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EUGENIA URSZULA ZAJĄC

RUDERAL VEGETATION
OF THE BIELSKO-BIAŁA TOWN

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CONTENTS

I. Introduction	5
II. Methods of research	5
III. Situation and climate of Bielsko-Biała	7
IV. History of the town of Bielsko-Biała	10
V. Ruderal communities of Bielsko-Biała	14
1. System of communities	14
2. Systematic review of communities	14
<i>Asplenietum rutae-murariae-trichomanis</i> Tx. 1937	14
<i>Hordeetum murini</i> Libbert 1932	17
<i>Tussilago farfara</i> community	18
<i>Tanaceto-Artemisietum</i> (Br.-Bl. 1936) Tx. 1942	23
<i>Leonuro-Arctietum tomentosi</i> (Felföldy 1942) Lohmeyer 1950	25
<i>Chenopodium bonus-Henricus</i> community	28
<i>Urtica dioica-Rumex obtusifolius</i> community	30
<i>Sisymbrietum sophiae</i> Kreh 1935	32
<i>Echio-Melilotetum albi</i> Tx. 1942	35
<i>Plantagini-Lolietum</i> Beger 1930	37
<i>Sagino-Bryetum</i> Diem., Siss. et Westhoff 1940	41
<i>Chenopodietum glauco-rubri</i> Lohm. 1950	41
<i>Bidens melanocarpus</i> community	43
3. Edaphic characteristic of sites of ruderal communities	43
4. Share of apophytes and antropophytes in ruderal communities of Bielsko-Biała	52
VI. Distribution of some synanthropic species in Bielsko-Biała	62
VII. Recapitulation of investigation results	77
References	80
Streszczenie	84

I. INTRODUCTION

Man, destroying natural plant communities, has created favourable conditions to expansion of certain group of native and foreign species which formed a new type of vegetation, particularly in settled areas — the ruderal communities. Although the ruderal vegetation by no means compensates the losses caused by wasteful economy carried out from the Neolithic times in natural communities, some information may be obtained from the research of ruderal communities namely that one: how in the shortest way may we regenerate the destroyed nature.

As natural communities are relatively well known in Poland, the ruderal associations still need scientific elaboration. Interest of Polish botanists in vegetation of towns and villages goes back only the last two decades. The least attention was paid to ruderal associations. Only few papers of this type may be mentioned here. They deal with such regions of Poland as Middle Odra River Basin (Libbert, 1932), Cracow Jura (Kornaś, 1952), towns of Chełm and Lublin (Fijałkowski, 1963, 1967), city of Łódź (Sowa, 1964), vicinities of Rypin (Korniak, 1966), the Białowieża Forest Reserve (Faliński, 1966). No data come so far from Southern Poland in this respect.

II. METHODS OF RESEARCH

Phytosociological and floristic investigations. The research of ruderal associations of the town of Bielsko-Biała was carried out during the years 1966 - 1969. One hundred and seven phytosociological records constitute the basis of the elaboration. Most of them were done in 1968 two records concerning *Asplenietum rutae-murariae-trichomanis* were done in Cieszyn.

The investigations were done during the optimal period for the growth of ruderal plants, namely from early August up to the end of October. The vegetation was observed in early and late spring as well. During the field work and compilation of results a generally used method by Braun-Blanquet (Braun-Blanquet 1964; Pawłowski 1959) has been applied. Minimal surface was empirically determined for many com-

munities. If possible 2-3 times larger than minimal surface was established in records. The classification of the communities was chiefly based on works by: Braun-Blanquet (1964), Gutte (1966), Kornaś (1952, 1968c), Medwecka-Kornaś, Kornaś and Pawłowski (1959), Oberdorfer (1957), Sissingh (1946, 1950) and Tüxen (1950). The scope of notion "association" has been accepted after Kornaś and Medwecka-Kornaś (1967). Names of associations were correlated with the rules given by Rauchert (1963), pH was determined in each record using soil colorimeter.

Nomenclature of vascular plants is that of "Rośliny polskie" (Szafer, Kulczyński and Pawłowski, 1953), and that of mosses — after Szafran (1957, 1961).

In order to elucidate the influence of climate, character of colonization and specificity of habitats onto the ruderal vegetation of Bielsko-Biała the distribution of about a dozen selected species was investigated in great detail. A map was plotted for each species using point method. The plant stations were mapped in the field, and then plotted on previously prepared map using symbols. The map of Bielsko-Biała 1967 was a basis for this map.

Methods of soil investigations. Chemical analyses of 18 soil samples were done in order to characterize the dependence of the ruderal communities on the soil. Six phytosociological units were investigated. Three samples were taken for each community from the most typical patches. Soil samples were taken down to depth of 15 cm because this layer is most frequently contaminated in urban environment by garbage, debris, trampling, digging, etc. Most root systems of ruderal plants occur in this level as well.

The following methods were in use in soil analysis:

1. for designation of mechanical composition areometric method of Bouyoncos-Casagrande with modification by Prószyński,
2. in designation of organic carbon content — oxydometric method of Tiurin (modified),
3. in designation of total nitrogen — Kjeldahl method,
4. in designation of pH in soil — potentiometric method using 1N KCl and distilled water and potentiometer with glass electrode,
5. in designation of K_2O and P_2O_5 content — Egner's method modified by Riehm,
6. in designation of $CaCO_3$ — volumetric method by Scheibler,
7. in designation of sulphides — weight analysis using $BaCl_2$ (with oxidation of possible sulphides with bromic water in acid environment).

All the analyses (except designation of per cent of C in sample 1) have been done in the Soil Science Chair of the High Agricultural School in Cracow.

The authoress is grateful to Professor Dr. Jan Kornaś for his many instructions done during the performance of this work and making available the unpublished materials from Bielsko-Biała. She also wishes to thank the late Professor B. Szafran and Mr. Krzysztof Jędrzejko for kind determination of *Bryophyta*, and to Dr. B. Adamczyk for his remarks on the soil chapter. Thanks are also due to Dr. B. Obrębska-Starkel and Mr. T. Niedźwiedź for their help in interpretation of climatic data and suggestions concerning literature, and to Dr. T. Tacik for his checking and partial determination of species from the genera *Epilobium* and *Verbascum* which occur in phytosociological record.

III. SITUATION AND CLIMATE OF BIELSKO-BIAŁA

Bielsko-Biała is a submontane town situated in a narrow belt of the Silesian Highlands (Klimaszewski, 1946) at the foot of the Beskids

Fig. 1. Hypsometrical cross-section of the Bielsko-Biała city area in the East—West direction

I — on the level of the Bielsko-Biała Główna station; II — on the level of the Bielsko Old Market Place; III — on the border line between the city and the country Kamienica

Table

Some climatic data for Bielsko-Biała in comparison

Name of station	Altitude m	Months							
		XII	I	II	III	IV	V	VI	VII
Mean monthly and yearly temperature in °C									
Bielsko-Biała	355	−0.6	−2.1	−1.2	2.9	7.5	12.6	15.6	17.4
Zakopane	846	−3.1	−4.9	−4.1	−0.5	4.4	10.0	12.7	14.7
Cracow	232	−0.8	−2.5	−1.4	3.0	8.1	13.9	16.8	18.8
Mean monthly and yearly temperature in °C for the									
Bielsko-Biała (Aleksandrowice)	355	0.1	−3.0	−3.2	1.9	6.9	12.0	15.4	17.0
Zakopane	846	−2.5	−5.8	−5.2	−0.8	4.2	9.1	12.9	14.5
Cracow	232	0.0	−3.0	−2.7	2.3	8.2	13.4	17.2	18.6
Mean monthly and yearly precipitation in mm for the									
Bielsko-Biała (Aleksandrowice)	355	64	38	40	56	62	115	146	154
Zakopane	846	60	39	42	52	85	108	186	190
Cracow	232	37	33	28	36	49	67	90	119

Mts. This region is strongly hilly with dense network of streams, which flow to the Biała river. The latter is separated from the Soła river basin by the Beskid Mały chain the northern slopes of which reach the outskirts of the town. Buildings are concentrated mainly on both banks of the Biała river and along the Niwka stream, and on the slopes of the neighbouring hills. Three morphological profiles are shown on Fig. 1, all of east-west direction. The first one from north through the Bielsko-Biała Główna railway station, second one — in the centre of the town near the Old Market Place, the third one — at the boundary with the old village of Kamienica. All these profiles demonstrate how quickly the valley narrows upstream and which are the differences in level in these three points of the town. The Silesian Highlands in the area of Bielsko-Biała rises gradually without any distinct steps. The lowest points covered with continuous buildings are situated about 304 m a.s.l., and the highest — about 350 m a.s.l. The difference in height is about 50 m.

