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Letter to Editor

Impact of Railway Facility Operation on Floral Growth in a Powodowo, the Region of Wielkopolska

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Abstract

Our paper presents research on flora, its characteristics and differences, at two adjacent railway stations in Powodowo, western Poland. One of stations has been shut down while the other continues to serve as a site of cement and lime handling. The presence or absence of such operations has been found to affect flora. At the operating station we have observed a larger number of species and families, as well as a relatively greater share of annual and non-indigenous (foreign) plants. At the non-operating station we have observed a relatively greater proportion of indigenous (native) species, particularly those common in meadow areas and a large share of perennial species. These observations indicate that a process of spontaneous flora naturalization has been underway at the non-operating station. Both of the stations are home to species that are otherwise rare in the region of Wielkopolska such as *Carex ligerica, Epilobium adnatum* and *Medicago minima*.

Keywords: railway stations, vascular plants

Introduction

At a time of robust economic and industrial growth and improved standards of living in the early 20th century, Poland built and expanded many of its railway lines and the related infrastructure, including sidings, reloading ramps, platforms and stations. Site preparation for railway development entailed extensive work that involved plant cover removal, landscape-altering earthwork (embankments and ditches), and the laying of coarse permeable stone and gravel ballast under the tracks. As it turned out, plants are well capable of growing in such inhospitable locations. This is how railway grounds have caught the interest of botanists ever since they were made [1-13].

In recent years, rail transport in some parts of Poland has been replaced with road haulage. This has led to some sections of railways being used occasionally or being shut down altogether [14-15]. A comparative analysis of the species makeup in operating and closed stations carried out by the author of this study [15] shows that stations put out of operation see their flora undergo a slow but spontaneous naturalization.

How will the floras of two adjacent railway stations differ if only one of them is closed down? Will they be naturalized? Can man-made habitats be a source of rare plants of high value in Poland's natural environment? This paper embarks on answering these very questions.

Material and Methods

Our paper compares the floras of vascular plants at two railway stations in Powodowo (Wolsztyn County along the Wolsztyn-Sulechów railway line). As mentioned earlier, the two are neighboring facilities separated by a mere chain-link

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Table 1. Alphabetical list and characterization of species of investigated railway stations.

