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VEGETATION OF THE „ŻABIE DOŁY" AREA (BYTOM) COVERING THE WASTELANDS OF ZINC-LEAD INDUSTRY

AGNIESZKA KOMPAŁA, AGNIESZKA BŁOŃSKA, GABRIELA WOŹNIAK

University of Silesia, Department of Geobotany and Nature Protection, Jagiellońska 28, 40-032 Katowice, Poland

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ROŚLINNOŚĆ NA OBSZARZE „ŻABICH DOŁÓW" (BYTOM) PORASTAJĄCA NIEUŻYTKI PRZEMYSŁU CYNKOWO-OŁOWIOWEGO

Badania prowadzono na obszarze „Żabich Dołów" (Bytom) na powierzchni osadników flotacyjnych i popłuczkowych powstałych w wyniku eksploatacji i przerobu rud cynku i ołowiu. Analiza zebranego materiału pozwoliła na wyodrębnienie 8 syntaksonów, w tym 2 zespołów i 6 zbiorowisk roślinnych z klas *Artemisietea, Calluno-Ulicetea, Molinio-Arrhenatheretea*. Wśród wyróżnionych syntaksonów dominują zbiorowiska roślinne należące do podzwiązku *Dauco-Melilotenion*, rozwijające się w miejscach przesuszonych, na podłożu piaszczystym, przepuszczalnym, często o słabo zaznaczonym procesie glebotwórczym (*Melilotetum albo-officinalis, Dauco-Picridetum hieracioidis*, zbiorowisko z *Calamagrostis epigejos* (L.) Roth; zbiorowisko z *Solidago canadensis* L.). Na badanych obiektach odnotowano również fitocenozy murawowe (zbiorowisko z *Festuca ovina* L s. str.) i łąkowe (zbiorowisko z *Deschampsia caespitosa* (L.) P. Beauv., zbiorowisko z *Agrostis capillaris* L.).

Summary

The article describes the vegetation growing on settlings and washing tanks situated in the „Żabie Doły" area (Bytom). There were recognised 2 plant associations and 6 plant communities which belong to *Artemisietea, Molinio-Arrhenatheretea, Calluno-Ulicetea* classes. Among them dominate communities from *Dauco-Melilotenion* suballiance which are confined to dry, permeable soils with the initial soil-forming process (*Melilotetum albo-officinalis, Dauco-Picridetum hieracioidis, Calamagrostis epigejos* community, *Solidago canadensis* community). There were recorded also swards (*Festuca ovina* community) and meadows (*Deschampsia caespitosa* community, *Agrostis capillaris* community)

INTRODUCTION

The exploitation of lead and zinc ores and their treatment have lead to drastic changes in the land relief, water conditions and caused physical (water and wind erosion), chemical (heavy metal contamination, soil salinity), biological (degradation of plant cover) and geotechnical (development mining, mining geology) soil degradation. In the landscape

many anthropogenic forms have been created: subsidence trough, artificial water reservoirs, spoil banks (consisting of dolomite, limestones, clay, gravel), sedimentation pools connected with ore flotation, and waste produced in smelters (acid and alkaline slag) and flotation tailings [20].

Spoil heaps are rarely as high as colliery dumps. In reference to their shape, domed and cone-like heaps dominate while the table-like forms are less frequent. A slope inclination depends on the age of the heap and can reach even 60 degrees [12].

Spoil heaps differ from each other by the type of waste material and its granulometric composition, water conditions, soil reaction, susceptibility to erosion, content of chemical elements, compounds (Zn, Pb, Cd, SiO_2, Al_2O_3, Fe, MgO, CaO) and salt [16]. This fact has a great influence both on the reclamation works and directions of wasteland management [17, 20]. There are some papers on the vascular flora [4, 9, 26, 27, 29, 35], plant communities [18, 29, 35], mechanisms of spontaneous plant colonisation [14, 29, 35], the plant's adaptation to the environmental conditions [9, 26, 36] and preliminary study on seed bank [9, 14, 26] conducted on lead-zinc wastelands.

The aim of this paper is to present the results of scientific research on the vegetation, its differentiation and its habitat preferences on the selected types of settling tank and heaps of the „Żabie Doły" area (Tab. 1).

Table 1. Description of the investigated objects: source [34]

Object	Classification of wastes*	Area [ha]	Waste [mln ton]	Years of establishment	Reclamation works	Pb [%]	Zn [%]	Fe [%]	Cd [%]
Z1	01.03.04	19.25	1.95	1926 – 1970	reclaimed (1971–1975, 1987)	1.1	2.9	9.3	0.01
Z2	01.03. 04	11.5	2.725	1971 – 1981	reclaimed (1981–1983; 1987–1989)	0.6	2.4	9.6	0.01
Z3	01.03.04	7.4	1.296	1982 – 1987	reclaimed, partly afforested	0.5	2.3	10.8	0.01
Z5	01.03.01	6.9	0.099	1970 – 1978	left to natural succession	1.5	5.2	8.0	0.03

Legend:
* 01. 03. 04 – flotation tailings [28], * 01. 03. 01 – tailings [28]

METHODS

Scientific research on the vegetation of the „Żabie Doły" area started in 2002. There were made 129 phytosociological relevés according to Braun-Blanquet method in order to recognise plant communities [6]. Fifty four of them made in phytocoenoses which cover settling and washing tanks were next arranged into phytosociological tables by using computer program „Profit 2.0"[2]. The relevés were compared to each other with the help of Jaccard's formula taking into account the abundance of species and their frequency. For each species in the table the value of constancy degree and coefficient cover was given [31].

Ecological indicator values were used in order to show ecological preferences of plants and to distinguish lower units [37].

Systematics and names of plant associations were based on Brzeg, Wojterska [7]

Matuszkiewicz [21]. The nomenclature of vascular plants follows Mirek *et al.* [22].

AREA OF INVESTIGATION

The area of research „Żabie Doły" (324 ha) is situated in Bytom-Tarnowskie Góry region of lead and zinc ores occurrence between Bytom-Rozbark; Chorzów-Maciejkowice and Siemianowice-Michałkowice. The artificial post-industrial water reservoirs cover 35 ha, meadows and fields 146.5 ha and wastelands (heaps, settling tanks connected with ore flotation, ruderal lands) 145.5 ha. Exploitation of lead and zinc ores, which occurred at a depth of 50–100 m, started here in the 12th century [8]. The intensive underground mining activities caused subsidence of the area and as a result subsidence throughs were created which were next filled with the ground water.

The excavated ores were subjected to enrichment by flotation and in smelting works. Spoils with the waste rocks were stored in sedimentation pools or heaps.

When exploitation and storage of wastes stopped some reclamation works were done [17].

The reclamation work included: forming of roads, proper modelling of the heaps and sedimentation's surface, covering them by coarse-grained substratum (sedimentation pool), mixture of the soil and sludge produced in sewage treatment plant (heaps), neutralising of toxic heavy metal by liming, fertilising. In the next step mixture of grasses (*Dactylis glomerata* L., *Deschampsia caespitosa* L. P. Beauv., *Festuca ovina* L. s. str., *F. rubra* L. s. str., *Lolium perenne* L.) and legumes were sown and shrubs and trees were planted [27, 29].