The surrounding hills still within the town boundaries are much higher attaining heights of 420 m a.s.l. The present day town of Bielsko-Biała covers a surface of 31 sq. km. The river Biała and the Niwka stream which were of considerable importance in the development of

with climatic data for Cracow and Zakopane

Months				Winter	Spring	Summer	Autumn	Mean yearly sum of temperature
VIII	IX	X	XI					

for the period from 1881-1930 (Ermich 1951)

16.7	13.3	8.9	3.0	-1.3	7.7	16.5	8.4	7.8
14.0	10.5	5.7	0.3	-4.0	4.6	13.8	5.5	5.0
17.5	13.8	8.6	3.1	-1.6	8.3	17.7	8.5	8.2

period from 1954-1963 (after "Roczniki Meteorologiczne PIHM")

16.6	13.4	9.2	4.0	-2.0	6.9	16.3	8.7	7.5
14.0	10.2	6.0	1.4	-4.5	4.7	13.4	5.9	4.9
18.0	13.8	9.2	4.1	-1.9	7.9	14.6	9.0	8.2

period from 1954-1966 (after "Opady Atmosferyczne PIHM")

107	75	66	59	47	84	136	67	1003
126	64	66	45	47	82	167	58	1082
85	63	35	42	33	51	98	47	712

the town and changed their channels in the past many times are regulated now along their course within the town.

The climate of Bielsko-Biała is a submontane one. Meteorological station exists at the Aleksandrowice airport which is situated in the south-western part of the town. The terrain is flat and only from the south it is bordered by the slopes of the Silesian Beskids. The climatic data shown in Table I characterize only the macroclimate. The data from Cracow and Zakopane are presented for comparison. Cracow is situated north-east of Bielsko-Biała and Zakopane south-east of it. The macroclimate of Bielsko-Biała is characterized by rather gentle winters and humid, moderately warm summer months. Some local climatic variation may be observed within the town. The warmest and least humid is the vicinity of the railway station situated on flat, northern area. This is probably caused by frequent winds of S and SW directions, i.e., from the mountains. Large air masses descending down the hill slopes warm up in the flat Biała river valley forming the so-called "fön" effect. This creates favourable conditions for plants of arid and warm environments, forming a sort of an oasis which is not passed by them within the town. Some corrections should be made within the town for the peculiarity of urban climate (Hess, 1969) which is characterized by variable condi-

tions of air and vapour convection by changes of insolation. Increasing air pollution has a considerable influence on the microclimate of Bielsko-Biała.

IV. HISTORY OF THE TOWN OF BIELSKO-BIAŁA

The history of colonization within the town is essential for the knowledge of the anthropogenic vegetation. Thus presentation of few data about Bielsko-Biała seems to be justified. Only those facts have been selected which throw some light on the direction and speed of changes in natural environment. The main source was a paper by Perzanowski (1958) supplemented by statistic data and remarks taken from various guide-books. The present day town has developed from two historically different towns: Bielsko and Biała. Colonization has developed relatively late, at the decline of the 12th and 13th centuries. During the Lusatian culture time an Amber Route crossed the settlement which was an important commercial connection between Cieszyn and Cracow (Fig. 2) and the rest of Little Poland. During Middle Ages the importance of this route remained the same because many fortified buildings were constructed along it. First settlements were situated rather in the peripheries in relation to the actual town boundaries. Lipnik developed in the south-eastern periphery which was the largest village of the Oświęcim Duchy.

This was an agricultural settlement thus the changes of the natural environment were toward rooting out the woods and turning the areas into fields and pastures. The second settlement situated in the north-western part of the town called Old Bielsko (Stare Bielsko) was formed around small castle and was of rural-handicraft character. Bog iron ore was smelted there and metal goods were produced. A road connecting the present Bielsko with Pszczyna and the Bytom run through the settlement. The type of people occupation points to a need to root out the woods to obtain fields and wood for smelting. At the decline of the 12th and 13th centuries still another settlement existed in the Carpathian virgin forest. A fortified hunting residence was built on a hill on the Biała river, as a princely watch-tower and a small market place has developed nearby at the junction of commercial routes.

Such sub-Carpathian villages as Bystra, Mikuszowice and Kamienica have started to develop during the same time. In such a way the early medieval colonization made first breaks in the so far uniform Carpathian virgin forest. In the area of the present day Bielsko-Biała the Lipnik village has developed in the valley of Niwka stream over the post-alder

Fig. 2. Development of the city-type colonization in the Bielsko-Biala area

a — until the 15th century; *b* from the 15th to 18th century; *c* — the ancient trade route; 1 — the way to the Old Bielsko; 2 — the way Cracow—Cieszyn

and post-oak-hornbeam forest sites. Similar situation was at the Old Bielsko. The town of Bielsko itself occupied the summit of a gentle hill of rather thick weathering cover, as there are no outcrops of the relatively poor Godula sandstones of the neighbouring Silesian Beskids. These were probably sites corresponding to more arid subassociation of oak-hornbeam forest.

The date of municipal consession to Bielsko is difficult to establish. In the year 1312 it was mentioned as a town. This is of importance to synanthropization of the vegetal cover because some privileges were granted to burghers concerning the use of land surrounding the castle. Through the whole 14th and 15th centuries the town developed and increased its properties buying from the Duke the vast forest between the villages of Kamienica and Mikuszowice. The character of that time urban buildings was entirely different from that of the present day. Houses crowded on small area, surrounded by the town walls left but little place to the development of synanthropic vegetation. This was most probably the ruderal vegetation of rural type with predominance of definitely nitrophilous plants and communities of the order *Plantaginetalia* along all roads and paths. Fields and pastures directly surrounding the town belonged to it. At the end of the 15th century an area was separated from pastures situated between the castle and river for princely garden. No remarkable changes occurred during the 16th century in the town area. Some suburbs have originated that time: Upper (Górne), Lower (Dolne) and Blich.

New buildings were constructed on pastures and fields along the already existing roads, i.e., on destroyed natural vegetation cover. At the end of 16th century the town was allowed to pasture cattle in the woods. Numerous gardens were created and the character of land use around the town has changed. There were many fires during the 17th century which in turn caused changes in architectonic conceptions. Each time however, the restoration was quick. Handicraft was in progress, cloth manufacture in particular, and the population in the town increased which caused farther synanthropization of environment. At the beginning of the 18th century (in 1728) there were 271 cloth manufacturers in Bielsko. Their guild obtained the privilege of dyeing cloth already in 1648. Because of large number of workshops and large cloth production the contamination of the Biała river had to be particularly great in the nearest vicinity of the town, as all the wastes from the dyehouse flew to the river. In the year 1723 the settlement of Biała has obtained the municipal concession. Biała is situated on the opposite side of the river. Its beginning may be seen in a settlement at the mouth of the Niwka stream to the Biała river. This settlement was founded during the first half of 16th century. The terrain on which it was established was probably devoid of natural vegetation cover from many years because there

were fields and pastures of the Lipnik subprefecture. The settlement from its very beginning was of handicraft character. Its farther development progressed northward because from the south it was limited by buildings of the subprefect's cottage. Thus a rapprochement took place of colonization with that of Lipnik around the castle. These two municipal organisms had spread along the Biała river during the next centuries.