Plant species	Frequency on shut-down RS	Frequency on Prefbet RS	Family	Geographic-historical group	Life form	Socio-ecological group
1	2	3	4	5	6	7
Acer platanoides L.	1	1	*Aceraceae*	Ap	M	1
Achillea millefolium L.	2	1	*Asteraceae*	Ap	G	9
Acinos arvensis (Lam.) Dandy	1	3	*Lamiaceae*	Ap	T	5
Agrostis gigantea Roth.	0	1	*Poaceae*	Ap	G	8
Anchusa officinalis L.	0	1	*Boraginaceae*	Arch	T	16
Apera spica-venti (L.) P. Beauv.	0	1	*Poaceae*	Arch	T	17
Arenaria serpyllifolia L.	1	3	*Caryophyllaceae*	Ap	T	5
Arrhenatherum elatius (L.) P. Beauv. ex J. Presl & C. Presl	4	1	*Poaceae*	Ap	H	9
Artemisia absinthium L.	0	1	*Asteraceae*	Ap	H	14
Artemisia campestris L.	1	2	*Asteraceae*	Ap	H	5
Artemisia vulgaris L.	2	1	*Asteraceae*	Ap	H	13
Avenula pubescens (Huds.) Dumort.	2	0	*Poaceae*	Ap	H	9
Barbarea vulgaris R. Br.	1	0	*Brassicaceae*	Ap	H	10
Berteroa incana (L.) DC.	0	2	*Brassicaceae*	Ap	T	14
Betula pendula Roth	1	0	*Betulaceae*	Ap	M	2
Betula pubescens Ehrh.	1	0	*Betulaceae*	Sp	M	6
Bromus hordeaceus L.	1	0	*Poaceae*	Ap	T	14
Bromus sterilis L.	1	0	*Poaceae*	Arch	T	3
Bromus tectorum L.	0	2	*Poaceae*	Arch	T	15
Calamagrostis epigejos (L.) Roth	3	3	*Poaceae*	Ap	G	2
Capsella bursa-pastoris (L.) Medik	1	0	*Brassicaceae*	Arch	T	16
Cardaminopsis arenosa (L.) Hayek	2	1	*Brassicaceae*	Sp	H	9
Carex hirta L.	3	0	*Cyperaceae*	Ap	G	10
Carex ligerica J. Gay	1	0	*Cyperaceae*	Ap	G	4
Centaurea jacea L.	0	1	*Asteraceae*	Ap	H	9
Centaurea stoebe L.	0	1	*Asteraceae*	Ap	H	5
Cerastium arvense L. s. s.	3	0	*Caryophyllaceae*	Ap	H	9
Cerastium holosteoides Fr. em. Hyl.	1	0	*Caryophyllaceae*	Sp	H	9
Cerastium semidecandrum L.	0	2	*Caryophyllaceae*	Ap	T	5
Chaenorhinum minus (L.) Lange	0	2	*Scrophulariaceae*	Ap	T	16
Chenopodium album L.	1	2	*Chenopodiaceae*	Ap	T	16
Chenopodium strictum Roth	0	1	*Chenopodiaceae*	Ken	T	15
Chondrilla juncea L.	0	1	*Asteraceae*	Ap	H	5
Cichorium intybus L.	0	1	*Asteraceae*	Arch	H	14
Cirsium arvense (L.) Scop	1	1	*Asteraceae*	Ap	G	13
Cirsium vulgare (Savi) Ten.	0	1	*Asteraceae*	Ap	T	13
Convolvulus arvensis L.	1	1	*Convolvulaceae*	Ap	G	14
Conyza canadensis (L.) Cronquist	0	2	*Asteraceae*	Ken	T	15
Coronilla varia L.	2	0	*Fabaceae*	Ap	H	4
Dactylis glomerata L.	1	0	*Poaceae*	Ap	H	9
Daucus carota L.	1	2	*Apiaceae*	Ap	T	9
Echium vulgare L.	1	3	*Boraginaceae*	Ap	T	14
Epilobium adnatum Griseb.	0	1	*Onagraceae*	Ap	H	19
Epilobium ciliatum Raf.	0	1	*Onagraceae*	Ken	H	12
Equisetum arvense L.	1	3	*Equisetaceae*	Ap	G	6
Erodium cicutarium (L.) L'Hér.	0	1	*Geraniaceae*	Ap	T	16

Species occurrence frequency: 1: very rare; 2: rare; 3: moderately rare; 4: frequent; 5: common.