In 1997 (enactment of the Voivode of Katowice no 23/97 6.02.1997) wastelands, pounds, arable lands covering area of 226.24 hectares were taken under law protection as the „Żabie Doły" natural landscape complex [3, 8].

RESULTS

There were recognised 8 plant communities, which develop on settling and washing tanks in the „Żabie Doły" area.

THE RUDERAL PLANT COMMUNITIES FROM *ARTEMISIETEA VULGARIS* CLASS

1. Community with *Urtica dioica* (Tab. 2)

Urtica dioica L. patch was recorded on the steep, northern slope of the settling tank (Z3). It contacts with *Agrostis capillaris* L., *Deschampsia caespitosa* (L.) P. Beauv. and *Calamagrostis epigejos* (L.) Roth communities. This poor in species phytocoenose is built mainly by ruderal and nitrophilous plants from *Artemisietea* class. Stinging nettle is considered as a strong competitor, which has high expansive ability and can successfully inhibit the growth of other plants. In some cases *Urtica dioica* L. can create hardly monodominant patches [30].

Table 2. Community with *Solidago gigantea* (1–2 relevés), community with *Urtica dioica* (3 relevé)

				NUMBER OF OCCURRENCE	COEFFICIENCY COVER	
Relevé number		1	2			3
Relevé field number		16	59			70
Day in 2002		9.05.	4.07.			10.07
Object		Z2	Z1			Z2
Slope exposure		N				N
Inclination [^{0}]		3				80
Relevé area [m^2]		20	16			25
Cover of shrub layer b [%]		5				
Cover of herb layer c [%]		90	25			100
Cover of moss layer d [%]		10	+			
Number of species per relevé		17	28			14
D: community with *Solidago gigantea* and *Solidago canadensis*						
Solidago gigantea	c	4.4	4.4	2	6250	
Solidago canadensis	c	1.2	+	2	275	+.2
D: community with *Urtica dioica*						5.5
I. Ch: *Dauco-Melilotenion^ + Artemisietea*						
*Picris hieracioides^*	c	+	1.1	2	275	.
*Daucus carota^*	c	+	+	2	50	.
*Pastinaca sativa^*	c	.	+.2	1	25	.
Artemisia vulgaris	c	.	+	1	25	.
Cirsium arvense	c	+	.	1	25	.
Melandrium album	c	+	.			+
Agropyron repens	c					1.1
II. Ch: *Molinio-Arrhenatheretea*						
Deschampsia caespitosa	c	+.2	2.2	2	900	+.2
Achillea millefolium	c	+	+	2	50	.
Crepis biennis	c	+	+.2	2	50	.
Leontodon hispidus	c	.	+.2	1	25	.
Odontites serotina s. s.	c	.	+	1	25	.
Rumex acetosa	c		+	1	25	+
III. Others						
Festuca ovina	c	+.2	1.2	2	275	.
Cardaminopsis arenosa subsp. *arenosa*	c	+	+	2	50	.
Vicia angustifolia	c	r	+	2	30	.
Silene vulgaris	c	.	1.1	1	250	.
Agrostis capillaris	c	.	+.2	1	25	.
Calamagrostis epigejos	c	.	+.2	1	25	+.2
Hieracium floribundum	c	.	+.2	1	25	.
Erigeron acris	c	.	+.2	1	25	.
Hieracium sabaudum	c	.	+	1	25	.
Species with single occurrence						
I.*Agropyron repens* 5(1.1), *Carduus acanthoides* 5(1.1), *Calystegia sepium* 5						
II. *Cerastium holosteoides* 1, *Cirsium oleraceum* 1, *Dactylis glomerata* 2, *Festuca arundinacea* 5, *F. rubra* 5, *Holcus lanatus* 5, *Lotus corniculatus* 2, *Plantago lanceolata* 2, *Poa pratensis* 1						
III. *Apera spica-venti* 2, *Carex spicata* 2, *Centaurium erythraea subsp. erythraea* 2, *Cornus alba* 5, *Fagus sylvatica* b 1, *Padus serotina* 1r, *Philadelphus coronarius* 5, *Robinia pseudacacia* 2						

Ordo: *Onopordetalia acanthii* Br.-Bl. et . Tx. 1943 corr. R.Tx. 1950
Alliance: *Onopordion acanthii* Br.-Bl. (1926) 1936
Suballiance: *Dauco-Melilotenion* (Görs) Brzeg et Pawlak 1998

2. *Melilotetum albo-officinalis* Sissingh 1950 (Tab. 3)

Melilotetum albo-officinalis phytocoenoses can be found over a wide range of slopes and aspects.

Phytocoenoses of the association have two- or three layered structure. The upper layer is built mainly by *Melilotus alba* Medik. and *Meliotus officinalis* (L.) Pall., which also dominate in most of patches. They are accompanied by *Artemisia vulgaris* L., *Calamagrostis epigejos* (L.) Roth, *Cirsium arvense* (L.) Scop. and *Tanacetum vulgare* L. In the lower layer other species from *Dauco-Melilotenion* suballiance grow. In the floristic composition of *Melilotetum albo-officinalis* an important part is played also by meadow species from *Molinio-Arrhenatheretea* class, xerothermic and psammophilous plants from *Festuco-Brometea* and *Koelerio-Corynephoretea* classes. It could be taken into account that in some relevés *Festuca arundinacea* Schreb. assumes the dominant role and gives them a specific grassy physiognomy. This grass prefers soils with different granulometric composition and with low salt content. It can accumulate a large amount of nitrate nitrogen. Some of its varieties can be used for sodden because they have a strong root system [10].

Phytocoenoses with melilots play an extremely important role in stabilisation of spoil slopes which protect them from water and wind erosions. The relatively large biomass production and atmospheric nitrogen fixation by legumes supply soil with humus and nitrogen which enables other plants to colonise it in further steps of succession [20].

Due to the floristic diversity of relevés two variants can be distinguished: meadow-like one with higher participation of species from *Molinio-Arrhenatheretea* class and typical one without any differential species.

3. *Dauco-Picridetum hieracioidis* (Faber 1933) Görs 1966 (Tab. 4)

Dauco-Picridetum hieracioidis phytocoenoses are met on dry, permeable places with initial soil-forming process. In the granulometric composition of the substratum fine-grained particles are the most common but bricks, stones and gravel can be also found.

Phytocoenoses prefer mainly N and S-facing slopes of the settling tanks but they develop along trampled paths and ground roads as well. *Dauco-Picridetum* phytocoenoses grow near *Melilotetum albo-officinalis* association patches and community with *Agrostis capillaris* L. There occur from 17 to 26 species in a patch. Apart from characteristic and differential species from *Dauco-Melilotenion* suballiance and *Artemisietea* class, meadow species appear more frequently in their floristic composition. However, they are not in abundance with the exception of *Lotus corniculatus* L. or *Deschampsia caespitosa* (L.) P. Beauv.

The floristic diversity of the patches enables to distinguish three variants: with *Carlina vulgaris* L., with *Rumex acetosa* L. and other species which are confined to eutrophic soils (meadow one) and typical one without any differential species. The studies on population dynamic of short-lived monocarpic perennials reveal that recruitment of *Carlina vulgaris* L. is limited by a combination of seed and microsite availability. Only the populations subjected to high disturbances have a positive growth rate [19].