Many factories were constructed in the 19th century. They eliminated individual looms. Municipal gas-house was established for both towns and in fifties a railroad was constructed which connected Bielsko with Czechowice with prolongation to Żywiec, and another one to Cracow through Kalwaria. Industry was located on free areas above and below the town, usually on the river banks because of need to water supply. Thus the meadows on the Biała banks were more and more degraded. Gardens and parks filled in the gaps between the buildings. Agriculture and raising had to withdraw to the outskirts. The neighbouring villages remained under the influence of industry and some factories were located in them as, e.g. at Mikuszowice, Kamienica and Komorowice on the Biała side. Installation of tramway connecting railway station with the municipal forest at the end of the 19th century was a symptom of the town's wealth. The northern part of the forest which bordered Mikuszowice and Bystra, was changed into a park.

Rapid growth of the town and development of industry caused an increase of garbage piles of which formed habitats for synanthropic plants in the peripheries. As buildings have grown, the garbage piles spread outwards and covered areas with natural and subnatural vegetation. After the Second World War a rapid growth of industry and residential buildings included many new suburban areas to the town and shifted the suburbs even farther toward typically rural terrains.

The unification of Bielsko and Biała into one municipal complex was an important event. It took place on January 1, 1951. This was the legalization of long existing fact of meeting of the two towns over the Biała river.

The present day town of Bielsko-Biała occupies an area of 31 sq. km and its population is over 84 thousands. Recently many industrial plants were enlarged and newly constructed. Seventy three thousands of workers are employed in them. The best developed is the textile industry, which is followed by metallurgy. Electric instalation, sport equipment, fat and building construction plants etc., are of importance for the town. This rapid growth of industrialization is accompanied by increasing process of synanthropization of environment. The construction of heat and power generating plant which has eliminated many smoking chimneys from the town may be a proof of interest of municipal administration in preservation of natural environment from industrial pollution. Des-

pite of that the pollution of environment in Bielsko-Biała still grows because of industrial development and increasing motorization which greatly influences the ruderal vegetation of this area.

V. RUDERAL COMMUNITIES OF BIELSKO-BIAŁA

1. SYSTEM OF COMMUNITIES

Class: *Asplenietea rupestris* Br.-Bl. 1934.

Order: *Potentilletalia caulescentis* Br.-Bl. 1934

Alliance: *Potentillion caulescentis* Br.-Bl. 1926

Asplenietum rutae-murariae-trichomanis Tx. 1937

Class: *Rudero-Secalietea* Br.-Bl. 1936

Order: *Onopordetalia* Br.-Bl. et Tx. 1943

Alliance: *Arction lappae* Tx. 1937

Hordeetum murini Libbert 1932

Tussilago farfara community

Tanaceto-Artemisietum (Br.-Bl. 1930) Tx. 1942

Leonuro-Arctietum tomentosum (Felföldy 1942) Lohmeyer 1950

Chenopodium bonus-Henricus community

Urtica dioica-Rumex obtusifolius community

Alliance: *Onopordion acanthii* Br.-Bl. 1936

Sisymbrietum sophiae Kreh 1935

Echio-Melilotetum albi Tx. 1942

Order: *Potentillo-Polygonetalia avicularis* Tx. 1947

Alliance: *Polygonion avicularis* Br.-Bl. 1931

Plantagini-Lolietum Beger 1930

Sagino-Bryetum Diem., Siss. et Westhoff 1940

Order: *Bidentetalia* Br.-Bl. et Tx. 1943

Alliance: *Bidention* Nordh. 1940

Chenopodietum glauco-rubri Lohm. 1950

Bidens melanocarpus community

2. SYSTEMATIC REVIEW OF COMMUNITIES

Asplenietum rutae-murariae-trichomanis Tx. 1937

Fissures in limestones are natural sites of this association. *Asplenietum rutae-murariae* may also grow on limy mortar of brick and stony walls. On such artificial sites it grows in Bielsko-Biała. *Asplenietum rutae-murariae* is rare in this area. It grows in fissures of old, uncleaned walls.

Characteristic species in Bielsko-Biała are: *Linaria cymbalaria*, *Corydalis lutea* and *Asplenium ruta-muraria*. Bryophyta play a role in some

patches, *Tortula muralis* first of all, which attains presence degree II. In no record all three characteristic species were observed; the particular patches show at most two of them. The differences in the occurrence of characteristic species are well observable on presence degree diagrams. Irregular distribution of presence degrees with a maximum in I and complete lack of species of V degree (Fig. 6D) clearly proves fragmentary development of patches. The specific composition of the association is poor (approximately 8 species per record). Among accompanying species *Chelidonium majus* is common which is explainable by its abundance in the area in question. Presence degree over 50% was also noted in *Taraxacum officinale* and *Solidago serotina*. Two supplementary records from Cieszyn are presented in Table II (records 7 and 8). A considerable share of species of class *Rudero-Secalieta* is remarkable.

Class: Asplenietea rupestris
Order: Potentilletalia caulescentis
Alliance: Potentillon caulescentis

Table II.
ASPENIETUM RUTAE-MURARIAE - TRICHOMANIS

Table number of record	1	2	3	4	5	6	7	8		
Field number of record	1	2	3	4	5	140	105	106		
Date	6.6 1968	6.6 1968	6.6 1968	6.6 1968	6.6 1968	1.10 1968	20.8 1968	20.8 1968		
Exposure	S	S	S	S	E	ES	SE	SE		
Total plant cover %	35	30	60	55	80	25	50	25		
Area of sample plot /m ² /	5	7,5	2,5	7	1,4	5	10	15		
										Presence degree
I. Ch. Asplenietum rutae-murariae - trichomanis:										
Linaria cymbalaria	3.4	3.4	4.4	3.3					50	III
Asplenium ruta - muraria	+			+	2.2		1.1		50	III
Corydalis lutea					1.1		3.2	1.1	37,5	
II. Ch. Asplenietea rupestris:										
Cystopteris fragilis	+				+	1.1		2.2	50	III
Asplenium trichomanes									12,5	I
III. Other spp. (RS = Rudero-Secalieta):										
Chelidonium majus RS	+	1.2	+	3.2		1.1	1.1	+	75	IV
Taraxacum officinale		+		+		+	0		62,5	IV
Solidago serotina RS	1.1			+	1.1				50	III
Plantago maior RS	+	+		+					37,5	II
Urtica dioica		+	1.2			+			37,5	II
Erigeron canadensis RS						+	1.1	+	37,5	II
Galeopsis cfr. tetrahit RS	+	+							25	II
Poa annua RS	+2								25	II
Epilobium montanum				+		+			25	II
Poa compressa						1.1	+		25	II
Senecio vulgaris RS						+	+		25	II
Bryophytes:										
Tortula muralis	1.1	+					1.1		37,5	II
Number of spp.:										
Total	10	9	3	6	13	12	11	6	8,7	
Accidental spp.	1	1	0	2	6	3	5	0	2,2	

Asplenietum rutae-murariae falls within the system aside of montane associations of limestone fissures, such as *Potentillo-Hieracietum* Br.-Bl. 1933 from the Alps (Oberdorfer, 1957), or Tatric association *Draba tomentosa-Artemisia petrosa* (Medwecka-Kornaś, Kornaś and Pawłowski, 1959).

Fig. 3. Distribution of phytosociological records
 a — *Asplenium rutae-murariae-trichomanis*; b — *Tanacetum-Artemisietum*

Two facies can be differentiated within the association at Bielsko-Biala. One with *Linaria cymbalaria* always on walls of southerly exposition and rather strong insolation, and another one with *Corydalis lutea* in sites of easterly and south-deasterly exposition in slightly shaded station. The records from Cieszyn should be classified to the second facies. Patch from record 5 occupies an isolated position, being situated in shaded site. It is characterized by prevalence of *Sagina procumbens* and abundant *Bryophyta*. This record seems to stand close to *Sagino-Bryetum* which is entirely different phytosociologically but similar in ecological requirements.

Asplenietum rutae-murariae is an initial plant association. If human influence is limited it may keep in site several years. Man is the main cause of its destruction when walls are cleaned from the vegetation.

So far *Asplenietum rutae-murariae* was not mentioned from ruderal localities of Poland. Fragments of the association are known in natural sites, e.g. in the Cracow-Częstochowa Jura (Medwecka-Kornaś and Kornaś, 1963). This association was first described in ruderal sites of Rheinland by Tüxen (1937). It was also cited from similar sites of Belgium (Lebrun and others, 1949).