Table 1. continued

1	2	3	4	5	6	7
Euphorbia cyparissias L	2	1	*Euphorbiaceae*	Ap	H	4
Festuca trachyphylla (Hack.) Krajina	3	4	*Poaceae*	Ap	H	5
Fragaria viridis Duchesne	1	1	*Rosaceae*	Ap	H	4
Frangula alnus Mill.	0	1	*Rosaceae*	Sp	N	6
Fraxinus excelsior L.	1	1	*Oleaceae*	Ap	M	1
Galinsoga parviflora Cav.	0	1	*Asteraceae*	Ken	T	16
Galium aparine L.	1	0	*Rubiaceae*	Ap	T	3
Galium mollugo L.	1	1	*Rubiaceae*	Ap	H	9
Galium spurium L.	1	0	*Rubiaceae*	Arch	T	17
Galium verum L.	2	1	*Rubiaceae*	Ap	H	9
Geranium pusillum Burm. F. ex L.	0	1	*Geraniaceae*	Arch	T	16
Geranium robertianum L.	0	1	*Geraniaceae*	Sp	T	3
Geum urbanum L.	0	1	*Rosaceae*	Ap	H	3
Humulus lupulus L.	0	1	*Cannabaceae*	Sp	H	7
Hypericum perforatum L.	1	2	*Clusiaceae*	Ap	H	2
Impatiens parviflora DC.	0	1	*Balsaminaceae*	Ken	T	3
Knautia arvensis (L.) J. M. Coult.	1	1	*Dipsacaceae*	Ap	H	2
Lactuca serriola L.	1	3	*Asteraceae*	Arch	T	15
Lamium album L.	1	0	*Lamiaceae*	Arch	H	3
Lathyrus tuberosus L.	1	0	*Fabaceae*	Arch	G	17
Leontodon autumnalis L	1	1	*Asteraceae*	Ap	H	10
Lepidium densiflorum Schrad.	0	2	*Brassicaceae*	Ken	T	15
Lepidium ruderale L.	1	0	*Brassicaceae*	Arch	T	15
Linaria vulgaris Mill.	0	1	*Scrophulariaceae*	Ap	G	2
Medicago falcata L.	1	0	*Fabaceae*	Ap	H	4
Medicago lupulina L.	1	2	*Fabaceae*	Ap	H	9
Medicago minima (L.) L.	0	3	*Fabaceae*	Ap	T	4
Medicago sativa L.	1	0	*Fabaceae*	Ken	H	19
Medicago x *varia* Martyn	1	0	*Fabaceae*	Ken	H	14
Melandrium album (Mill.) Garcke	1	1	*Caryophyllaceae*	Ap	H	14
Melilotus alba Medik.	1	1	*Fabaceae*	Ap	T	15
Myosotis stricta Link ex Roem. & Schult.	1	0	*Boraginaceae*	Ap	T	17
Oenothera biennis L. s. s	0	1	*Onagraceae*	Ap	T	14
Oenothera depressa Greene	0	1	*Onagraceae*	Ken	H	14
Oenothera hoelscheri Renner ex Rostański	0	2	*Onagraceae*	Ken	H	14
Oenothera casimiri Rostański	0	1	*Onagraceae*	Ken	H	14
Oenothera wienii Renner ex Rostański	0	1	*Onagraceae*	Ken	T	14
Ononis spinosa L.	3	0	*Fabaceae*	Ap	Ch	9
Padus avium Mill.	1	0	*Rosaceae*	Sp	M	1
Padus serotina (Ehrh.) Borkh.	1	1	*Rosaceae*	Ken	M	19
Papaver dubium L.	0	1	*Papaveraceae*	Arch	T	17
Parthenocissus quinquefolia (L.) Planch. in A.&C. DC.	0	1	*Vitaceae*	D	N	19
Pastinaca sativa L.	2	1	*Apiaceae*	Ap	H	9
Petrorhagia prolifera (L.) P. W. Ball & Heywood	0	1	*Caryophyllaceae*	Ap	T	4
Picris hieracioides L.	0	1	*Asteraceae*	Ap	H	14
Pimpinella saxifraga L.	2	1	*Apiaceae*	Ap	H	9
Pinus sylvestris L.	1	1	*Pinaceae*	Ap	M	5

Species occurrence frequency: 1: very rare; 2: rare; 3: moderately rare; 4: frequent; 5: common.