4. Community with *Calamagrostis epigejos* (Tab. 5)

Tall-grass phytocoenoses with *Calamagrostis epigejos* (L.) Roth. develop on slopes with different inclination and exposure. In the investigated area they contact with patches

Table 3. *Melilotetum albo-officinalis* Sissingh 1950

Number of relevé		1	2	3	4	5	6	7	8	9	10	11		
Relevé field number		71	79	86	69	83	75	45	46	49	47	48		
Day in 2002		10.07.	10.07.	10.07	10.07.	10.07.	10.07.	8.06.	8.06.	8.06.	8.06.	8.06.		
Object		Z3	Z3	Z3	Z3	Z3	Z3	Z2	Z2	Z2	Z2	Z2	CONSTANCY	COEFFICIENT COVER
Aspect		E	E	N	-	NW	N	-	-	-	S	SW		
Slope [^{0}]		15	5	5	-	3	2	-	-	-	15	10		
Relevé area [m^2]		25	25	25	25	15	25	25	24	27	25	25		
Cover of shrub layer b [%]		-	-	-	-	-	+	+	-	-	-	-		
Cover of herb layer c [%]		95	90	100	90	80	75	60	70	65	85	80		
Cover of mosses layer d [%]		10	5	5	5	10	20	30	30	20	20	10		
Number of species per relevé		18	13	27	22	23	23	18	20	13	16	17		
I. Ch:*Melilotetum albo-officinalis*														
Melilotus alba	c	4.4	4.4	5.5	4.4	+	1.1	.	.	.	+	+	IV	2559
Melilotus officinalis	c	.	.	+	1.1	.	.	1.2	1.1	3.3	4.4	4.4	IV	1618
D: lower units														
Plantago lanceolata (IV)	c	+.2	+.2	+.2	+.2	+.2	+.2	.	.	.	+.2	.	IV	32
Dactylis glomerata (IV)	c	.	+.2	1.2	.	+.2	+.2	.	+.2	.	.	.	III	64
Melandrium album (III)	c	.	+	+.2	+	+	+	.	.	.	.	.	III	23
Agrostis capillaris (V)	c	.	.	+.2	.	1.2	+.2	.	.	.	.	.	II	55
Rumex acetosa (IV)	c	.	.	1.2	+	1.2	+.2	.	.	.	.	.	II	100
Crepis biennis (IV)	c	.	.	+.2	+.2	.	+	.	.	+.2	.	.	II	18
Trifolium pratense (IV)	c	.	.	+.2	+	+.2	+	.	.	.	.	.	II	18
II. D:*Dauco-Melilotenion*														
Picris hieracioides	c	+.2	+	+	+	+	+.2	1.2	1.1	1.1	1.1	1	V	255
Daucus carota	c	+.2	+.2	1.2	+	+.2	+	1.2	+	+	+	1.2	V	173
Medicago lupulina	c	+	.	.	.	+.2	+	.	.	.	.	+.2	II	18
Tussilago farfara	c	+	.	.	+	.	.	.	.	.	+	+	II	18
Tanacetum vulgare	c	.	+.2	+.2	.	.	.	.	.	.	.	.	I	9
III. Ch:*Artemisietea*														
Artemisia vulgaris	c	+	.	+	+	1.1	1.1	+	.	+	+	+	V	123
Cirsium arvense	c	1.1	+	.	+	.	.	1.1	+	.	+	+	IV	114
Solidago canadensis	c	+	.	+	.	.	.	+	.	.	+	+	III	23
IV. Ch:*Molinio-Arrhenatheretea*														
Achillea millefolium	c	+	+.2	1.2	+	1.2	1.1	+	+	.	.	1.2	V	205
Festuca arundinacea	c	1.2	.	+.2	2.2	4.4	3.3	3.3	3.2	1.2	.	.	IV	1845
Festuca rubra s. s.	c	2.2	.	.	.	.	2.2	2.2	2.2	2.2	2.2	.	III	955
Leontodon hispidus	c	.	.	+.2	.	+.2	.	+.2	+.2	+.2	.	+	III	27
Taraxacum officinale	c	.	+.2	.	+.2	.	.	+.2	.	.	.	+	II	18
V. Others														
Erigeron acris	c	+	+	+	+	+	+.2	+	+	1.1	+	+	V	91
Cardaminopsis arenosa	c	+.2	+.2	+.2	+.2	+.2	+.2	+	+	+	+.2	.	V	45
Calamagrostis epigejos	c	+.2	.	1.1	+.2	+.2	1.2	+	+.2	.	.	.	IV	114
Festuca ovina	c	.	3.3	1.2	.	1.2	.	.	.	.	.	2.2	II	591
Silene vulgaris	c	.	.	.	1.1	+	.	.	+.2	.	.	+.2	II	59
Hieracium floribundum	c	.	.	.	.	.	.	+	+.2	+.2	.	+.2	II	18
Sorbus aucuparia	c	.	.	.	.	.	.	.	+	+	+	.	II	14

Sporadic species

III. *Aegopodium podagraria* 5, *Agropyron repens* 6(1.2), *Oenothera biennis* s. s. 1, *Solidago gigantea* 3, *Urtica dioica* 4r

IV. *Centaurea jacea* 8, *Cerastium holosteoides* 3, *Deschampsia caespitosa* 5, 8, *Galium mollugo* 4, *Phleum pratense* 6, 10, *Poa pratensis* 10, *Ranunculus acris* s. s. 3, *Trifolium repens* c 5

V. *Conyza canadensis* 1, 10, *Hieracium pilosella* 7, 8, *H. sabaudum* 9, *Hypochoeris radicata* 8, *Hippophaë rhamnoides* b 6, *Medicago sativa* 3, *Poa angustifolia* 1, 6, *P. annua* 7, *P. compressa* 3, 5, *Polygonum amphibium* 8, *Robinia pseudacacia* b 6, 7, c 11, *Solidago virgaurea* s.s. 3, *Syringa vulgaris* 4