Table II — sites of records are marked in Fig. 3.

Accidental species:

III. *Arctium* sp. (RS) 5; *Dactylis glomerata* 6; *Euphorbia peplus* (RS) 7; *Gallinsoga parviflora* (RS) 7; *Glechoma hederacea* 4; *Lamium purpureum* (RS) 6; *Lamium* sp. 2; *Sagina procumbens* 5 (4.5); *Oxalis stricta* (RS) 7; *Rumex acetosella* 5; *Sonchus oleraceus* (RS) 4; *Stellaria media* (RS) 6; *Tanacetum vulgare* (RS) 1; *Viola* sp. 7. *Bryophyta*: *Bryum caespitium* 5; *Leptobryum pyriforme* 5; *Marchantia polymorpha* 5.

Hordeetum murini Libbert 1932

The association in its typical form develops in towns, on edges of streets, roads, on consolidated heaps of rubble, etc. It demands arenaceous, well pervious soils, rich in CaCO_3 and other mineral compounds. It occupies warm sites of very strong insolation. From such sites it was described by many authors in Europe (Libbert, 1932; Tüxen, 1937, 1950; Felföldy, 1942; Lebrun and others, 1949, Sissingh, 1950; Rochow, 1951; Pfeiffer, 1957; Weber, 1961; Sowa, 1964; Gutte, 1966). *Hordeetum murini* is very rare at Bielsko-Biala. Only one patch has been found on the surface of which a phytosociological record could be done. The ecology of the patch does not differ from that mentioned in literature. The association grows on small square situated between the road and uninhabited house. Substratum is sandy-gravelly-rubbish and exposition is to the south. Because of nearby road the vegetation is subject to weak trampling by people and dogs, who also manure

the site. Many authors (among others Sissingh, 1950; Weber, 1961; Gutte, 1966) accentuate the influence of trampling on the association. Libbert (1932) and Sowa (1964) are of different opinion believing that *Hordeetum murini* does not tolerate trampling.

The characteristic species of the association in the area are: *Hordeum murinum* and to lesser extent *Sisymbrium officinale*. There is lot of *Lolium perenne*, probably because of vicinity of patches of *Plantagini-Lolietum*. Patches of these associations do not contact with a sharp boundary but overlap.

Many diagnoses of lower phytosociological units within the association are to be found in literature. Among others the following subassociation have been distinguished: *Hordeetum murini typicum* Tüxen et Sissingh, 1942, *Hordeetum murini diplotaxietosum* Sissingh et Westhoff, 1946, (Sissingh, 1950), and a facies with *Lolium perenne* (Knapp, 1945). Because of its impoverished character the patch of association from Bielsko-Biała cannot be referred to any of those units.

Mechanical factors (trampling in particular) in proper intensity influence the stability of community. Weak trampling prolongs short period of lasting of *Hordeetum murini* (about 1 year) even to several years (Sissingh, 1950). Lack of this factor causes a succession toward *Tanaceto-Artemisietum*, excess — toward *Plantagini-Lolietum*. The latter phenomenon might have been observed at Bielsko-Biała.

In Poland *Hordeetum murini* is known from the Middle Odra River Basin (Libbert, 1932), the city of Łódź (Sowa, 1964), Chełm (Fijałkowski, 1963) and Lublin (Fijałkowski, 1967). According to map by Sissingh (1950) its range may be defined as Subatlantic-Middle European one.

The composition of *Hordeetum murini* at Bielsko-Biała is illustrated by the following record:

Record No. 27: Biała, Mariana Buczka street (Fig. 5a); 1(8) 1967; S exposition; surface 3 sq.m; cover 60%; pH 7.0; number of species — 14.

Ch. *Hordeetum murini*: *Hordeum murinum* 2.2, *Sisymbrium officinale* +; Ch. *Onopordetalia*: *Rumex obtusifolius* +, *Chrysanthemum parthenium* +; Ch. *Rudero-Secalieta*: *Galinsoga parviflora* 1.1, *Poa annua* +, *Chenopodium album* +, *Matricaria discoidea* +, *Sonchus oleraceus* +, *Erysimum cheiranthoides* +, *Polygonum aviculare* +; Other (spp.) *Lolium perenne* 2.2, *Agrostis* sp. 1.1, *Taraxacum officinale* +.

Tussilago farfara community (Table III)

Pioneer aggregations of *Tussilago farfara* develop at Bielsko-Biała on building grounds, earth works, humid, loamy heaps of rubble with small admixture of skeletal parts. Similar communities were described both by Polish and foreign authors from natural and ruderal sites. The communities of *Tussilago farfara* usually occupy open sites, but largely differentiated in ecological conditions. From sites frequently shaded — on

wet, gravelous soils in river alluvium (Zarzycki, 1956), through ruderal ones such as, e.g. heaps of rubble (Oberdorfer, 1957; Weber, 1961; Kostuch, 1960), areas of open mines of brown coal (Gutte, 1966) or slopes of chalk mines (Fijałkowski, 1963) to extremely xerothermal slopes of natural landslides (Ceynowa, 1968; Sławiński, 1952). In Bielsko-Biała the communities of *Tussilago farfara* are not rare but there were some difficulties in finding proper patches. This was due to frequent removal of stabilized heaps by man.

Species which locally individualize the community in question are *Tussilago farfara*, which attain the largest cover (4-5), and *Equisetum arvense* of much smaller cover but of rather high presence degree. *Epilobium adnatum* (Gutte, 1966) mentioned as characteristic for "Tussi-

Fig. 4. Presence diagrams of ruderal plant communities

A — *Tanaceto-Artemisietum*; B — *Plantagini-Lolietum*; C — community of *Tussilago farfara*

laginetum" in Leipzig was present only in two records from Bielsko-Biała. The community is moderately rich floristically (from 14 to 26 species); A large variability of specific content was observed (144 species per 7 phytosociological records). Distribution of presence degrees of that community in Bielsko-Biała is presented in Fig. 4C.

Various views can be found in Polish and foreign literature concerning the systematics of the *Tussilago farfara* communities. Klika (1950) and Tüxen (1937) classify these communities to class *Festuco Brometea* Br.-Bl. et Tx. 1944, order *Brometalia* (Koch, 1926 n.n.) Br.-Bl. 1936, alliance *Bromion erecti* (Koch, 1926 n.n.) Br.-Bl. 1936. Sławiński

Class: Rudero - Secalietea
Order: Onopordetalia
Alliance: Arction lappae

Table III.

