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FLORAL AND PHYTOSOCIOLOGICAL DIVERSITY OF SELECTED LAWNS IN THE CITY OF SZCZECIN

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ABSTRACT

Species composition of lawns in the housing estates, planted – among other reasons – in order to diversify the urban landscape, is often modified and enriched with other, spontaneously appearing species. The aim of the present work was to determine the floristic and phytosociological diversity of selected housing estate lawns of three different age groups, in the city of Szczecin, in three neighbouring housing estates (Niebuszewo, Warszewo, and Żelechowa). It was assumed that over the years, lawns are gradually becoming weaker, which may be due to the occurrence of negative anthropogenic factors of increasing intensity. It was found that despite the one designated plant community in all the analysed housing estate lawns (namely, *Poa pratensis* – *Festuca rubra*), there are differences between the studied areas, in terms of the number of species occurring therein, and the values of selected ecological (environmental) indicators.

Key words: housing estate, communities, flora, ecological indicators

INTRODUCTION

According to Ignatiev et al. [2017], the lawns, being part of the urbanized space, are artificially created or transformed plant communities, consisting mainly of grass species. As an element of green areas, they perform many functions, which include diversifying the landscape, shaping the microclimate and ecological relations, as well as exhibiting the ability to absorb pollutants [Rutkowska and Pawluśkiewicz 1996, Stawicka 2003, Ignatieva et al. 2015]. Sitarski [2011] agrees with the above, pointing to a fairly multi-layered definition of green areas included in the legal framework. The Act on Nature Conservation [Ustawa… 2004] defines green areas as "areas including technical infrastructure and buildings functionally connected therewith, covered with vegetation, located within the boundaries of villages with compact built environments or within the boundaries of cities, performing aesthetic, recreational, health and/or protective functions, in particular: parks, green spaces, promenades, boulevards, botanical gardens, zoological gardens, playgrounds, historic gardens and cemeteries, as well as greenery accompanying streets, squares, historic fortifications, buildings, landfills, airports, and railway and industrial facilities".

Chojecka [2014] presents a slightly different point of view. In her work, she subdivides urban green areas according to the manner of their creation, namely, in respect to whether it is natural greenly, or whether it has been designed and maintained. Among natural green areas, she includes: forests, meadows, greenery near water reservoirs, and insulation greenery. By contrast, she counts the following among the artificially designed greenery: green squares, parks, street greenery, cemeteries, allotment gardens, lawns, flowerbeds, and boulevards [Chojecka 2014].

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Most people in Western Europe perceive lawns as a mandatory element of the urban landscape, almost an icon, without questioning their social, symbolic, ecological, or aesthetic values. Lawns are especially valued as important places for various outdoor activities (fun, rest, picnicking, walking, socializing). There is a demand for a variety of spaces that provide favourable conditions for the sensory impressions (sound, smell, touch, and sight) and ground for activity [Hedblom et al. 2017, Ignatieva et al. 2017]. However, it is considered that the main function of lawns is their impact on shaping the urban landscape, becoming an important part of everyday life of the community, as evidenced by the size of public and residential green areas in cities, which is increasing every year. In 2015, an 8-percent increase in the number of green areas in Szczecin was recorded in comparison to the previous year. At present, there are approximately 21 m^2 of green areas in the city per one inhabitant [GUS… 2016].

In the present work, we have assumed that over the years, lawn surfaces are gradually becoming weaker, which may be due to the occurrence of negative anthropogenic factors, including, among others, mowing the sward, and compacting the soil structure by trampling and fouling [Thompson et al. 2004, Trzaskowska 2011, Trzaskowska and Adamiec 2012, Pal et al. 2013].

The aim of the work was to determine the floristic and phytosociological diversity of selected housing estate lawns, belonging to three different age groups, in the city of Szczecin, in three neighbouring housing estates (Niebuszewo, Warszewo, and Żelechowa). The obtained results will be confronted with the values of selected ecological indicators.