Table 4. *Dauco-Picridetum hieracioidis* (Faber 1933) Görs 1966

Relevé number		1	2	3	4	5	6	7	8	9	CONSTANCY	COEFFICIENT COVER
Relevé field number		5	77	66	68	58	57	80	93	72		
Day in 2002		9.05.	10.07.	4.07.	4.07.	4.07.	4.07.	10.07.	9.08.	10.07.		
Object		Z2	Z2	Z1	Z1	Z1	Z1	Z3	Z2	Z3		
Slope exposure		N	N	-	SE	S	SE	E	WN	EN		
Inclination [^{0}]		15	30	-	5	1	50	5	40	5		
Relevé area [m^2]		25	25	20	15	15	25	25	25	24		
Cover of shrub layer b [%]		+	-	-	+	-	-	-	+	-		
Cover of herb layer c [%]		80	85	40	90	70	80	90	60	60		
Cover of moss layer d [%]		30	15	10	-	15	15	5	5	5		
Number of species per relevé		29	27	26	24	25	17	20	18	17		
I. Ch + D: *Dauco-Picridetum*												
Picris hieracioidis	c	+	1.2	2.2	+	2.2	3.2	3.3	3.3	2.2	V	1900
Daucus carota	c	+	1.2	+	+	+	2.2	+.2	1.1	+.2	V	339
D: lower units												
Carlina vulgaris (IV)	c	2.2	3.2	.	.	.	.	.	.	.	II	611
Ranunculus acris s. s. (III)	c	1.1	1.2	.	.	.	.	.	.	.	II	111
Hieracium sabaudum (V)	c	1.2	+	.	.	.	.	.	.	.	II	61
*Solidago virgaurea s. s.** (IV)	c	1.2	+.2	.	.	.	.	.	.	.	II	61
Trifolium pratense (III)	c	+	+								II	11
Cerastium holosteoides (III)	c	+.2	+	.	.	.	.	.	.	.	II	11
Rumex acetosa (III)	c	+	.	1.2	1.2	+.2	1.2	.	.	.	III	178
Melandrium album (II)	c	+	.	+	+	+	+	.	.	.	III	28
Taraxacum officinale (III)	c	.	.	+.2	+.2	+	.	.	.	.	II	17
Centaurium erythraea (V)	c	.	.	+	+	+	.	.	.	.	II	17
Lotus corniculatus (III)	c	.	.	1.2	3.3	.	.	.	.	.	II	472
Trifolium arvense	c	.	.	+	+	.	.	.	.	.	II	11
Dactylis glomerata (III)	c	.	.	.	.	+.2	+.2	.	.	.	II	11
II. Ch: *Dauco-Melilotenion** + *Artemisietea*												
Solidago canadensis	c	.	1.1	.	+	+	.	+	+	+	IV	83
Pastinaca sativa	c	.	.	+	+	+	.	+.2	.	.	III	22
Solidago gigantea	c	2.2	+	+	.	.	.	.	+	.	III	211
Artemisia vulgaris	c	.	.	+	.	+	.	+	.	+	III	22
Melilotus alba	c	.	.	.	.	.	.	+	.	+	II	61
*Medicago lupulina**	c	.	+	.	.	.	.	+	.	+	II	17
III. Ch: *Molinio-Arrhenatheretea*												
Leontodon hispidus	c	1.2	+.2	+	+.2	+.2	.	1.2	1.2	+.2	V	194
Achillea millefolium	c	1.2	+	1.2	1.2	+	.	1.2	+	+	V	244
Plantago lanceolata	c	+.2	+.2	+.2	+	+.2	.	.	+.2	+.2	IV	39
Deschampsia caespitosa	c	+	+.2	1.2	2.2	3.2	1.2	.	.	.	IV	733
Crepis biennis	c	+	+.2	.	.	+.2	+.2	.	.	+.2	III	28
Vicia cracca	c	1.1	+	+	+	.	.	.	.	.	III	72
Odontites serotina s. s.	c	.	.	.	+	+	.	.	.	.	II	11
Trifolium repens	c	.	+	.	.	+	.	+.2	.	.	II	17
Leontodon autumnalis	c	.		.	.	+	.	+	.	.	II	11
IV. Ch: *Festuco-Brometea* + *Calluno-Ulicetea**												
Erigeron acris	c	1.1	.	+	.	+.2	+	+	+.2	1.1	IV	139
*Agrostis capillaris**	c	.	.	+	+.2	+.2	1.1	+.2	+.2	+.2	IV	89
*Hieracium pilosella**	c	+	.	+	.	+.2	.	1.2	+.2	.	III	78
V. Others												
Cardaminopsis arenosa subsp. arenosa	c	+	+.2	+	+	.	+	+.2	+	+.2	V	44
Festuca ovina	c	1.2	3.3	.	+.2	.	.	3.3	1.2	2.2	IV	1144
Hieracium floribundum	c	+	+.2	1.2	.	2.2	+.2	.	.	+.2	IV	272
Silene vulgaris	c	+.2	+	+	+	+	+.2	.	1.1	.	IV	89
Calamagrostis epigejos	c	+	.	+	1.1	.	.	.	+.2	.	III	72
Conyza canadensis	c	.	.	.	.	.	2.1	+	.	.	II	200
Apera spica-venti	c	.	.	.	.	+	+	.	.	.	II	11

Sporadic species

II. *Cirsium arvense* 7, *C. vulgare* 7, *Eupatorium cannabinum* 4, *Linaria vulgaris** 8, *Oenothera biennis* s. s. 3, *Reseda lutea** 8, *Rubus caesius* c 1,

III. *Festuca arundinacea* 7, *F. pratensis* 9, *Erubra* s. s. 5, *Holcus lanatus* 4, *Lathyrus pratensis* 4, *Lolium perenne* 3, *Poa pratensis* 6, *Trifolium dubium* 6,

V. *Apera spica-venti* 5, 6, *Betula pendula* 2, *Carex spicata* 3, *Centaurea cyanus* 6, *Hypochoeris radicata* 9, *Linum catharticum* 2(1.1), *Philadelphus coronarius* b 8, *Physocarpus opulifolius* b 1, *Pinus sylvestris* 1 r, *Quercus robur* 2 r, *Rhus typhina* 8, *Robinia pseudacacia* b4, c4, *Salix caprea* 2 r, *Sorbus aucuparia* b 1, *Symphoricarpos albus* c 2 r,

of *Dauco-Picridetum, Melilotetum albo-officinalis* and *Urtica dioica* community. The most frequent and abundant in patches is *Calamagrostis epigejos.* It is accompanied by ruderal plants from *Artemisietea* class, meadow species from *Molinio-Arrhenatheretea* and grassland species from *Festuco-Brometea* and *Calluno-Ulicetea* classes.

Calamagrostis epigejos (L.) Roth. copes very well with extremely dry and poor in nitrogen habitat conditions. Such traits as "internal nitrogen circulation" and extensive, well-organised, deep root system facilitate *Calamagrostis epigejos* (L.) Roth. to colonise different types of spoils [5].

5. *Solidago canadensis* community (Tab. 2).

The patches with alien species in our flora *Solidago canadensis* L. and *Solidago gigantea* Aiton. were recorded on the top and at the upper part of settling slope. However, they do not cover too large areas. These species higher abundance can reach also in other plant communities, for example in some patches with *Festuca ovina* L. The community consists of fresh meadow species from *Arrhenatheretalia* order and *Molinio-Arrhenatheretea* class and ruderal plants from *Artemisietea* class.

Taking into account the species composition these phytocoenoses are different from nitrophilous plant association *Rudbeckio-Solidaginetum,* where patches with *Solidago* are frequently placed.

Such features of *Solidago canadensis* L. and *Solidago gigantea* Aiton. as a wide range of ecological tolerance and different types of life strategy enable them to colonise and survive in new, open, sometimes very unstable, habitats and successfully compete with other plants [15].

In the area of research phytocoenoses with *Solidago canadensis* L. and *Solidago gigantea* Aiton. grow also on railway scarps and wastelands situated close to settling tanks.

