalis* s.l. (Rchb.) P.F. Hunt et Summerh., *Dianthus superbus* L. *ssp. superbus*, *Orchis militaris* L., *Lathyrus palustris* L., *Tragopogon pratensis* L. *ssp. orientalis* (L.) Čelak, *Cirsium rivulare* (Jacq.) All. and *Cynosurus cristatus* L. In 2017, lower numbers but the similar stability of *Cirsium rivulare* (Jacq.) All. specimens were found at sites of its previous occurrence (2005) even though a clear decline in the number of sites of this species can be observed in Poland. An increased presence of *Dactylorhiza majalis* s.l. (Rchb.) P.F. Hunt et Summerh. was found in herbaceous communities (*Lythro-Filipenduletum ulmariae* Hadač et al. 1997 and *Valeriano-Filipenduletum* Siss. in Westh. et al. 1946), where the disappearance of *Orchis militaris* L., a species under strict protection (1.336), can be observed as well. *Dianthus superbus* L. *ssp. superbus*, also under strict protection (1.195), is another endangered species, previously occurring in these communities sporadically. However, the number of specimens of

this species has continued to fall recently. According to the Red List (Kaźmierczakowa et al. 2016), it is a vulnerable species (VU). *Tragopogon pratensis* L. *ssp. orientalis* (L.) Čelak is a species that is very rarely found among characteristic species of typical *Arrhenatheretum* meadows during the current investigations. The most endangered pasture plant species is *Cynosurus cristatus* L. In the study area, this species can be regarded as very rare, even vulnerable, if the community for this association is not placed under active protection.

4. Conclusions

The phytosociological investigations carried out on the grasslands in the Middle Wieprz Valley revealed a serious threat for stability of plant communities. A consequence of extensive or abandoned utilization usually is the disappearance or reduced presence of typical characteristic species in the sward of meadow communities.

1. The most important changes in the species composition of meadow sward concern the *Molinio-Arrhenatheretea* class, particularly the *Lolio-Cynosuretum* association. A decreasing number of own characteristic species and a considerably greater presence of characteristic species of the *Molinio-Arrhenatheretea* class, found in the sward of this association in 2017 (in comparison with the state of the vegetation cover in 2005) can confirm negative dynamics of this association sward. A similar trend, but with less distinct changes can be observed in the *Cirsietum rivularis* association.
2. Changes in the vegetation cover of the *Arrhenatheretum elatoris* association were no significant. However, sward condition of this plant community was also not good enough in the previous study period.
3. Among plant species in studied grassland communities in the Middle Wieprz Valley there are some very rarely occurring species: *Dactylorhiza incarnata* (L.) SOÓ, *Dactylorhiza majalis* s.l. (Rchb.) P.F. Hunt et Summerh., *Dianthus superbus* L. *ssp. superbus*, *Orchis militaris* L., *Lathyrus palustris* L., *Tragopogon pratensis* L. *ssp. orientalis* (L.) Čelak, *Cirsium rivulare* (Jacq.) All. and *Cynosurus cristatus* L. In the study area, *Cynosurus cristatus* L. can be regarded as very rare, even vulnerable, if the community for this association is not placed under active protection by grazing.

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Zmiany szaty roślinnej i rzadkie gatunki roślin na użytkach zielonych w Dolinie Środkowego Wieprza (PLH060005)

Streszczenie

Badania przeprowadzono w latach 2005 i 2017 metodą Braun-Blanqueta w Dolinie Środkowego Wieprza (PLH060005). Przedmiot fitosocjologicznych badań na tym obszarze stanowiła szata roślinna łąk szuwarowych, wilgotnych i świeżych oraz obecność w badanych zbiorowiskach – gatunków charakterystycznych, rzadkich i zagrożonych. Obecnie prowadzi się monitoring poprzednio badanych zbiorowisk szuwarowych oraz zbiorowisk łąk wilgotnych i świeżych w celu oceny zmian w szacie roślinnej badanych użytków zielonych. Obszar Natura 2000 (PLH060005) stanowi mozaikę środowisk lądowych i wodnych, a taki układ warunków środowiska sprzyja występowaniu różnorodnych zespołów roślinnych. Jednakże, ekstensywne użytkowanie łąk lub jego brak stanowią w Dolinie Środkowego Wieprza poważne zagrożenie dla zbiorowisk roślinnych. Do zbadania zmian w udziale różnych gatunków charakterystycznych w 3 różnych typach zbiorowisk między latami 2005 i 2017 wykonano również wielowymiarową analizę składowych głównych PCA. Wyniki obecnie prowadzonych badań fitosocjologicznych wskazują, że najmniejsze zmiany w składzie florystycznym runi obserwuje się w zbiorowiskach szuwarowych i łąk wilgotnych, chociaż dostrzega się tam wahania liczebności niektórych