RESEARCH MATERIAL AND METHODS

In 2016 and 2017, floristic and phytosociological studies covered 30 housing estate lawn areas located within three urban housing estates on the left-bank part of the city of Szczecin, namely: 1 – Warszewo, 2 – Żelechowa, and 3 – Niebuszewo. The housing estates were divided into three age groups, depending on the date of establishment of the estate, and thus the date of developing the area in terms of small and green architecture, including lawn areas: 10 years (Warszewo), 20 years (Żelechowa) and 30 years (Niebuszewo). According to the classic Braun-Blanquet method [Dzwonko 2007], 30 phytosociological images were taken (respectively: 1–10, 2–10 and 3–10). The surface covered by each photo was 20m^2. These photos were then used to determine plant communities [Matuszkiewicz 2007]. Using the research works by Skrajna and Kubicka [2009], Sadowska [2011], and Dyguś [2012], life forms were defined for individual plant species, according to Raunkiaer.

For statistical calculations, the phytosociological data was transformed to the ordinal transform scale according to van der Maarel [Zarzycki 2009 quoting Maarel 1998]. Shannon-Wiener equivalence and diversity indicators (ecological indicators) were also calculated, and a dendrogram was developed, presenting hierarchical classification, and taking into account the quantitative aspect of the species occurrence using the MVSP [MultiVariate Statistical Package 2017].

RESULTS AND DISCUSSION

The obtained results have indicated that a mixture of grasses consisting mainly of: *Lolium perenne*, *Festuca rubra* and *Poa pratensis* was sown on the examined surfaces. According to Knot et al. [2017], this is the basic species composition of lawns in central Europe.

66 species of herbaceous plants and two species of mosses were identified within the studied area, respectively: in object 1 – 55 species; object 2 – 43 species; object 3 – 32 species. Hemicryptophytes constituted the dominant form of life, including 38 species (58%). 24 species (36%) represented Terophytes, and four species (6%), Geophytes. Similar results in terms of determining the dominant life forms were obtained by Trzaskowska [2011], who conducted research on the floristic and phytosociological diversity of urban lawns in the city of Lublin. Based on 134 phytosociological photographs, she identified 224 species in the undergrowth, including Hemicryptophytes – amounting to 131 species (58%), Terophytes – 64 species (29%), Geophytes – 20 species (9%), and Chamaephytes – 9 species (4%).

Research by Smith et al. [2006] indicated that plants in urban gardens in the United Kingdom were

dominated by alien species. 24 species of foreign origin were designated in the study area, which include species such as: *Anagallis arvensis, Artemis vulgaris,* and *Berteroa incana*.

The species found on the three studied lawn surfaces belonged mainly to the families of *Asteraceae* (16 species), *Poaceae* (10 species), and *Fabaceae* (8 species). The other syntaxonomic groups were represented by a few species (including *Plantaginaceae* – 4 species, and *Brassicaceae Caryophyllaceae, Lamiaceae, Polygonaceae,* and *Rosaceae* – 3 species each), and also by sporadically occurring species (*Apiaceae,* and *Geraniaceae* – 2 species each and *Chenopodiaceae, Hypericaceae, Malvaceae, Onagraceae, Papaveraceae, Primulaceae, Ranunculaceae, Resedaceae, Rubiaceae,* and *Urticaceae* – 1 species each). Smith et al. (2006) also demonstrated in their studies that in urban gardens in the United Kingdom it was the *Asteraceae* (98 species), *Rosaceae* (77 species), and *Poaceae* (51 species) that were dominating among all plant families. Thompson et al. (2004) indicated that in respect to the total area of vascular plants, grasses amounted to 84% on average, wherein only three commonly sown grasses (*Agrostis capillaris, Festuca rubra*, and *Lolium perenne*) accounted for more than half of the total area of the plant cover. Five of the further six species are also grasses: *Agrostis stolonifera, Holcus lanatus, Poa trivialis, P. pratensis*, and *P. annua*. Among the herbaceous vegetation, *Trifolium repens, Bellis perennis, Ranunculus repens*, and *Taraxacum officinale* had their share. In turn, Stawicka's (2003) research showed that the average share in the sward, for grasses, was 24% in Warsaw, and 23% in Płock. On the lawns in both cities, the largest share was held by: *Elymus repens, Festuca rubra, Lolium perenne, Medicago lupulin, Trifolium pratense*, and *T. repens*.