THE PLANT COMMUNITIES FROM *MOLINIO-ARRHENATHERETEA* R.TX. (1937) EM. 1970 CLASS

6. Community with *Deschampsia caespitosa* (Tab. 6)

Phytocoenoses where *Deschampsia caespitosa* (L.) P. Beauv. plays a crucial role develop both on the top surface of settling tanks and their slopes. They cover relatively large areas. They grow in the vicinity of *Agrostis capillaris* stands. Patches of the community are built by meadow species from *Molinio-Arrhenatheretea* class and ruderal from *Dauco-Melilotenion* suballiance. *Deschampsia caespitosa* (L.) P. Beauv. has dense tufts and strong, well-developed root system which enables it to colonise variety of habitat conditions. It can grow on soils with defective physical properties and with low content of mineral forms of basic nutrients [11]. There were distinguished two lower units (variants): drier with admixture of grassland species from *Festuco-Brometea* class and wet with *Centaurium erythraea* Rafn. subsp. *erythraea.* The latter species is under law protection in Poland. It can colonize a wide range of unproductive habitats. For its establishment it requires bare areas where its seedlings are subjected to a weak competition [13].

Table 5. Community with *Calamagrostis epigejos*

Relevé number		1	2	3	4	5	NUMBER OF OCCURRENCE	COEFFICIENT COVER
Field number of relevé		14	35	104	82	74		
Day in 2002		9.05.	8.06.	9.08.	10.07.	10.07.		
Object		Z2	Z2	Z2	Z3	Z3		
Aspect		N	NW	NW	N	N		
Slope [^{0}]		20	3	20	5	5		
Relevé area [m^2]		25	25	30	25	25		
Cover of shrub layer b [%]		-	-	-	-	+		
Cover of herb layer c [%]		60	90	80	90	90		
Cover of moss layer d [%]		20	+	10	10	10		
Number of species per relevé		20	18	23	18	22		
D: community with *Calamagrostis epigejos*								
Calamagrostis epigejos	c	3.3	5.5	4.4	5.5	4.4	5	6750
I. Ch: *Onopordion acanthii*								
Daucus carota	c	+	+.2	+.2	+.2	+	5	50
Picris hieracioides	c	+	+	.	+.2	.	3	30
D: lower units								
Artemisia vulgaris (II)	c	.	+	+	1.1	+	4	130
Melilotus alba(I)	c	.	.	+	+.2	1.1	3	120
Tanacetum vulgare (I)	c	.	.	+.2	+.2	1.1	3	120
Poa compressa (IV)	c	.	.	1.1	+	+	3	120
Vicia cracca	c	.	.	.	+	+	2	20
Pastinaca sativa (I)	c	.	.	.	+.2	+	2	20
Festuca ovina (V)	c	1.2	1.2	1.2	.	.	3	300
Leontodon hispidus (III)	c	1.2	+	+.2	.	.	3	120
Silene vulgaris (V)	c	+	+.2	+.2	.	.	3	30
Plantago lanceolata (III)	c	+	.	+.2	.	.	2	20
Deschampsia caespitosa (III)	c	+.2	.	+.2	.	.	2	20
II. Ch: *Artemisietea*								
Solidago canadensis	c	.	1.1	1.2	+.2	+	4	220
Cirsium arvense	c	.	+	.	+	+	3	30
Melandrium album	c	.	+	.	+	.	2	20
Solidago gigantea	c	+	.	.	+.2	.	2	20
III. Ch:*Molinio-Arrhenatheretea*								
Achillea millefolium	c	+.2	+.2	+	+.2	+	5	50
Rumex acetosa	c	+	.	+.2	+.2	+	4	40
Festuca arundinacea	c	.	+	.	.	+.2	2	20
Trifolium pratense	c	.	+.2	.	.	+	2	20
IV. Ch: *Festuco-Brometea* + *Calluno-Ulicetea**								
*Agrostis capillaris**	c	.	.	1.2	+.2	.	2	110
Erigeron acris	c	.	+	.	+	+.2	3	30
V. Others								
Cardaminopsis arenosa subsp. *arenosa*	c	+	+	+.2	+.2	+.2	4	50
Sporadic species								

I. *Reseda lutea* 5

II. *Aegopodium podagraria* 5, *Convolvulus arvensis* 3, *Eupatorium cannabinum* 1, *Medicago lupulina* 5

III. *Festuca pratensis* 2, *F. rubra* 5, *Holcus lanatus* 2, *Odontites serotina* s. s. 3, *Ranunculus acris* s. s. 5,

IV. *Hieracium pilosella** 1, *Solidago virgaurea* s. s.* 3,

V. *Betula pendula* b 1; c 1, *Conyza canadensis* 3, *Hieracium floribundum* 1(1.2), *Oenothera sp.* 2, *Physocarpus opulifolius* b 1, *Populus tremula* 1, *Robinia pseudacacia* b 5, c 3, *Salix caprea* 1, *Sorbus aucuparia* 1, *Spiraea media* b 5, *Vicia hirsuta* 3,

Table 6. Community with *Deschampsia caespitosa*

Relevé number		1	2	3	4	5	6	7	8	9		
Relevé field number		84	63	64	55	105	61	73	60	62		
Day in 2002		10. 07	4. 07	4. 07	4. 07	9. 08	4. 07	10. 07	4. 07	4. 07		
Object		Z3	Z1	Z1	Z1	Z2	Z1	Z3	Z1	Z1		
Slope exposure		N	-	-	-	W N	SE	N	EN	-		
Inclination [^{0}]		10	-	-	-	20	10	70	1	-		
Relevé area [m^2]		25	25	25	25	25	25	25	25	25		
Cover of shrub layer b [%]		-	20	20	15	-	-	+	+	10		
Cover of herb layer c [%]		80	80	90	90	60	70	60	90	70		
Cover of moss layer d [%]		10	10	5	15	+	10	15	10	10		
Number of species per relevé		10	16	18	26	12	14	25	24	23		
D: community with *Deschampsia*												
Deschampsia caespitosa	c	4.4	4.4	4.4	4.4	3.3	4.4	3.3	3.3	3.3	V	5139
D : lower units												
Leontodon hispidus (I)	c	.	.	.	.	+.2	1.2	+	2.2	+	III	267
Hieracium pilosella (III)	c	.	.	.	.	.	+	.	+.2	+.2	II	17
Holcus lanatus (I)	c	.	.	.	.	.	.	+.2	1.2	+	II	67
Erigeron acris (III)	c	.	.	.	.	.	.	+	.	+	II	11
Solidago gigantea	c	.	.	.	.	.	.	+	+	.	II	11
Hieracium floribundum (III)	c	.	.	.	.	.	.	.	+.2	+	II	11
Centaurium erythraea	c	.	+	1.2	+	.	.	.	+	.	III	72
Calamagrostis epigejos (III)	c	.	+	+	+.2	+	.	.	.	.	III	22
Robinia pseudacacia (III)	b/c'	.	2.2	2.2	1.1	.	+.2'	.	.	+.2	II	450
I. Ch: *Molinio-Arrhenatheretea*												
Rumex acetosa	c	1.2	1.2	2.2	+.2	+.2	+	+.2	+.2	+.2	V	339
Plantago lanceolata	c	.	1.2	+	2.2	1.2	+	+.2	.	+.2	IV	328
Odontites serotina s. s.	c	.	2.2	+	+	.	.	.	+	+	III	217
Achillea millefolium	c	.	+	+	.	.	.	+	.	.	II	17
Crepis biennis	c	.	.	.	+.2	.	+.2	+	.	.	II	17
Dactylis glomerata	c	.	+	.	+.2	.	.	.	.	+.2	II	17
Vicia cracca	c	.	+	+	.	.	.	.	.	.	II	11
Galium mollugo	c	.	.	+	.	.	.	+	.	.	II	11
II. Ch: *Onopordetalia acanthii** + *Artemisietea*												
*Melandrium album**	c	+	+.2	+	+	.	+	+	+	+	V	44
*Daucus carota**	c	.	1.2	+	+	+.2	.	+	+	1.2	IV	139
*Picris hieracioides**	c	.	.	+	.	+.2	1.1	+	+	1.2	IV	133
Solidago canadensis	c	.	+	+	+.2	.	+	+	1.1	.	IV	83
*Pastinaca sativa**	c	.	.	.	+	.	.	.	+	.	II	11
III. Others												
Sorbus intermedia	b	.	.	.	.	.	.	.	+	2.2	II	200
Alnus glutinosa	b'/c	.	.	.	1.1'	.	.	.	+	+'	II	61
Agrostis capillaris	c	2.2	1.2	1.2	1.2	2.2	.	1.2	2.2	1.2	V	861
Cardaminopsis arenosa	c	2.2	+	+	+	+.2	+.2	+.2	+	+	V	239
Silene vulgaris	c	+	+	.	+.2	1.2	+	1.2	+	1.2	V	194
Carex spicata	c	.	.	+.2	+.2	.	.	+	.	.	II	17
Viola arvensis	c				+					+	II	11
Quercus rubra	c							+		+	II	11
Hieracium sabaudum	c	.	.	.	.	.	.	r	+	.	II	7