COMMUNITY OF TUSSILAGO FARFARA									
Table number of record.....	1	2	3	4	5	6	7		
Field number of record.....	9	15	16	17	32	18	19		
Date.....	31.7 1968	31.7 1968	31.7 1968	31.7 1968	1968	31.7 1968	31.7 1968		
Exposure	NW	NW	W	W	N	N	N		
Total plant cover %/.....	130	130	120	100	120	120	130		
Height	100	70	40	50	70	130	120		
max. cm.									
average	50	20	20	20	30	70	30		
pH of soil	6,5	7,0	7,0	6,5	6,0	6,5	6,5		
Area of sample plot /m ² /	18	10	15	12	9	80	100		
								Presence %/	Presence degree
I. Dif. loc. Community of <i>Tussilago farfara</i> :									
<i>Tussilago farfara</i>	5.5	4.4	5.5	4.4	5.5	4.4	5.5	100	V
<i>Equisetum arvense</i>	.	+	+	.	1.1	1.1	+	71,5	IV
<i>Epilobium adnatum</i>	.	.	.	+	.	.	+	28,6	II
II. Ch. Arction lappae:									
<i>Tanacetum vulgare</i>	.	.	+	+	.	1.1	1.1	57,2	III
<i>Artemisia vulgaris</i>	.	.	.	.	.	+	+	28,6	II
III. Ch. Onopordetalia:									
<i>Sonchus oleraceus</i>	+	+	+	+	+	.	.	71,5	IV
<i>Potentilla anserina</i>	1.1	1.1	1.1	.	.	.	.	42,9	III
<i>Melilotus officinalis</i>	.	.	.	.	+	+	2.1	42,9	III
<i>Melilotus albus</i>	.	.	.	.	.	2.1	1.1	28,6	II
<i>Cirsium lanceolatum</i>	.	.	+	+	.	+	.	28,6	II
<i>Rumex obtusifolius</i>	.	.	.	+	.	.	.	28,6	II
IV. Ch. Rudero-Secalietea (SV = Secali - Violetalia):									
<i>Cirsium arvense</i>	+	.	1.1	+	.	+	+	85,8	V
<i>Plantago maior</i>	.	1.1	.	.	+	+	+	71,5	IV
<i>Tripleurospermum inodorum</i> (SV)	.	.	.	.	+	.	.	28,6	II
<i>Rumex crispus</i>	1.2	.	.	.	.	.	+	28,6	II
<i>Chenopodium album</i>	+	.	.	.	.	.	.	28,6	II
<i>Agropyron repens</i>	.	+	.	.	+	.	.	28,6	II
<i>Odontites rubra</i>	.	.	.	.	.	+	.	28,6	II
<i>Polygonum tomentosum</i> (SV)	.	.	.	+	.	.	.	28,6	II
V. Other spp. :									
<i>Ranunculus repens</i>	3.2	+	+	.	1.1	1.1	+	85,8	V
<i>Agrostis alba</i>	+	.	.	+	.	+	+	85,8	V
<i>Trifolium repens</i>	+	1.1	1.1	.	.	+	+	71,5	IV
<i>Medicago lupulina</i>	+	.	.	+	.	1.1	1.1	71,5	IV
<i>Plantago lanceolata</i>	.	+	.	+	+	.	.	57,2	III
<i>Taraxacum officinale</i>	.	.	+	.	.	+	.	57,2	III
<i>Lolium perenne</i>	+	2.2	1.1	1.1	.	.	.	57,2	III
<i>Crepis biennis</i>	.	.	+	+	.	+	.	42,9	III
<i>Deschampsia caespitosa</i>	.	.	.	+	.	.	+	42,9	III
<i>Achillea millefolium</i>	+	.	.	1.1	+	.	.	42,9	III
<i>Poa compressa</i>	.	.	.	.	.	+	1.1	28,6	II
<i>Trifolium pratense</i>	.	.	.	.	.	+	.	28,6	II
<i>Lathyrus pratensis</i>	+	.	.	+	.	.	.	28,6	II
Number of spp.									
total	26	15	14	21	26	19	23	20,5	
accidental spp.	12	1	1	3	11	2	5	7,0

Fig. 5. Distribution of phytosociological records

a — *Hordeetum murini*; b — community of *Tussilago farfara*; c — *Leonuro-Arctietum tomentosi*; d — community of *Chenopodium bonus-Henricus*

(1952) puts them to the same class and order but to the alliance *Mesobromion* (Koch, 1926) Br.-Bl. 1936. The riverside association *Tussilagineto-Pseudophragmitetum* Pawł. et Wal. 1949 from the Czywczyn Mts. as classified by Pawłowski and Walas (1949) to the order *Myricarietalia germanicae* Br.-Bl. 1931, alliance *Epilobion Fleicheri* Br.-Bl. 1931. Within the order *Onopordetalia* Br.-Bl. et Tx. 1943, alliance *Arction lappae* Tx. 1937 em. Siss. 1946, put the communities of *Tussilago farfara* the following authors (among others): Oberdorfer (1957), Weber (1961) and Ceynowa (1968). A thorough analysis of floristic lists concerning the communities of *Tussilago farfara* presented in papers of the above mentioned authors has revealed close connections of their composition with the communities of the direct vicinity. The bulk of the community is formed by *Tussilago farfara* but it is in each case accompanied by different set of species from contact associations. Penetration of species from them to the communities of *Tussilago farfara* is undoubtedly the first step of succession toward those associations. For instance near a xerothermal association the community of *Tussilago farfara* may develop into one of communities from the class *Festuco-Brometea*, on riverside gravels into *Petasitetum Kablikiani* (Pawłowski and Walas, 1949; Zarzycki, 1956).

Two patches of the community in question (Table III, records 6 and 7) form a separate facies with *Melilotus albus* and *M. officinalis*. Similar varieties of *Tussilago farfara* community were mentioned by Ceynowa (1968) from the Lower Vistula, and Gutte (1966) from Leipzig.

At Bielsko-Biała the succession of the *Tussilago farfara* community clearly tends toward *Tanaceto-Artemisietum*, but frequently in sites poor in nitrogen and more stony *Echio-Melilotetum albi* is an intermediate link. Facies with *Melilotus albus* and *M. officinalis* is a first stage of natural succession to *Echio-Melilotetum albi*.

The *Tussilago farfara* community is probably widespread all over Poland.

Table III — record stations are marked in Fig. 5.

Accidental species:

- II. *Sisymbrium officinale* 1.
- III. *Atriplex patulum* 1; *Galeopsis pubescens* 3; *Lactuca serriola* 5.
- IV. *Bidens tripartitus* 5; *Erysimum cheiranthoides* (SV) 5; *Galeopsis tetrahit* 1; *Galinsoga parviflora* (SV) 1; *Lapsana communis* (SV) 1; *Lolium multiflorum* 5; *Mentha arvensis* (SV) 5; *Poa annua* 5; *Polygonum aviculare* 1; *Rorippa silvestris* 5 (1.1); *Senecio vulgaris* 1; *Sonchus arvensis* (SV) 2; *S. asper* (SV) 1.
- V. *Aegopodium podagraria* 4; *Dactylis glomerata* 6 (+2); *Daucus carota* 7; *Epilobium hirsutum* 7; *Festuca pratensis* 3; *Glechoma hederacea* 4; *Linaria minor* 1; *Mentha longifolia* subsp. *spicata* 5 (1.1); *Phleum pratense* 6; *Polygonum mitte* 5; *Prunella vulgaris* 7; *Raphanus sativus* 1; *Rorippa palustris* 1; *Scrophularia nodosa* 4; *Solidago serotina* 7; *Stachys palustris* 7; *Trifolium hybridum* 5; *Vicia hirsuta* 1.

Tanaceto-Artemisietum develops within the boundaries of Bielsko-Biała frequently, mostly on garbage heaps, edges of roads, rail road and industrial areas. It occupies already fixed sites, in which during at least 3 - 4 vegetative seasons the influence of disturbing factors was limited to such an extent that almost free development vegetation was possible. The association grows well both on arid and humid sites, sandy, loamy and gravelous soils, moderately rich in nitrogen, with southerly and northerly expositions. *Tanaceto-Artemisietum* occupies large areas attaining up to 150 sq.m.

At Bielsko-Biała the following species are characteristic in the association: *Tanacetum vulgare*, *Artemisia vulgaris* and *Linaria vulgaris* (the latter species occurs only in railroad areas). *Tanaceto-Artemisietum* attains its full development in midsummer (end of July and August). That time mainly diagnostic species flower and together with other high perennial and biennial plants of the association as *Urtica dioica*, *Arctium minus*, *Rumex obtusifolius*, and *Solidago serotina* form the characteristic colourful aspect of the community. In well developed patches of *Tanaceto-Artemisietum* the vegetation is arranged in several layers. The highest one attaining in Bielsko-Biała over two metres in height is formed among others by *Tanacetum vulgare*, *Artemisia vulgaris*, *Rumex obtusifolius*, *Solidago serotina*, and frequently also by young trees and shrubs. A considerable amount of meadow species occurs in lower layers such as: *Daucus carota*, *Taraxacum officinale*, *Achillea millefolium*, *Lolium perenne*, *Plantago lanceolata*, *Trifolium repens*, *Deschampsia caespitosa*, *Dactylis glomerata*. Out of other plants rather frequent are: *Equisetum arvense*, *Erigeron canadensis*, *Poa compressa*, *Potentilla anserina*, *Chenopodium album* and *Plantago maior*. Similarly as in Łódź (Sowa, 1964) species of winding plants occur in this association such as: *Convolvulus arvensis* and *Calystegia sepium* attaining in some patches a cover of 3 degree. The association is diversified floristically. In 26 phytosociological records 15 to 45 species have been noted (approximately 26 per one record). There is large number of sporadic species (over 120) (Fig. 4A).