gatunków roślin. Bardziej znaczące zmiany w składzie gatunkowym runi łąkowej potwierdzono w następujących zespołach roślinnych klasy *Molinio-Arrhenatheretea*: *Lolio-Cynosuretum* R.Tx. 1937, *Cirsietum rivularis* NOWIŃSKI 1927 i mniejsze zmiany w zespole *Arrhenatheretum elatioris* BR.-BL. ex SCHERR. 1925. Analizując różnice w składzie gatunkowym runi, które zaistniały w badanych zbiorowiskach w okresie między 2005 i 2017 rokiem można stwierdzić, że największe zmiany dotyczą zespołu *Lolio-Cynosuretum*. W runi tego zespołu stwierdzono w 2017 roku znacznie większą obecność gatunków charakterystycznych dla klasy *Molinio-Arrhenatheretea* niż w 2005 roku. Podobną tendencję, ale mniej wyraźne zmiany dotyczą zespołu *Cirsietum rivularis*. W badanych latach nie zaobserwowano znaczących zmian w szacie roślinnej zespołu *Arrhenatheretum elatoris*, o czym świadczy rozmieszczenie punktów odpowiadających poszczególnym stanowiskom występowania tego zbiorowiska, które zajmują podobne obszary w obu porównywanych latach. Wśród roślin kształtujących zbiorowiska użytków zielonych w Dolinie Środkowego Wieprza bardzo rzadko występowały następujące gatunki: *Dactylorhiza incarnata* (L.) SOÓ, *Dactylorhiza majalis* s.l. (Rchb.) P.F. Hunt et Summerh., *Dianthus superbus* L. *ssp. superbus*, *Orchis militaris* L., *Lathyrus palustris* L., *Tragopogon pratensis* L. *ssp. orientalis* (L.) Čelak, *Cirsium rivulare* (Jacq.) All. i *Cynosurus cristatus* L. Brak pastwiskowego użytkowania runi przyczynił się prawdopodobnie do znacznego spadku liczebności gatunku charakterystycznego – *Cynosurus cristatus* L. W badanym rejonie gatunek ten można uznać jako bardzo rzadki, a nawet narażony na wyginięcie, jeśli zbiorowisko tego zespołu nie zostanie objęte czynną ochroną.

Abstract

The studies were conducted in the years 2005 and 2017 using the Braun-Blanquet method. The objective of studies was to investigate the condition of the grassland vegetation, including the presence of rare and endangered plant species in the Middle Wieprz Valley (PLH060005). The investigation in this area concerned the vegetation of rush meadows, wet and fresh meadows, and the presence of characteristic rare and endangered species in the communities under study. A Natura 2000 area (PLH060005) comprises a mosaic of land and water habitats and such a pattern of natural environment conditions favours the occurrence of varied plant associations. However, the extensive utilization of meadows or the lack of it pose a serious threat in the Middle Wieprz Valley to plant communities. The previously investigated rush communities as well as wet and fresh meadow communities are currently monitored to evaluate changes in vegetation of the studied grasslands. Principal Component Analysis was used to examine the changes in the percentage share of various characteristic species in three different types of

communities between 2005 and 2017. The results of the currently conducted phytosociological survey indicate that the smallest changes in the floristic composition of the sward occur in the rush and wet meadow communities although fluctuations of the number of some plant species can be observed there. The more important changes in the species composition of meadow sward were confirmed in the following associations of the *Molinio-Arrhenatheretea* class: Ass. *Lolio-Cynosuretum* R.Tx. 1937, Ass. *Cirsietum rivularis* NOWIŃSKI 1927 and lower changes in the assotiation of the *Arrhenatheretum elatioris* BR.-BL. ex SCHERR. 1925. Analyzing the differences in the species composition of the sward that occurred in the studied communities between 2005 and 2017, it can be concluded that the biggest changes concern the *Lolio-Cynosuretum* association. A considerably greater presence of species characteristic of the *Molinio-Arrhenatheretea* class was found in the sward of this association in 2017 in comparison with the state of the vegetation cover in 2005. A similar trend, but with less distinct changes, can be observed in the *Cirsietum rivularis* association where an increasing proportion of characteristic species of the *Molinio-Arrhenatheretea* class was confirmed. In the period under study, no significant changes in the vegetation cover of the *Arrhenatheretum elatoris* association were found, as evidenced by the distribution of points corresponding to the particular sites of this community, covering similar areas in both years compared. However, sward condition of this plant association was not good enough in the previous study period. Among species from studied grassland communities in the Middle Wieprz Valley, the following species were very rarely occurring: *Dactylorhiza incarnata* (L.) SOÓ, *Dactylorhiza majalis* s.l. (Rchb.) P.F. Hunt et Summerh., *Dianthus superbus* L. *ssp. superbus*, *Orchis militaris* L., *Lathyrus palustris* L., *Tragopogon pratensis* L. *ssp. orientalis* (L.) Čelak, *Cirsium rivulare* (Jacq.) All. and *Cynosurus cristatus* L. The lack of utilization of the sward for pasturage has probably contributed to the considerably decreased numbers of the characteristic species *Cynosurus cristatus*. In the study area, this species can be regarded as very rare, even vulnerable, if the community for this association is not placed under active protection.

Słowa kluczowe:
użytki zielone, zmiany szaty roślinnej, rzadkie i zagrożone gatunki roślin, Dolina Środkowego Wieprza

Keywords:
grasslands, vegetation changes, rare and endangered plant species, Middle Wieprz Valley