Herbaceous species in the laws studied by the latter authors occupied larger patches, for instance, *Trifolium repens* (III-365-IV-2175), *Taraxacum officinale* (III-328), *Bellis perennis* (I-50), or *Ranunculus repens* (I-38). On all lawn surfaces, grasslands communities of *Poa pratensis – Festuca rubra* (see: Table 1) were found.

Table 1. Grassland community *Poa pratensis – Festuca rubra* (Fijałkowski 1959 pro ass.)

Number of lawn area section	**1**	**2**	**3**
Stability (S) – Coefficient of coverage (D)	***S-D**	**S-D**	**S-D**
I Community *Poa pratensis – Festuca rubra*, ChAll. *Arrhenatherion elatioris, ChO. *Arrhenatheretalia elatioris***, ChCl. *Molinio-Arrhenatheretea***			
Festuca rubra D	V-2565	V-3775	V-5000
Poa pratensis D	V-2196	III-925	II-450
Trifolium repens	III-365	IV-650	IV-2175
***Achillea millefolium*	IV-963	IV-850	III-227
****Plantago lanceolata*	III-1019	I-350	IV-425
****Trifolium pratense*	II-673	.	III-700
***Dactylis glomerata*	V-827	I-100	III-200
****Vicia cracca*	II-423	I-100	.
***Heracleum sphondylium*	I-1	.	II-400
***Taraxacum officinale*	III-328	.	.
***Trifolium dubium*	II-153	.	.
**Rumex thyrsiflorus*	II-116	.	.

Table 1. cont.

Number of lawn area section	1	2	3
**Stability (S) – Coefficient of coverage (D)	*S-D	S-D	S-D
****Arctium lappa*	.	I-50	III-120
*****Cerastium holosteoides*	II-85	.	.
ChAll. *Agropyro-Rumicion crispi,* O. *Trifolio fragiferae-Agrostietalia stoloniferae*			
Potentilla anserina	.	.	IV-1225
Potentilla reptans	.	III-325	V-825
Festuca arundinacea	II-424	.	.
Elymus repens	I-135	II-200	I-50
ChAll. *Polygonion avicularis,* O. *Plantaginetalia majoris*			
Plantago major	I-38	V-1700	III-625
Poa annua	.	II-20	III-450
Lolium perenne	II-365	I-100	.
II ChCl. *Stellarietea mediae*			
Polygonum aviculare	II-115	III-775	V-2175
Malva neglecta	.	III-875	II-350
Hordeum murinum	.	II-470	IV-800
Stellaria media	II-153	II-150	III-150
Galinsoga parviflora	I-39	II-150	III-200
Bryum argenteum d D	II-78	II-150	II-150
Lamium purpureum	I-1	II-30	III-100
Geranium pusillum	II-155	II-30	III-120
Sonchus arvensis D	.	II-275	.
Setaria viridis D	.	I-100	III-130
Lactuca serriola D	II-78	II-150	.
Erodium cicutarium	II-115	.	.
Vicia hirsuta	II-115	.	.
Sisymbrium officinale	.	II-100	.
III ChCl. *Artemisietea vulgaris*			
Cichorium intybus	I-1	III-800	III-800
Artemisia vulgaris	I-1	II-100	IV-1151
Tanacetum vulgare	I-423	I-100	II-400
Oenothera biennis	II-78	I-100	II-400
Glechoma hederacea	II-153	II-275	.

Table 1. cont.

Number of lawn area section	1	2	3
Stability (S) – Coefficient of coverage (D)	***S-D**	**S-D**	**S-D**
Erigeron ramosus	I-77	I-350	.
Picris hieracioides D	.	II-400	.
Urtica dioica	I-38	II-60	III-250
Silene alba	I-39	III-250	.
Medicago sativa D	I-289	.	.
Cirsium arvense	I-38	III-10	III-200
Reseda lutea	II-154	.	.
Berteroa incana	I-77	II-30	II-120
Erysimum heiranthoides	I-1	I-100	.
Inne/Other			
Ceratodon purpureus d	II-615	I-50	III-410
Trifolium arvense	II-115	.	.