Variability of sites occupied by *Tanaceto-Artemisietum* causes development of patches differing in occurrence or lack of particular species. This comprised a basis to describe many lower phytosociological units within *Tanaceto-Artemisietum* by many authors, for example subassociations; *Tanaceto-Artemisietum arctietosum* (Braun-Blanquet, 1948; Oberdorfer, 1957 and others), *T.-A. chrysanthemetosum* (Oberdorfer, 1957; Faliński, 1966), *T.-A. hypericetosum* (Gutte 1966; Sissingh, 1950), *T.-A. diplotaxetosum* (Sissingh, 1950), and facies with *Tussilago farfara* (Gutte, 1966). At Bielsko-Biała the asso-

ciation in question develops in two separated forms. Dry and moderately rich in mineral compounds sites such as rubbish roadsides and railroad areas are occupied by a community showing combination of species typical for *Tanaceto-Artemisietum* (Sissingh, 1950). In patches rich in nitrogen and more wet situated frequently directly on dumping grounds or in vicinity appear in great numbers *Arctium minus*, *Rumex obtusifolius*, and *Urtica dioica*, which in confrontation with the published data (Gutte, 1966; Faliński, 1966; Oberdorfer, 1957) allows to differentiation of subassociation *Tanaceto-Artemisietum arctietosum*. *Arctium tomentosum*, *Cirsium arvense*, *Taraxacum officinale* and *Calystegia sepium* play major role in this type of community. The presence of *Arctium tomentosum* which attains large covers in some cases, may suggest a connection between *Tanaceto-Artemisietum arctietosum* and *Leonuro-Arctietum tomentosi* for which the species in question is characteristic. This is probably caused by similar ecological conditions in sites of *Tanaceto-Artemisietum arctietosum* to site types preferred by *Arctium tomentosum*.

Tanaceto-Artemisietum is always one of farther links in natural succession of ruderal communities. Under favourable conditions it keeps in the same site even several years. Such stability is mainly due to the prevalence of geophytes, hemicryptophytes and chamaephytes in the association (Sissingh, 1952). With time *Tanaceto-Artemisietum* changes into an association of higher organisation of forest or seldom meadow type as *Arrhenatheretum* (Gutte, 1966). At Bielsko-Biała the succession trend is marked by abundant undergrowth of such species as *Acer negundo*, *Alnus incana*, *Pirus communis*, *Populus nigra*, *P. nigra* var. *italica*, *P. cfr. Simoni*, *Rubus* sp., *Salix caprea*, *S. fragilis*, *S. daphnoides*, *S. cinerea*, *S. caprea*, *S. fragilis* × *S. alba*, and *Sambucus nigra*.

A broad ecological amplitude of the whole association and small requirements of the two main characteristic species (native in the area), cause great distribution of *Tanaceto-Artemisietum* in Poland (Faliński, 1966; Fijałkowski, 1963, 1967; Sowa, 1964) and many other European countries (Braun-Blanquet, 1948; Gutte, 1966; Oberdorfer, 1957; Sissingh, 1950; Rochow, 1951; Weber, 1961).

Table IV — localities of records are given in Fig. 3.

Accidental species:

- III. *Aethusa cynapium* 9; *Arctium lappa* 4, 14, 26 (2.1); *Armoracia lapathifolia* 3 (1.2), 5; *Chelidonium maius* 5, 8, 10, 12, 13; *Epilobium adnatum* 13; *Malva silvestris* 2 (3.4), 8, 10, 14; *Sisymbrium officinale* 1, 3, 20.
- IV. *Atriplex patulum* 11, 20; *Barbarea vulgaris* 10 (1.1); *Bunias orientalis* 13; *Carduus acanthoides* 10, 18; *Echium vulgare* 10, 14, 15, 23; *Galeopsis pubescens* 18, 20 (1.1); *Lactuca scariola* 12, 15, 16, 19, 22; *Lepidium ruderae* 2; *Melilotus officinalis* 14; *Sisymbrium altissimum* 23; *S. Loeselii* 12, 23; *Verbascum thapsus* 10, 14.

Table IV.