Sporadic species

I. *Cardaminopsis halleri* 1, *Cerastium holosteoides* 7, *Festuca arundinacea* 7, *Leontodon autumnalis* 8, *Phleum pratense* 4, *Poa pratensis* 4, *Ranunculus acris* 7, *Taraxacum officinale* 9, *Trifolium dubium* 4

II. *Aegopodium podagraria* 7, *Cirsium arvense* 1, *Erigeron annuus* 6, *Reseda lutea** 5, *Urtica dioica* 1, *Verbascum phlomoides** 4

III. *Apera spica-venti* 4, *Carpinus betulus* b 7, *Cornus alba* 8, *Elaeagnus angustifolia* 6, *Festuca ovina* 5, 9, *Hypericum perforatum* 4, *Populus tremula* 1, *Rumex acetosella* 4, *Spiraea media* 8, *Vicia angustifolia* 8, *V. hirsuta* 3

CONSTANCY

COVER COEFFICENT

7. Community with *Agrostis capillaris* (Tab. 7)

The community with *Agrostis capillaris* L. often occurs on overdried and poor in nutrients lead and zinc settling tanks. Common Bent-grass is considered as an effective colonist of artificial habitats. Its persistent and colonising ability is connected in large measure with: the diversity of regenerative strategies, the mobility of seeds and the ability to develop genetically specialised populations and rapid lateral spread which enables it to assume a role of a dominant. It was also proved that in unproductive habitats there could be met individuals with inherently slower growth rate [13]. This floristically poor community is built from 8 species to 21 (on average 13). The phytocoenoses occupy large patches. Grasses give them specific physiognomy. Apart from *Agrostis capillaris* L. high value of constancy degree and cover coefficient are reached by *Deschampsia caespitosa* (L.) P. Beauv. or *Festuca ovina* L. In the floristic composition of the community meadow species and some plants which have low nutrient requirements such as: *Hieracium pilosella* L., *Silene vulgaris* (Moench) Garcke, *Cardaminopsis arenosa* (L.) Hayek. take part.

There were distinguished two variants. The first of them is positively distinguished by *Daucus carota* L. and *Leontodon hispidus* L. and the typical one without any differential species. First unit shows further differentiation which enables to describe two subvariants: wet with *Phragmites australis* (Cav.) Trin. ex Steud. and drier with *Hieracium pilosella* L. and *Euphrasia stricta* D. Wolff ex J. F. Lehm., species which prefer rather dry, oligotrophic habitats with low humus content.

THE PLANT COMMUNITIES FROM *CALLUNO-ULICETEA* CLASS BR.-BL. ET R. TX. 1943 EM. PREISING 1949

8. Community with *Festuca ovina* (Tab. 8)

Phytocoenoses in which *Festuca ovina* L. assumes a role of dominant overgrow slopes and flat parts of the settling tanks. They develop on soils with sand admixture, often overdried. The main participation in structure of this community have meadow species from *Molinio-Arrhenatheretea* class, ruderal from *Artemisietea* class, xerothermic from *Festuco-Brometea* class and species from *Calluno-Ulicetea* class. They reach a high value of constancy degree and cover coefficient. This community shows significant floristic diversity so two lower units (variants) could be identified. The first one is poorer in species, while the variant with *Solidago virgaurea* L. s.s. is positively distinguished by some meadow and ruderal species from *Dauco-Melilotenion* suballiance. In some patches *Linum catharticum* L. was found. According to some authors this species can be considered as an important indicator of soil humification because it appears in places with the advanced weathering process [4]. In the investigated area community with *Festuca ovina* L. can be found in the vicinity of *Melilotetum albo-officinalis, Dauco-Picridetum* and *Solidago gigantea* phytocoenoses.

DISCUSSION

A type of wastes (Tab. 1), origin of wastelands (settling or washing tanks) and reclamation works cause that differentiation of „Żabie Doły" vegetation is much higher than on other lead and zinc wastelands and recorded plant communities are significantly