Table 1. continued

1	2	3	4	5	6	7
Plantago lanceolata L.	1	1	*Plantaginaceae*	Ap	H	10
Plantago major L.	1	0	*Plantaginaceae*	Ap	H	10
Poa compressa L.	2	1	*Poaceae*	Ap	H	14
Poa pratensis L.	2	0	*Poaceae*	Ap	H	9
Polygonum aviculare L.	0	1	*Polygonaceae*	Ap	T	10
Polygonum persicaria L.	0	1	*Polygonaceae*	Ap	T	16
Populus alba L.	0	1	*Salicaceae*	Ap	M	7
Populus nigra L.	0	1	*Salicaceae*	Ap	M	7
Populus tremula L.	0	1	*Salicaceae*	Ap	M	2
Potentilla argentea L. s. s.	1	1	*Rosaceae*	Ap	H	14
Potentilla recta L.	1	1	*Rosaceae*	Ap	H	14
Potentilla reptans L.	2	1	*Rosaceae*	Ap	H	10
Prunus cerasifera Ehrh.	1	0	*Rosaceae*	Ken	M	19
Prunus spinosa L.	0	1	*Rosaceae*	Ap	N	4
Pteridium aquilinum (l.) Kuchn.	0	1	*Hypolepidaceae*	Sp	G	2
Quercus robur L.	1	1	*Fagaceae*	Sp	M	1
Ranunculus acris L. s. s.	2	0	*Ranunculaceae*	Ap	H	9
Reseda lutea L.	1	1	*Resedaceae*	Ken	H	15
Rhamnus catharticus L.	1	0	*Rhamnaceae*	Sp	N	1
Ribes spicatum E. Robson	1	0	*Grossulariaceae*	Sp	N	1
Ribes uva-crispa L.	1	1	*Grossulariaceae*	Sp	N	2
Robinia pseudacacia L.	0	1	*Fabaceae*	Ken	M	14
Rosa canina L.	0	1	*Rosaceae*	Ap	N	4
Rubus caesius L.	2	1	*Rosaceae*	Ap	Ch	13
Rumex thyrsiflorus Fingerh.	3	1	*Polygonaceae*	Ap	H	14
Salix alba L.	0	1	*Salicaceae*	Ap	M	7
Salix caprea L.	0	1	*Salicaceae*	Ap	N	3
Saponaria officinalis L.	1	0	*Caryophyllaceae*	Ap	G	14
Sarothamnus scoparius (L.) Wimm.	0	1	*Fabaceae*	Ken	Ch	5
Sedum acre L.	1	1	*Crassulaceae*	Ap	H	5
Sedum sexangulare L.	2	0	*Crassulaceae*	Sp	H	5
Senecio vernalis Waldst. & Kit.	1	1	*Asteraceae*	Ken	T	15
Setaria viridis (L.) P. Beauv.	0	3	*Poaceae*	Arch	T	16
Silene vulgaris (Moench) Garcke	1	1	*Caryophyllaceae*	Ap	H	14
Sisymbrium altissimum L	0	1	*Brassicaceae*	Ken	T	15
Solidago canadensis L.	0	1	*Asteraceae*	Ken	G	13
Sonchus oleraceus L.	0	1	*Asteraceae*	Arch	T	16
Tanacetum vulgare L.	1	1	*Asteraceae*	Ap	H	13
Taraxacum officinale F. H. Wigg	2	1	*Asteraceae*	Ap	H	9
Tilia cordata Mill.	1	0	*Tiliaceae*	Ap	M	1
Torilis japonica (Houtt.) DC.	1	0	*Apiaceae*	Ap	T	3
Tragopogon dubius Scop.	0	1	*Asteraceae*	Ap	T	14
Tragopogon pratensis L. s. s.	0	1	*Asteraceae*	Ap	T	9
Trifolium arvense L.	0	1	*Fabaceae*	Ap	T	5
Trifolium campestre Schreb.	2	1	*Fabaceae*	Ap	T	9
Trifolium pratense L.	1	0	*Fabaceae*	Ap	H	9
Triticum aestivum L.	0	1	*Poaceae*	D	T	19

Species occurrence frequency: 1: very rare; 2: rare; 3: moderately rare; 4: frequent; 5: common.

Table 1. continued

1	2	3	4	5	6	7
Tussilago farfara L.	0	1	*Asteraceae*	Ap	G	10
Urtica dioica L.	1	0	*Urticaceae*	Ap	H	3
Veronica arvensis L.	2	0	*Scrophulariaceae*	Ap	T	17
Veronica chamaedrys L.	1	0	*Scrophulariaceae*	Ap	H	9
Vicia cracca L.	1	1	*Fabaceae*	Ap	G	8
Vicia hirsuta (L.) S. F. Gray	1	0	*Fabaceae*	Arch	T	17
Vicia tetrasperma (L.) Schreb	2	0	*Fabaceae*	Arch	T	17
Vicia villosa Roth	2	1	*Fabaceae*	Arch	T	17
Viola arvensis Murray	1	1	*Violaceae*	Arch	T	17