Table number of record.....		1	2	3	4	5	6	7	8	9	10	11	12	TANACETO - ARTEMISIETUM												18	19	20	21	22	23	24	25	26	Presence / %	Presence degree
Field number of record		11	12	14	21	22	23	30	31	40	41	102	54	13	14	15	16	17	18	19	20	21	22	23	24	25	26									
Date		31.7	31.7	31.7	1.8	1.8	1.8	2.8	2.8	4.8	4.8	10.8	5.8	6.8	6.8	6.8	26	29	33	53	78	82	75	74	73	79	69									
Exposure		1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968									
Total plant cover /% /		N	NE	N	E	N	N	E	NE	W	W	E	E	SW	NE	N	NE	E	N	W	SE	E	NW	W	W	E	E									
Height		160	140	170	150	160	130	150	130	130	100	140	150	150	140	130	80	130	150	160	130	130	140	95	95	140	120									
Height max. average cm.		150	170	170	170	170	150	200	170	200	180	170	170	200	200	180	130	170	180	150	220	200	120	200	210	230	180									
pH of soil		7.5	6.5	7.0	7.5	7.5	7.5	6.5	7.0	8.0	6.5	8.0	7.0	6.5	7.0	7.0	7.0	7.0	7.5	7.0	7.0	6.5	7.5	6.0	8.0	7.5	8.0									
Area of sample plot /m ² /		10	40	150	150	170	100	35	50	30	110	7	50	50	50	100	30	150	40	70	70	5	15	10	40	15	25									
I. Ch. Tanaceto - Artemisieta:																																				
Artemisia vulgaris		3.3	2.2	3.3	+	1.1	.	3.2	2.2	3.2	3.2	3.3	4.3	4.3	3.3	4.4	2.2	2.2	4.3	2.2	3.2	3.2	4.3	4.4	3.3	3.2	3.2	96.1	V							
Tanacetum vulgare		3.2	2.2	3.2	4.4	4.3	4.4	1.1	2.2	2.2	2.2	3.3	1.1	2.2	3.2	2.2	2.2	2.2	3.2	4.3	3.3	1.1	1.1	1.1	3.3	2.2	2.2	100	V							
Linaria vulgaris		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.1	+	+	+	+	15.3	I							
II. Dif. loc. Tanaceto-Artemisieta																																				
arctioides:																																				
Arctium minus		+	3.2	2.1	+	1.1	+	3.3	+	+	2.2	1.1	+	+	+	.	.	.	+	.	.	.	+	.	.	+	.	65.3	IV							
Urtica dioica		+	.	1.1	2.2	1.1	1.1	1.1	2.2	1.1	+	1.1	+	1.1	1.1	+	.	+	.	+	.	.	.	.	.	.	1.1	69.2	IV							
Rumex obtusifolius		1.1	.	1.1	2.2	1.1	1.1	.	+	.	1.1	.	.	+	.	+	+	.	.	+	.	.	.	.	.	.	.	38.4	II							
III. Ch. Arction leppae:																																				
Tussilago farfara		.	1.1	1.1	1.1	1.1	1.1	.	1.1	.	+	.	.	.	2.2	2.1	1.1	+	.	.	.	.	.	.	.	.	1.1	57.6	III							
Arctium tomentosum		2.2	.	1.1	1.1	1.1	+	+	.	+	.	.	.	+	.	+	+	1.1	.	.	.	.	.	.	.	.	.	46.1	III							
Equisetum arvense		.	.	+	.	.	+	.	+	.	.	.	+	.	.	.	+	.	.	.	.	1.1	.	.	.	.	.	26.9	II							
IV. Ch. Onopordetalia:																																				
Melandrium album		.	1.1	.	.	+	+	.	+	+	+	.	.	+	+	.	.	.	+	.	.	.	.	.	.	.	.	42.3	III							
Sonchus oleraceus		.	+	+	+	+	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	30.7	II							
Cirsium lanceolatum		.	.	+	+	+	.	1.1	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	30.7	II							
Melilotus albus		.	.	+	.	.	1.1	1.1	+	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	26.9	II							
Potentilla anserina		+	+	.	.	.	.	.	.	.	1.1	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	26.9	II							
Cichorium intybus		.	.	.	.	.	.	.	.	.	.	.	.	+	1.1	.	.	.	.	.	.	.	.	.	.	.	+	23.0	II							
Erigeron canadensis		.	1.1	.	.	.	.	+	+	.	1.1	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	23.0	II							
V. Ch. Rudero - Secalietea (SV = Secali																																				
Violetalia):																																				
Tripleurospermum inodorum (SV)		.	+	.	.	.	.	.	+	.	.	.	+	+	+	+	+	.	.	.	1.1	+	.	.	.	.	.	46.1	III							
Plantago maior		.	+	+	+	+	.	.	+	.	.	.	.	1.1	+	+	+	.	.	.	.	.	.	.	.	.	.	42.3	III							
Cirsium arvense		.	.	.	+	1.1	1.1	.	+	.	.	.	.	+	+	+	+	1.1	+	.	.	.	.	.	.	.	.	42.3	III							
Chenopodium album		1.1	.	.	+	.	.	.	.	.	.	.	+	.	.	1.1	.	.	.	.	.	.	.	.	.	.	.	30.7	II							
Erysimum cheiranthoides (SV)		+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	30.7	II							
Poa annua		+	.	.	.	.	.	1.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.1	.	30.7	II							
Torilis japonica		.	.	.	.	.	.	2.2	+	.	.	.	1.1	+	.	.	1.1	.	+	.	.	.	.	.	.	.	.	26.9	II							
Convolvulus arvensis		.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	2.2	.	3.3	+	.	.	.	.	23.0	II							
Rumex crispus		.	+	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	23.0	II							
VI. Other spp. :																																				
Achilles millefolium		+	1.1	2.2	+	+	.	.	2.2	+	+	1.1	3.2	2.2	1.1	+	+	2.2	+	1.1	+	1.1	+	1.1	+	1.1	92.3	V								
Taraxacum officinale		+	+	.	+	+	.	.	+	+	+	.	.	.	1.1	+	+	.	.	.	1.1	+	+	+	.	.	1.1	65.3	IV							
Daucus carota		+	+	1.1	+	+	.	.	+	+	+	.	.	.	.	2.2	.	+	.	.	.	.	.	.	.	.	.	53.8	III							
Solidago serotina		.	.	1.1	1.1	.	.	1.1	.	.	.	.	1.1	1.1	.	.	.	1.1	.	.	.	.	.	.	.	1.1	50.0	III								
Ranunculus repens		.	1.1	.	+	1.1	1.1	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.1	42.3	III								
Agrostis alba		.	.	.	+	+	.	.	.	.	1.1	.	1.1	.	.	.	.	.	.	.	.	.	2.2	1.1	.	.	.	38.4	II							
Aegopodium podagraria		+	.	1.1	+	+	.	.	.	.	.	.	.	.	.	.	.	1.1	+	.	.	.	.	.	.	.	.	34.6	II							
Plantago lanceolata		+	2.2	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	34.6	II							
Trifolium repens		.	.	.	+	.	1.1	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	34.6	II							
Calystegia sepium		+	+	1.1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	30.7	II							
Poa compressa		.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	30.7	II							
Lolium perenne		.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.1	.	26.9	II							
Deschampsia caespitosa		.	.	1.1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	1.1	+	.	.	.	.	.	.	.	26.9	II							
Lamium maculatum		.	.	.	+	.	.	.	.	.	.	.	.	1.1	1.2	.	.	.	.	.	.	.	.	.	.	.	.	26.9	II							
Dactylis glomerata		.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.1	.	.	23.0	II							
Number of spp.																																				
Total		29	36	31	41	36	34	14	27	18	35	16	25	32	30	32	30	21	31	15	15	20	22	30	27	20	21	26.5								
Accidental spp.		13	18	11	13	14	11	3	8	5	16	5	11	13	13	13	9	5	14	7	8	10	8	14	12	5	6	10.2								

Class: Rudero - Secalietea
Order: Onopordetalia
Alliance: Arction lappae

Table V.

LEONURO - ARCTIETUM TOMENTOSI FRAGM.

Table number of record	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Presence /%	Presence degree
Field number of record.....	28	36	52	45	51	62	89	59	60	61	63	65	13	88		
Date.....	1.8	2.8	3.8	3.8	3.8	6.8	8.8	6.8	6.8	6.8	6.8	6.8	31.7	8.8		
Exposure	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968		
Total plant cover %/.....	NE	N	NW	NW	NE	NE	W	NW	NE	NE	NE	NW	NE	S		
max	110	170	120	130	100	130	100	140	120	150	160	120	170	130		
Height	200	100	180	170	170	200	180	160	190	210	200	180	170	120		
average cm.	80	50	160	150	150	170	130	100	140	160	170	120	150	100		
pH of soil.....	6,5	6,5	6,5	7,5	7,0	7,0	7,0	8,0	7,0	7,0	6,0	7,0	6,5	7,0		
Area of sample plot /m2/	30	7	55	40	120	35	40	10	90	200	75	20	55	50		
I. Ch. Leonuro - Arctietum tomentos:																
Arctium tomentosum	4.3	4.4	4.4	4.3	3.2	5.5	3.3	3.3	4.4	4.4	4.4	4.4	3.2	4.4	100	V
Ballota nigra	.	.	.	.	.	.	.	+	+	1.1	.	.	.	.	21,4	II
II. Ch. Arction lappae:																
Artemisia vulgaris	+	.	.	.	2.2	+	.	2.2	1.1	2.2	+	+	.	.	57,2	III
Sisymbrium officinale	.	.	+	.	+	+	.	+	+	+	.	+	.	+	57,2	III
Armoracia lapathifolia	2.2	2.2	1.1	.	.	.	.	.	.	.	.	3.3	3.2	.	35,7	II
Arctium minus	.	.	.	.	.	.	2.2	.	.	.	.	.	2.2	+	21,4	II
III. Ch. Onopordetalia:																
Rumex obtusifolius	.	.	+	1.1	1.1	.	.	.	+	.	.	+	1.1	.	42,9	III
Potentilla anserina	.	.	.	.	+	.	+	+	.	1.1	.	.	+	+	42,9	III
Melandrium album	.	.	.	.	.	+	.	+	+	+	.	.	.	.	28,6	II
Sonchus oleraceus	+	.	.	.	.	.	+	.	.	.	.	+	.	.	21,4	II
Atriplex patulum	.	.	+	.	.	.	.	.	+	.	.	.	.	+	21,4	II
IV. Ch. Rudero-Secalietea (SV = Secali - Violetalia):																
Plantago maior	+	.	+	.	+	.	+	+	.	+	.	.	+	+	57,2	III
Polygonum nodosum	1.1	.	.	.	.	+	.	2.2	+	.	+	+	.	+	50,0	III
Cirsium arvense	+	.	.	.	+	.	+	.	+	+	.	.	1.1	+	50,0	III
Rumex crispus	+	1.1	.	.	.	.	1.1	.	+	+	.	.	1.1	+	50,0	III
Poa annua	+	.	+	.	+	.	1.1	1.1	.	+	.	1.1	.	.	50,0	III
Polygonum aviculare	.	.	+	.	.	+	.	+	+	+	.	1.1	.	+	50,0	III
Cichorium intibus	.	.	.	.	.	+	+	.	+	+	.	+	.	1.1	42,9	III
Lolium multiflorum	.	.	.	.	.	1.1	.	1.1	1.1	.	.	1.1	.	+	35,7	II
Galinsoga parviflora (SV)	1.1	.	+	.	.	+	.	+	.	.	.	+	.	.	35,7	II
Chenopodium album	1.1	.	+	.	.	+	.	1.1	.	.	.	.	.	2.2	35,7	II
Matricaria discoidea	.	.	.	.	.	.	.	+	+	+	.	+	.	.	28,6	II
Capsella bursa - pastoris	.	.	.	.	.	+	.	.	+	+	.	.	.	+	28,6	II
Polygonum tomentosum (SV)	.	.	+	.	.	.	.	.	+	+	.	.	+	+	28,6	II
Torilis japonica	.	.	.	.	.	+	.	.	2.2	2.2	.	.	.	.	21,4	II
V. Other asp.:																
Urtica dioica	.	2.2	2.2	1.1	1.1	.	1.1	.	+	1.1	.	.	1.1	2.2	64,3	IV
Dactylis glomerata	.	.	.	+	.	1.1	2.3	+	+	1.1	3.4	.	.	+	57,2	III
Achillea millefolium	.	.	.	.	.	1.1	+	1.1	+	+	+	.	.	+	50,0	III
Aegopodium podagraria	.	.	.	.	.	.	.	2.2	2.2	2.2	1.1	1.1	1.1	1.1	50,0	III
Taraxacum officinale	+	.	+	.	.	.	1.1	.	.	.	.	+	.	+	35,7	II
Chaerophyllum aromaticum	.	2.2	1.1	3.2	+	1.1	.	.	.	.	.	.	.	.	35,7	II
Ranunculus repens	.	+	1.1	+	+	.	.	.	.	.	.	.	.	1.1	35,7	II
Lolium perenne	.	.	+	.	.	+	.	+	.	.	.	+	.	.	28,6	II
Heracleum sphondylium	.	.	.	+	.	.	+	.	.	.	1.1	.	1.1	.	28,6	II
Lamium maculatum	.	2.2	+	.	.	.	1.1	.	.	.	.	.	.	.	21,4	II
Anthriscus silvester	.	1.1	.	.	.	.	.	.	+	.	2.2	.	.	.	21,4	II
Glechoma hederacea	.	1.1	.	+	.	.	.	.	.	.	.	.	.	1.1	21,4	II
Calystegia sepium	.	+	1.1	.	.	.	.	.	.	.	.	.	.	+	21,4	II
Mentha longifolia subsp. spicata	.	.	.	+	.	.	.	.	.	+	.	.	.	+	21,4	II
Trifolium repens	.	.	.	.	.	.	+	.	.	+	.	.	.	+	21,4	II
Number of spp.																
total	22	11	24	11	23	20	20	21	26	25	12	18	17	44	21,0	
accidental spp.	10	1	6	2	12	4	4	3	4	4	4	2	5	19	5,7	