Sporadically occurring species: I *Bellis perennis* (1) I-50, *Daucus carota* (1) I-38, *Galium mollugo* (1) I-38, *Ranunculus repens* (1, 2) I-38, *Rumex acetosa* (1) I-38, (2) I-50, (3) I-100, *Leucanthemum vulgare* (1) I-2, *Arrhenatherum elatius* (2) I-275, **II** *Pastinaca sativa* (1) I-1, *Anagallis arvensis* (1) I-38, *Papaver rhoeas* (2) I-2, *Vicia sativa* (1) I-1, *Chenopodium album* (1) I-39, *Veronica hederifoli*a D (1) I-1, **III** *Lamium album* (2) I-100, *Hypericum perforatum* D (1) I-2, *Melilotus albus* (1) I-1, **Other:** *Aster amellus* (1) I-8, *Potentilla erecta* (1) I-38, *Hypochaeris radicat*a (1) I-38

*S – stability, D – coefficient of coverage

Species forming the given community belonged mainly to the class of *Molinio-Arrhenatheretea* (21 species). Rudder species from the *Artemisietea vulgaris* class (14 species) and segetal from the *Stellarietea mediae* class (14 species) also formed large groups.

On the lawn areas within the Warszewo housing estate (site No. 1) the *Poa pratensis – Festuca rubra* community was observed. That same community was formed also by other meadow species: *Achillea millefolium, Dactylis glomerata, Plantago lanceolata, Taraxacum officinale, Trifolium pratense* and *T. repens*.

The species which co-created the community of *Poa pratensis – Festuca rubra* on the lawn areas within the Żelechowa housing estate (site No. 2) included the following: *Achillea millefolium, Cichorium intybus, Festuca rubra, Plantago major, Poa pratensis, Polygonum aviculare, Potentilla anserina* and *Trifolium repens*.

The oldest housing estate, the Niebuszewo (object No. 3), was characterized by the occurrence, within the lawn surfaces, of mainly such species as: *Artemis vulgaris, Cichorium intybus, Festuca rubra, Hordeum murinum, Plantago lanceolata, Poa pratensis, Polygonum aviculare, Potentilla anserina, P. reptans, Trifolium pratense* and *T. repens*.

With the increasing age of the lawns, the share of meadow species characteristic of the class *Molinio-Arrhenatheretea* decreased, with the simultaneous increase in the share of species occupying fertile mineral soils with densified structure and small porosity due to unfavourable air regime, that is species from the *Stellarietea mediae* class. With age, the species of high ruderal perennials increase their coverage, particularly those from the *Artemisietea-vulgaris* class, which are resistant to drought (including *Artemisia vulgaris, Cichorium intybus, Cirsium arvense, Oenothera biennia,* and *Tanacetum vulgare*).

The diversity of *Poa pratensis – Festuca rubra* communities ranged from 7 to 20 species in the given area (patch). The value of the Shannon-Wiener diversity index in this particular set ranged from 2.6 in the 7-species patch to 4.1 in the 20-species patch (see: Table 2).

The results point to the correlation between the size of the diversity index, the number of species and the indicator of equivalence. The highest values of the diversity index were found in relation to the photographs with the largest number of species (photos No. 14, No. 16, and No. 17). At the same time, it can be observed that with the same number of species (in photos No. 14 and No. 17), the value of the diversity index was slightly different. In both cases, 19 species of plants were determined, however, the Shannon-Wiener index in picture No. 14 was larger, amounting to 4.134, while in the picture No. 17, that same index was 4.012. The higher value of the diversity index resulted from the more even participation of species in picture No. 14, which is indicated by the higher value of the equivalence index (0.963) than in photo No. 17 (0.944).