Species occurrence frequency: 1: very rare; 2: rare; 3: moderately rare; 4: frequent; 5: common.

fence that constitutes no barrier to plant migration. The area of the two stations is around 0.5 ha each. One of the stations lies along a closed line and includes an inhabited station building and a yard set between the tracks and the building. No regular passenger or freight traffic has operated there since the 1990s. The only traffic left is an occasional handcar or a tourist train. Maintenance work at the station is limited to weed mowing along a short stretch of the tracks in front of the station building.

The other facility in question is a line leading to an unloading ramp owned by Prefbet, a manufacturer of cellular concrete blocks. Once a week on average the line is used to move cement and lime for the company's purposes. Despite precautions, certain amounts of these materials end up spilled into the local environment during handling. The area also undergoes periodic spraying for weed control purposes.

We conducted floristic studies in the vegetative seasons of 2005 and 2006. We applied a one-to-five scale of species occurrence based on the summarized cover.

The scale ranged from:

1: very rare (cover of less than 10%);
2: rare (10%-25%);
3: moderately frequent (25%-50%);
4: frequent (50%-75%); to
5: very frequent (75%-100%).

The species names were adopted after [16]. The descriptions of each species included the life form after Raunkiaer [17-19], a classification by geographic-historical and socio-ecological category [19, 20], and a taxonomic classification by family [21]. To define human impact on the respective floras of the two areas, the author computed the percent share of non-indigenous species that have succeeded to settle permanently (archeophytes + kenophytes) and the flora modernization ratio M (kenophytes / archeophytes – after [22]).

The relevant herbary material has been deposited in the Herbary of the Botany Department of the Agricultural University in Poznań (POZNB).

Results

The flora was found to be richer in the Prefbet station (109 species compared to 91 in the shut-down station; see Table 1). The Prefbet station is also home to more families, as shown in Table 3. The distribution of species by the frequency of their occurrence indicates that the Prefbet station holds a greater number of very rare species and fewer rare ones. Prefbet grounds feature twice the number of terophytes (annual plants), seen in the neighboring station (Table 3).

Both facilities are home to an equal number of plants representing other forms of life. The conditions in both are most conducive to hemicryptophytic growth – such plants occur in the greatest numbers showing the highest variability of occurrence frequencies. As hemicryptophytes and terophytes are better adjusted to life in the habitats in question, plants that represents these very forms of life (such as *Fabaceae* and *Poaceae*) are the most numerous (9-14 species) in both stations. Notably, the Prefbet station features nearly three times more *Asteraceae* species, thanks to the thriving populations of such annuals as *Conyza canadensis, Galinsoga parviflora, Tragopogon dubius*, and *Cirsium vulgare* as well as such hemicryptophytes as *Picris hieracioides, Centaurea jacea, C. stoebe, Chondrilla juncea*, and *Cichorium intybus*. The Prefbet station is the only one to feature representatives of the *Salicaceae* and *Onagraceae* families (5 and 7 species respectively). The *Salicaceae* family is represented by such common light-seeded tree species as the willow and poplar, which are quite widespread throughout the country and which successfully colonize open spaces with limited plant cover. Of particular interest here is the presence, on Prefbet grounds, of *Oenothera* species that are rare in Poland: *Oenothera depressa, Oenothera hoelscheri, Oenothera casimiri, Oenothera wienii* as well as the fireweed *Epilobium adnatum*. On the other hand, it is only in the shut-down station that one can find representatives of the *Cyperaceae* family, including *Carex ligerica*, a species at risk of extinction in Wielkopolska [23].

Table 2. Proportion of families in the flora of the investigated railway stations.