Table 7. Community with *Agrostis capillaris*

Relevé number		1	2	3	4	5	6	7	8	9	CONSTANCY	COEFFICIENT COVER
Relevé field number		100	103	99	54	56	67	65	53	85		
Day in 2002		9.08.	9.08.	9.08.	4.07.	4.07.	4.07.	4.07.	4.07.	10.07.		
Object		Z5	Z5	Z5	Z1	Z1	Z1	Z1	Z1	Z3		
Slope exposure		-	-	-	ES	SE	-	NE	-	N		
Inclination [^{0}]		-	-	-	1	2	-	10	-	15		
Releve area [m^2]		25	25	24	18	25	25	25	25	20		
Cover of shrub layer b [%]		-	-	5	-	-	-	-	-	-		
Cover of herb layer c [%]		65	70	85	85	50	50	60	75	80		
Cover of moss layer d [%]		20	20	15	40	10	5	20	50	10		
Number of species per relevé		10	17	19	21	16	14	13	9	8		
D: community with *Agrostis capillaris*												
Agrostis capillaris	c	3.3	3.3	2.2	4.4	2.2	2.2	4.4	3.3	4.4	V	3917
D: lower units												
Daucus carota (II)	c	2.2	1.2	1.1	+	+	1.2	.	.	.	IV	372
Leontodon hispidus (I)	c	.	+.2	+.2	2.2	.	1.2	1.2	.	.	III	317
Centaurium erythraea (IV)	c	.	+	+	1.1	+.2	+	.	.	.	III	78
Angelica sylvestris (I)	c	+	+.2	+	.	.	.	+	.	.	III	22
Phragmites australis (IV)	c	1.1	2.1	+	.	.	.	.	.	.	II	256
*Solidago virgaurea s. s.** (III)	c	+.2	2.1	2.1	.	.	.	.	.	.	II	394
*Hieracium pilosella** (III)	c	.	.	.	+.2	2.2	2.2	+	.	.	III	400
Euphrasia stricta (III)	c	.	+	.	+	+	+	.	.	.	III	22
Picris hieracioides (II)	c	.	.	.	1.1	+	+	.	.	.	II	67
Pastinaca sativa (II)	c	.	.	.	.	+	+	.	.	.	II	11
Festuca ovina (IV)	c	.	.	.	.	1.2	+.2	.	+.2	.	II	67
I. Ch: *Molinio-Arrhenatheretea*												
Deschampsia caespitosa	c	1.2	+.2	.	1.2	1.2	1.2	1.2	2.2	+.2	V	483
Rumex acetosa	c	.	+.2	+.2	+.2	+.2	+.2	+.2	+.2	1.2	V	94
Odontites serotina s. s.	c	1.1	1.2	1.1	+	+	.	+	+.2	.	IV	189
Plantago lanceolata	c	.	1.2	+.2	+.2	.	+	+.2	+.2	.	IV	83
Leontodon autumnalis	c	.	.	+.2	+.2	.	.	.	+.2	.	II	17
Crepis biennis	c	.	.	+.2	+.2	.	.	.	.	.	II	11
Taraxacum officinale	c	.	+.2	.	.	.	.	+	.	.	II	11
II. Ch: *Artemisietea*												
Melandrium album	c	.	.	.	+.2	.	.	.	.	+	II	11
Calamagrostis epigejos	c	.	.	.	.	+.2	.	.	.	1.1	II	61
III. Ch: *Festuco-Brometea* + *Calluno-Ulicetea**												
IV. Others												
Cardaminopsis arenosa	c	.	+.2	+.2	+	1.2	.	+.2	+	2.2	IV	278
Silene vulgaris	c	.	.	+.2	1.1	1.1	1.2	+	1.2	+	IV	239
Robinia pseudacacia	c	.	.	.	+	.	+.2	+.2	.	+.2	III	22

Sporadic species

I. *Achillea millefolium* 2, *Carex hirta* 3(3.3), *Dactylis glomerata* 4, *Valeriana officinalis* 1, *Vicia cracca* 5

II. *Eupatorium cannabinum* 1 r, *Reseda lutea* 5

III *Erigeron acris* 4, *Poa compressa* 7

IV. *Betula pendula* b 3(1.1), c 2, *Carex spicata* 4, *Hieracium floribundum* 4, *Juncus articulatus* 2, *Pimpinella saxifraga* 3, *Populus tremula* 3, *Quercus robur* 3, *Sonchus arvensis subsp. arvensis* 1

Table 8. Community with *Festuca ovina*

Relevé number		1	2	3	4	5	6	7	8		
Relevé field number		94	78	106	87	88	4	76	81		
Day in 2002		9.08.	10.07.	9.08.	10.07.	10.07.	9.05.	10.07.	10.07		
Object		Z2	Z3	Z2	Z3	Z3	Z2	Z3	Z3	CONSTANCY	COEFFICIENT COVER
Aspect		WN	S	-	E	N	N	-	E		
Slope [^{0}]		2	2	-	4	10	20	-	5		
Relevé area [m^2]		25	25	25	25	25	25	20	25		
Cover of shrub layer b [%]		-	+	-	-	-	-	-	-		
Cover of herb layer c [%]		85	70	80	50	60	60	95	90		
Cover of moss layer d [%]		15	15	5	10	10	20	+	10		
Number of species per relevé		18	16	20	16	24	17	21	25		
D: community with *Festuca ovina*											
Festuca ovina fo.	c	4.4	4.4	4.4	3.3	3.3	3.2	5.5	5.5	V	5938
D: lower units											
Deschampsia caespitosa (II)	c	+.2	+.2	.	+.2	+.2	.	.	.	III	25
Reseda lutea (III)	c	1.1	+	1.2	.	.	.	.	.	II	131
Centaurea jacea (II)	c	+	.	+.2	.	.	.	.	.	II	12
Solidago canadensis (III)	c	.	.	+	.	1.1	+	+	+	IV	88
Trifolium repens (II)	c	.	.	.	.	+.2	+	1.1	1.2	III	138
Dactylis glomerata (II)	c	.	.	.	.	+.2	.	+.2	.	II	12
Ranunculus acris s. s. (II)	c	.	.	.	.	1.2	2.2	.	.	II	281
Trifolium pratense (II)	c	.	.	.	.	+.2	+	.	.	II	12
Festuca arundinacea (II)	c	.	.	.	.	.	.	1.2	+.2	II	69
Melilotus alba (III)	c	.	.	.	.	.	.	+	+	II	12
Artemisia vulgaris (III)	c	.	.	.	+	.	.	+	+	II	19
Cirsium arvense (III)	c	.	.	.	.	.	.	+	+	II	12
Medicago lupulina (III)	c	.	.	.	.	.	.	+	+.2	II	12
I. Ch: *Festuco-Brometea + Calluno-Ulicetea**											
*Hieracium pilosella**	c	+.2	+.2	+.2	+.2	+.2	1.2	.	+.2	V	100
Erigeron acris	c	+.2	.	+	1.1	.	1.2	+	.	IV	144
*Agrostis capillaris**	c	.	1.2	.	1.2	1.2	.	+.2	+.2	IV	200
*Solidago virgaurea s. s.**	c	.	.	+.2	.	1.1	.	.	.	II	69
Carlina vulgaris	c	.	.	+	.	+	.	.	.	II	12
Centaurea stoebe	c	.	1.1	.	.	.	.	.	.	I	62
II. Ch: *Molinio-Arrhenatheretea*											
Plantago lanceolata	c	+	+.2	+.2	2.2	+.2	+	+.2	1.2	V	319
Achillea millefolium	c	+	.	+	+.2	+	+	1.1	+.2	V	100
Leontodon hispidus	c	+.2	1.2	1.2	.	2.2	.	+.2	+.2	IV	362
Rumex acetosa	c	.	.	.	+.2	.	.	+	+	II	19
Vicia cracca	c	.	.	.	+	+	+	.	.	II	19
III. Ch: *Artemisietea*											
Picris hieracioides	c	1.1	+.2	1.2	+	1.2	+.2	+.2	1.2	V	275
Daucus carota	c	+	+.2	1.2	+.2	+.2	+	+.2	+.2	V	106
Melandrium album	c	+	.	.	+	+	.	.	+	III	25
IV. Others											
Silene vulgaris	c	+	+	1.2	+.2	+.2	+	.	+	V	100
Hieracium floribundum	c	+.2	+.2	+.2	1.2	.	+	.	+.2	IV	94
Cardaminopsis arenosa	c	.	.	+.2	+.2	+	+	+.2	+.2	IV	38
Calamagrostis epigejos	c	+.2	.	1.1	.	.	.	1.2	.	II	131
Physocarpus opulifolius	c	+	+	.	.	.	.	.	.	II	12
Sorbus aucuparia	c	.	.	+	.	+.2	.	.	.	II	12

Sporadic species

II. *Centaurea oxylepis* 1, *Crepis biennis* 7, *Phleum pratense* 8

III. *Eupatorium cannabinum* 3, *Melilotus officinalis* 7, *Oenothera biennis* s. s. 2, *Pastinaca sativa* 8, *Solidago gigantea* 6(1.1), *Tanacetum vulgare* 8, *Urtica dioica* 8

IV. *Betula pendula* c 3, *Cornus alba* 2r, *Hieracium sabaudum* 1, *Linum catharticum* 5(1.2), *Majanthemum bifolium* 5, *Philadelphus coronarius* b 2, *Robinia pseudacacia* c 8, *Trifolium arvense* 6, *Vicia hirsuta* 5

floristically richer [35].