It can also be observed that there is a correlation between the size of the diversity index, the number of species, the equivalence index, and the examined objects within the given housing estates. The highest average number of species (15) and the average Shannon-Wiener index (3.6654) as well as the average equivalence ratio (0.952) were describing the oldest housing estate, established over 30 years ago (the Niebuszewo housing estate), whereas the smallest values related to the Warszewo housing estate.

Phytosociological photos with the highest values of ecological indicators were taken in the housing estate No. 3 (Niebuszewo). By contrast, the lowest values were observed in the youngest of the housing estates, which was created within the last 10 years. The average number of species on the Warszewo estate is 36% lower than on the Niebuszewo housing estate, and the average diversity index is 13% lower. The values of ecological indicators obtained for the Żelechowa estate were somewhere in-between those for the oldest housing estate (Niebuszewo), and the youngest (Warszewo).

The dendrogram representing the quantitative aspect of the occurrence of species in the areas (patches)

Table 2. The values of selected ecological indices

	Index		Number of species in the phytosociological photograph
	Shannon-Wiener diversity	equivalence	
Housing estate No. 1			
1	2.977	0.939	9
2	2.579	0.919	7
3	2.772	0.924	8
4	2.953	0.932	9
5	3.086	0.929	10
6	3.484	0.972	12
7	3.849	0.962	16
8	3.223	0.932	11
9	3.383	0.978	11
10	3.351	0.969	11
Average value	**3.1657**	**0.9456**	**10**
Housing estate No. 3			
11	3.741	0.958	15
12	3.725	0.954	15
13	3.454	0.964	12
14	4.134	0.973	19
15	4.039	0.969	18
16	4.107	0.95	20
17	4.012	0.944	19
18	3.373	0.941	12
19	2.914	0.919	9
20	3.155	0.95	10
Average value	**3.6654**	**0.9522**	**15**
Housing estate No. 2			
21	3.53	0.985	12
22	3.624	0.979	13
23	3.461	0.965	12
24	3.767	0.964	15
25	3.631	0.981	13
26	3.739	0.982	14
27	3.821	0.978	15
28	3.89	0.952	17
29	3.239	0.936	11
30	3.37	0.94	12
Average value	**3.6072**	**0.9662**	**13**