Families	Shut-down RS						Prefbet RS					
	Frequency				No. of species	[%]	Frequency				No. of species	[%]
	1	2	3	4			1	2	3	4		
Aceraceae	1	.	.	.	1	1.10	1	.	.	.	1	0.92
Apiaceae	2	2	.	.	4	4.40	2	1	.	.	3	2.75
Asteraceae	6	3	.	.	9	9.89	20	2	1	.	23	21.10
Balsaminaceae	.	.	.	.	.	.	1	.	.	.	1	0.92
Betulaceae	2	.	.	.	2	2.20	.	.	.	.	.	.
Boraginaceae	2	.	.	.	2	2.20	1	.	1	.	2	1.83
Brassicaceae	3	1	.	.	4	4.40	2	2	.	.	4	3.67
Cannabaceae	.	.	.	.	.	.	1	.	.	.	1	0.92
Caryophyllaceae	5	.	1	.	6	6.59	3	1	1	.	5	4.59
Chenopodiaceae	1	.	.	.	1	1.10	1	1	.	.	2	1.83
Clusiaceae	1	.	.	.	1	1.10	.	1	.	.	1	0.92
Convolvulaceae	1	.	.	.	1	1.10	1	.	.	.	1	0.92
Crassulaceae	1	1	.	.	2	2.20	1	.	.	.	1	0.92
Cyperaceae	1	.	1	.	2	2.20	.	.	.	.	.	.
Dipsacaceae	1	.	.	.	1	1.10	1	.	.	.	1	0.92
Equisetaceae	1	.	.	.	1	1.10	.	.	1	.	1	0.92
Euphorbiaceae	.	1	.	.	1	1.10	1	.	.	.	1	0.92
Fabaceae	9	4	1	.	14	15.38	7	1	1	.	9	8.26
Fagaceae	1	.	.	.	1	1.10	1	.	.	.	1	0.92
Geraniaceae	.	.	.	.	.	.	3	.	.	.	3	2.75
Grossulariaceae	2	.	.	.	2	2.20	1	.	.	.	1	0.92
Hypolepidaceae	.	.	.	.	.	.	1	.	.	.	1	0.92
Lamiaceae	2	.	.	.	2	2.20	.	.	1	.	1	0.92
Oleaceae	1	.	.	.	1	1.10	1	.	.	.	1	0.92
Onagraceae	.	.	.	.	.	.	6	1	.	.	7	6.42
Papaveraceae	.	.	.	.	.	.	1	.	.	.	1	0.92
Pinaceae	1	.	.	.	1	1.10	1	.	.	.	1	0.92
Plantaginaceae	2	.	.	.	2	2.20	1	.	.	.	1	0.92
Poaceae	3	3	2	1	9	9.89	5	1	2	1	9	8.26
Polygonaceae	.	.	1	.	1	1.10	3	.	.	.	3	2.75
Ranunculaceae	.	1	.	.	1	1.10	.	.	.	.	.	.
Resedaceae	1	.	.	.	1	1.10	1	.	.	.	1	0.92
Rhamnaceae	1	.	.	.	1	1.10	.	.	.	.	.	.
Rosaceae	6	2	.	.	8	8.79	10	.	.	.	10	9.17
Rubiaceae	3	1	.	.	4	4.40	2	.	.	.	2	1.83
Salicaceae	.	.	.	.	.	.	5	.	.	.	5	4.59
Scrophulariaceae	1	1	.	.	2	2.20	1	1	.	.	2	1.83
Tiliaceae	1	.	.	.	1	1.10	.	.	.	.	.	.
Urticaceae	1	.	.	.	1	1.10	.	.	.	.	.	.
Violaceae	1	.	.	.	1	1.10	1	.	.	.	1	0.92
Vitaceae	.	.	.	.	.	.	1	.	.	.	1	0.92
Sum	**64**	**20**	**6**	**1**	**91**	**100**	**88**	**12**	**8**	**1**	**109**	**100**

Table 3. Proportion of life form groups in the flora of investigated railway stations.