In the floristic list of plant communities native, synanthropic species (apophytes) prevail. There were recorded 19 alien species – anthropophytes in the vegetation which grow on washing and settling tanks. There are species, which are permanently established, in Polish flora (kenophytes) and some (mainly shrubs and trees) which were planted. However, alien species do not play a significant role in the vegetation of the investigated objects with the exception of *Solidago canadensis* L. and *Solidago gigantea* Aiton. Similar results were obtained also by Skrzypek [29], Rostański [26] and Rostański, Kapa [27] who explored vascular flora of these objects.

The highest participation in creation of compact vegetation cover have grasses: *Agrostis capillaris* L., *Calamagrostis epigejos* (L.) Roth., *Deschampsia caespitosa* (L.) P. Beauv., *Festuca ovina* L. s. str. and also *Festuca arundinacea* Schreb. on Z2 and Z3 settling tanks. Among dicotyledones more frequent and abundant appeared: *Daucus carota* (L.), *Picris hieracioides* L., *Leontodon hispidus* L., *Plantago lanceolata* L., *Rumex acetosa* L., *Achillea millefolium* L. s. str., *Cardaminopsis arenosa* (L.) Heyek, *Silene vulgaris* (Moench) Garcke. Some species from *Fabaceae* family *Melilotus alba, Melilotus officinalis* play a role of dominants in some phytocoenoses. Tokarska-Guzik *et al.* [35] emphasised the role of *Festuca ovina* L. s. str., *Silene vulgaris* (Moench) Garcke, *Cardaminopsis arenosa* (L.) Heyek, and *Calamagrostis epigejos* (L.) Roth. (in further stages of succession) in creation of plant communities of zinc spoils in Katowice-Wełnowiec

The plant communities of the investigated objects differ significantly from phytocoenoses, which developed on the zinc mine spoils located in the Olkusz region [14]. They represent *Koelerio-Festucetum glaucae* Klika 1931 community there, whose phytocoenoses are constituted mainly by termophilous species from the *Festuco-Brometea* class, species of habitats poor in nutrients from the *Nardetalia* order and meadow species from the *Molinio-Arrhenatheretea* class. In the species composition of the plant communities which were recorded on „Żabie Doły" settling and washing tanks the highest participation have species from the *Artemisietea* class and meadow ones from the *Molinio-Arrhenatheretea* class. Among ruderal plants the most common are components of plant communities from the *Onopordion acanthii* alliance which develop on initial, very frequently containing $CaCO_3$ soils. The character species of the *Festuco-Brometea* and *Calluno-Ulicetea* classes distinguish lower units of the investigated plant communities (Tab. 4, 7). Similar results obtained also Balcerkiewicz, Pawlak [1]; Pawlak [25]; Szary [32] who explored the vegetation of other types of wastelands. There were not found on settling and washing tanks communities of trampled places from the *Trifolio-Plantaginetalia* order and phytocoenoses from the *Stellarietea mediae* class, which appear spontaneously in early stages of succession [25, 32, 33].

The grassland communities covering „Żabie Doły" settling and washing tanks are impoverished. Because of the lack in their patches of character species they cannot be placed into defined associations of the Braun-Blanquet's system. Skrzypek [29] described in „Żabie Doły" wastelands two meadow communities with *Calamagrostis epigejos* (L.) Roth. and *Deschampsia caespitosa* (L.) P. Beauv. as dominants. On the investigated objects the community with *Calamagrostis epigejos* (L.) Roth. is mostly built by species from the *Artemisietea* class.

There were not recorded on investigated objects thickets and forest plant phytocoenoses, similar to results obtained by Tokarska-Guzik *et al.* [35].

Most shrubs and trees were probably introduced by a man during reclamation work. They reach low values of constancy degrees and cover coefficient and only *Robinia pseudacacia* L. appear abundantly in the shrub layer (Tab. 6). This fact can be connected with the habitat conditions (low nutrient availability, bad physical and chemical soil's substratum conditions, susceptibility to water and wind erosion) and surrounding of the settling and washing tanks (building areas, tracks, wastelands, artificial water reservoirs where develop reed and sedge communities as well as ruderal communities). The succession into forest communities was examined on zinc mine spoils situated near Bytom, Chrzanów, Olkusz, and Tarnowskie Góry [22, 24]. The community which developed there represented deciduous forests (*Dentario glandulosae-Fagetum).* The results of investigation on afforestation of mine zinc spoils showed that the most appropriate species for forestry reclamation are: *Acer pseudoplatanus* L., *Betula pendula* Roth., *Fagus sylvatica* L., *Fraxinus excelsior* L., *Padus avium* Mill., *P. serotina* (Ehrh.) Borkh., *Robinia pseudocacia* L. [22]. During research which was conducted on wasteland created by lead and zinc irons enrichment in smelters there were examined forest phytocoenoses whose tree layer is built by *Betula pendula* Roth., *Populus tremula* L., shrub layer by *Betula pendula* Roth., *Populus tremula* L., *Salix caprea* L., *S. purpurea* L., *Pinus sylvestris* L. and the herb layer is strongly differentiated (unpublished data).

CONCLUSIONS

1. Perennial ruderal plant communities from *Onopordion acanthii* alliance (*Dauco-Melilotenion* suballiance) dominate on settling and washing tanks. The widely distributed are *Melilotetum albo-officinalis* and *Dauco-Picridetum.* They are rich in species and occupy large areas of the chosen objects.

2. The grassland communities recorded on investigated objects area are impoverished and they can not be placed into defined associations of the Braun-Blanquet's system.

3. Similar to other investigations native, synanthropic species (apophytes) prevail in the floristic list of plant communities. Alien species do not play a significant role with the exception of *Solidago canadensis* and *Solidago gigantea.*

4. In species composition of the recorded plant communities occurred 14 species which tolerate increased heavy metal content in the soil [37].

5. Some grasses such as: *Agrostis capillaris*, *Calamagrostis epigejos, Deschampsia caespitosa, Festuca arundinacea, Festuca ovina* and species of *Fabaceae* family *Melilotus alba, Melilotus officinalis* play a role of dominants in some phytocoenoses. These species play an important role in stabilization of spoil slopes and in improvement of their edaphic conditions.

6. There were not recorded on investigated objects thickets and forest plant phytocoenoses. Most shrubs and trees were probably introduced by a man during reclamation work.

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