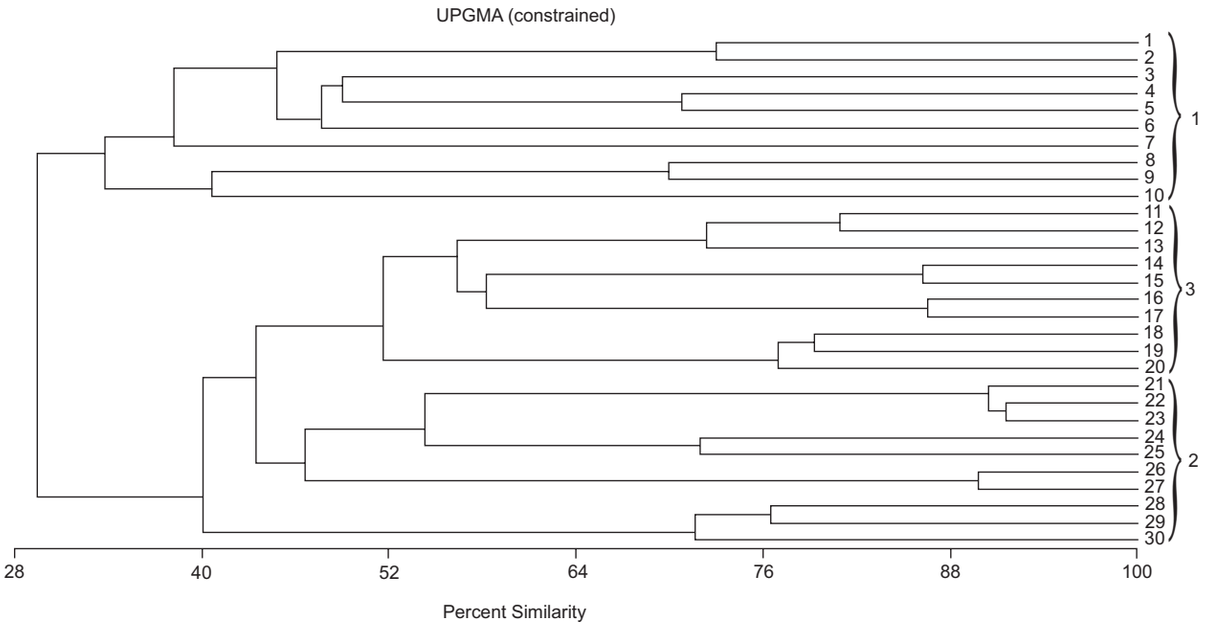

Fig. 1. Hierarchical classification taking into account the quantitative aspect of species occurrence

within the three studied housing estates made it possible to distinguish three separate groups (see: Figure 1). Confrontation with phytosociological tables confirms the dendrogram's division into housing estates: Group 1 denotes Warszewo (photos 1–10), Group 2 denotes Żelechowa (21–30), and Group 3 denotes Niebuszewo (11–20).

When comparing the structure of clusters, it can be concluded that the samples representing the second housing estate are more similar to each other than in the case of other estates. This indicates that the Żelechowa estate (No. 2) is more homogeneous in terms of species composition and the share of individual species than other settlements. The hierarchical structure suggests a greater similarity of the Warszewo housing estate to the Żelechowa housing estate than to the Niebuszewo housing estate.

CONCLUSIONS

Among the symbols of the modern urban landscape are lawns, which occupy a significant part of green open spaces in cities (up to 75%). Their role in preserving biodiversity in the city justifies their inclusion in the sustainable spatial planning, as well as the design and management of the urban landscape [Ignatieva et al. 2015].

Selected lawns of Szczecin city, despite their sharing one designated community (*Poa pratensis – Festuca rubra*) on all the analysed real estate lawns, exhibited differences between the studied points in terms of the number of species occurring (respectively: 55 in Warszewo, 43 in Żelechowa, and 32 in Niebuszewo) as well as the values of selected ecological indicators. Between the various housing estates, the community also differs with respect to co-dominant species. It can be assumed that the longer impact of anthropogenic factors resulted in the occurrence of a lower number of plant species in the Żelechowa and the Niebuszewo housing estates compared to the youngest estate of Warszewo: by 22% and 42%, respectively. In addition, the lowest values of ecological indicators obtained at the Warszewo housing estate would indicate the unstable habitat therein. The results of the study also indicate that with the age of lawn areas, the share of meadow species of *Molinio-Arrhenatheretea* as well as selected ruderal species *Artemisietea-vulgaris* decreased with the growth of segetal flora of the *Stellarietea mediae* class.

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ZRÓŻNICOWANIE FLORYSTYCZNO-FITOSOCJOLOGICZNE WYBRANYCH TRAWNIKÓW MIASTA SZCZECIN

ABSTRAKT

Skład gatunkowy trawników osiedlowych, zakładanych m.in. w celu urozmaicenia krajobrazu miejskiego, ulega często zmianom poprzez wzbogacanie ich przez gatunki pojawiające się spontanicznie. Celem pracy było określenie zróżnicowania florystyczno-fitosocjologicznego wybranych trawników osiedlowych w trzech różnych grupach wiekowych w mieście Szczecin w trzech sąsiadujących ze sobą osiedlach mieszkaniowych (Niebuszewo, Warszewo, Żelechowa). Założono, że wraz z upływem lat powierzchnie trawnikowe ulegają stopniowemu zubożeniu gatunkowemu, co może być spowodowane występowaniem nasilających się negatywnych czynników antropogenicznych. Stwierdzono, iż pomimo wyznaczonego jednego zbiorowiska na wszystkich analizowanych trawnikach osiedlowych (*Poa pratensis – Festuca rubra*) występują różnice pomiędzy punktami badawczymi pod względem liczby występujących gatunków oraz wartości wybranych wskaźników ekologicznych.

Słowa kluczowe: osiedle, zbiorowiska, flora, wskaźniki ekologiczne