Life form	Shut-down RS						Prefbet RS					
	Frequency				No. of species	[%]	Frequency				No. of species	[%]
	1	2	3	4			1	2	3	4		
N	3	.	.	.	3	3.30	6	.	.	.	6	5.50
Ch	.	1	1	.	2	2.20	2	.	.	.	2	1.83
G	7	1	2	.	10	10.99	9	.	2	.	11	10.09
H	26	14	3	1	44	48.35	35	4	.	1	40	36.70
M	10	.	.	.	10	10.99	10	.	.	.	10	9.17
T	18	4	.	.	22	24.18	26	8	6	.	40	36.70

M – megaphanerophytes; N – nanophanerophytes; Ch – chamaephytes; H – hemicryptophytes; G- geophytes; Hel – helophytes; T – terophytes.

Table 4. Proportion of geographic-historical groups in the flora of investigated railway stations.

Geographic-historical group		Shut-down RS						Prefbet RS					
		Frequency				No. of species	[%]	Frequency				No. of species	[%]
		1	2	3	4			1	2	3	4		
Native plants	Ap	42	16	6	1	65	71.43	57	8	6	1	72	66.06
	Sp	7	2	.	.	9	9.89	7	.	.	.	7	6.42
Foreign plants	Arch	9	2	.	.	11	12.09	8	1	2	.	11	10.09
	D	1	.	.	.	1	1.1	2	.	.	.	2	1.83
	Ken	5	.	.	.	5	5.49	14	3	.	.	17	15.6
M ratio		0.45						1.55					
Settled species [%]		17.58						25.69					

Ap - apophytes; Sp - spontaneophytes; Arch - archaeophytes; Ken - kenophytes; D - diaphytes.

In terms of plant origin, note that despite the transformation of both of the habitats in question, the largest populations are those of the indigenous apophytes and sponataneophytes, which account for over 80% of the total flora occurring in the shut-down station and more than 70% of the flora in the Prefbet facility (Table 4). Most of these species are varieties common in meadows and species originating from the adjacent forests (*Geranium robertianum, Pteridium aquilinum*). The majority of the native plants occurring in the Prefbet station prefer open and dry spaces that receive fair amounts of sunlight (*Medicago minima, Petrorhagia prolifera* and *Reseda lutea*). As for non-indigenous plants, Prefbet grounds are dominated by kenophytes, which account for as much as 15%. These include primarily *Conyza canadensis, Lepidium densiflorum, Impatiens parviflora, Sisymbrium altissimum*, and *Chenopodium strictum*. All of these are plants associated with ruderal communities. The larger share of non-indigenous species in the handling facility results in its higher rate of flora modernization *M*.

Discussion of Results

The fact that the number of vascular plant species in the Prefbet station exceeds that of the shut-down facility by nearly 20% appears to be noteworthy considering the small size of the area that both stations occupy. This very feature as well as the larger proportion of very rare species in the Prefbet station suggests that the flora is only at the stage of colonization and forming its plant communities. The fact that phytocenoses formation on Prefbet grounds is only at a very early stage of development is undoubtedly the consequence of weed control measures taken there in preceding years. The smaller number of species in the shut-down station suggests the existence of a more stable plant community with a substantially shorter plant turnover.

The species best adjusted to living in the challenging habitats of industrial grounds (characterized by sprayings, lack of dense plant cover and rapid water evaporation from the ground) are the terophytes, or annuals. Terophytes are

Table 5. Proportion of socio-ecological groups in the flora of investigated railway stations.

Socio-ecological group	Shut-down RS				Prefbet RS			
	No. of native plants	No. of foreign plants	Sum	[%]	No. of native plants	No. of foreign plants	Sum	[%]
1	7	.	7	7.69	3	.	3	2.75
2	5	.	5	5.49	7	.	7	6.42
3	3	2	5	5.49	3	1	4	3.67
4	5	.	5	5.49	6	.	6	5.50
5	7	.	7	7.69	10	1	11	10.09
6	2	.	2	2.20	2	.	2	1.83
7	.	.	.	0.00	4	.	4	3.67
8	1	.	1	1.10	2	.	2	1.83
9	20	.	20	21.98	13	.	13	11.93
10	6	.	6	6.59	5	.	5	4.59
11	.	.	.	0.00	.	.	.	0.00
12	.	.	.	0.00	.	1	1	0.92
13	4	.	4	4.40	5	1	6	5.50
14	10	1	11	12.09	13	6	19	17.43
15	1	4	5	5.49	1	8	9	8.26
16	1	1	2	2.20	4	5	9	8.26
17	2	6	8	8.79	.	4	4	3.67
18	.	.	.	0.00	.	.	0	0.00
19	0	3	3	3.30	1	3	4	3.67

1 – Fagetalia, Prunetalia; 2 – Quercion robori-peraeae, Quercion petraeae, Epilobion, Nardetalia; 3 – Sambuco-Salicion, Alliarion; 4 – Trifolio-Geranietea, Festuco-Brometea; 5 – Dicrano-Pinion, Sedo-Scleranthetea, Corynephoretea; 6 – Alnion, Magnocaricion, Caricetalia fuscae, Sphagnion fusci; 7 – Salicion, Phragmition, Glycerio-Sparganion, Potamogetonetea, Lemnetea, Utricularietea; 8 – Molinietalia; 9 –Arrenatheretalia; 10 – Plantaginetea; 11 – Thero-Salicornietea, Astereteа tripolium, 12 – Bidentetea, Nanocyperion; 13 – Arction; 14 – Onopordion; 15 – Sisymbrion, Eragrostion; 16 – Polygono-Chenopodietalia; 17 –Aperetalia; 18 – Asplenietea; 19 – native species or naturalized antropophytes of undetermined phytosociological status and ephemerophytes.

unable to compete with parennials and hence prefer open spaces, which they successfully colonize by producing a large number of seeds and maintaining high reproduction capacities [24].

The high frequencies of hemicryptophyte occurrence result from the plants' characteristic ability to multiply their shoots vegetatively. As can be seen, this approach to reproduction and conquering new territories has proven to be highly effective in both habitats, i.e. in the shut-down station and the handling facility.

What is particularly precious in both stations is the presence of papilionaceous plants. The plants are capable of binding and accumulating nitrogen in the soil, thus creating conditions favorable for settlement by more nitrophilic species.

Conclusions

On the basis of our observations at Powodowo and previous research concerning operating and shut-down stations [15], we conclude that the shut-down station in Powodowo shows typical features of railway facilities undergoing the process of naturalization. Our research shows that despite the proximity of the two railway stations, there has been no significant interaction between their floras, hence the two retained their separate unique characteristics. The succession (naturalization) in the shut-down station, therefore, proceeds uninterrupted despite the immediate proximity of the handling facility.

The business operations in the Prefbet grounds have driven the number of species and families, helped protect

annual species and promoted the settling down of non-indigenous species, mainly those prepared to survive in dry open spaces exposed to great amounts of sunlight. Operating railway stations act as corridors through which certain non-indigenous species enter new territories. Extensive observations [25-28] show that such plants at the handling station include *Lepidium densiflorum, Impatiens parviflora*, and *Sisymbrium altissimum*. Although the plants have not yet been discovered in the shut-down station, they pose a potential threat to the adjacent areas.

As it turns out, man-made habitats that offer a new quality may offer a refuge to plants that are otherwise rare in the country or the region. The Prefbet station features *Epilobium adnatum, Potentilla recta,* and *Medicago minima* as well as several Oenothera species, whose links with railway areas in the Sandomierz Valley have also been noted in [14]. One cannot overestimate the presence on the tracks of the shut-down station of the sedge *Carex ligerica*, a plant included on the list of rare and endangered species of Wielkopolska (the Red List) [23].

Studies on man-made habitat ecosystems, including railway area habitats, show that an assessment of changes made by man in the natural environment is not always simple and unequivocal. On the one hand, one can readily observe the negative effects of human activities such as erosion of the natural environment, the formation of new habitats and new plant combinations within them, the protection of cosmopolitan species of broad ecological scope and the intrusion of alien plants and animals. On the other hand, less degraded habitats may well be a source of precious plants, contributing to an overall rise in biodiversity.

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