- V. *Acer negundo* 26 (1.1); *Agropyron repens* 9, 14 (1.1), 21 (1.1), 23; *Amaranthus retroflexus*, 20; *Arctium tomentosum* $\times$ *A. lappa* 14; *Arctium* sp. 22 (+°); *Bidens tripartitus* 1, 2, 20, 23; *B. sp.* 4; *Capsella bursa pastoris* 22; *Crepis capillaris* 10, 15; *Epilobium adenocaulon* 7, 24; *Erigeron annuus* 1, 4 (1.1); *Euphorbia helioscopia* (SV) 15, 16; *E. peplus* (SV) 8, 16; *Galeopsis ladanum* 16; *G. tetrahit* 3 (1.1); *Galinsoga parviflora* (SV) 2, 8 (1.1), 22, 23, 24; *G. quadriradiata* (SV) 13; *Impatiens parviflora* 5, 14, 18, 26 (1.1); *Lapsana communis* (SV) 5, 10, 13; *Lolium multiflorum* 2 (+2), 3 (1.1), 5, 10, 24; *Matricaria discoidea* 2, 15, 16; *Mentha arvensis* (SV) 2, 6, 15; *Odontites rubra* 6; *Oenothera* sp. 12, 13 (1.1), 23 (1.1), 24 (1.1); *Oxalis stricta* (SV) 10, 13 (1.1), 24; *Polygonum aviculare* 2 (2.1), 15, 21, 24; *P. convolvulus* (SV) 4; *P. cuspidatum* 1 (3.4), 4, 5, 17 (1.1), 25 (1.1); *P. hydropiper* 4, 5, 21, 23; *P. nodosum* 2, 15, 20; *P. persicaria* (SV) 13; *P. tomentosum* (SV) 1, 2, 24; *P. sp.* 5; *Reseda lutea* 23; *Rudbeckia hirta* 1 (1.1); *Rumex confertus* 3; *Sambucus nigra* 25 (2.2); *Senecio viscosus* 16, 21, 23, 24; *S. vulgaris* 1, 2, 23, 26; *Setaria glauca* (SV) 23; *Solanum nigrum* (SV) 12; *Sonchus arvensis* (SV) 3, 25; *S. asper* (SV) 12 (1.1); *Stellaria media* 22.
- VI. *Alnus incana* 11; *Angelica silvestris* 18; *Anthriscus silvester* 14, 25; *Arabis arenosa* 18, 21, 24; *Arrhenatherum elatius* 18, 19 (2.2), 21, 23; *Calamagrostis epigeios* 6, 17, 18, 19; *Centaurea oxylepis* 5, 15, 23 (1.1), 21 (1.1), 24 (1.1); *C. oxylepis* $\times$ *C. jacea* 1; *Chrysanthemum leucanthemum* 10; *Cirsium oleraceum* 18; *Cosmos* sp. 2; *Crepis biennis* 4, 6, 8, 20, 26; *Epilobium hirsutum* 18; *Eupatorium cannabinum* 26; *Festuca gigantea* 20; *F. pratensis* 7 (1.1), 16, 17; *Galium mollugo* 9 (1.1), 18, 19 (1.1); *Geranium Robertianum* 10; *Glechoma hederacea* 11 (2.2), 17, 26 (2.2); *Heracleum sphondylium* 3, 4, 18, 25; *Hieracium* sp. 11; *Holcus lanatus* 5, 6, 12, 16, 17; *Hypericum perforatum* 2, 4, 8, 13, 15; *Lycopus europaeus* 3, 6; *Lysimachia vulgaris* 21; *Mentha longifolia* subsp. *spicata* 3, 4, 8 (1.1), 10; *Medicago lupulina* 2, 12, 14, 24; *M. sativa* 15, 24; *M. sp.* 22 (+°); *Phleum pratense* 5, 6, 9; *Pirus communis* 9 (+°); *Poa palustris* 18, 22; *P. pratensis* 7, 13, 14, 19; *Populus nigra* 6; *P. nigra* var. *italica* 1; *P. cfr. Simoni* 6; *Potentilla norvegica* 2; *P. reptans* 11 (2.2); *Prunella vulgaris* 4, 13, 15; *Rubus* sp. 10, 13 (1.1), 14, 15; *Rorippa palustris* 1, 5, 10; *Rumex acetosa* 18, 22; *Salix caprea* 1, 3, 4, 6 (1.1); *S. daphnoides* 6; *S. fragilis* 5; *S. cinerea* $>$ *S. caprea* 12 (2.2); *S. fagilis* $\times$ *S. alba* 13; *Scrophularia nodosa* 18; *Solanum tuberosum* 1, 2, 16; *Solidago virga-aurea* 12; *Stellaria graminea* 19 (1.1); *Symphytum officinale* 1 (2.1), 2, 12; *Tragopogon pratensis* 10; *Trifolium pratense* 4, 5; *Triticum vulgare* 2, 3; *Verbascum nigrum* 8, 19; *Vicia cracca* 21.

Leonuro-Arctietum tomentosum (Felföldy, 1942) Lohmeyer, 1950
(Table V)

Leonuro-Arctietum tomentosum because of its high edaphic requirements occurs chiefly in villages, on sites manured with excrements of domestic animals, on edges of drains and dungpits. Optimal conditions it finds in warm and moderately wet sites. Its high affiliation to sites rich in nutritious components can be illustrated by the fact that *Leonuro-Arctietum tomentosum* is to be found in slightly shaded sites what prevents to some extent excessive outwashing of mineral substances from soil (K o r n a ś, 1952). At Bielsko-Biała the association in question occupies an area from 7 to 200 sq.m, mainly in the peripheries which is justified by lack of proper sites in the centre of the town. It occurs in

fertile sites (heaps of organic waste, sites after old cow dung dumps, etc.).

Arctium tomentosum and *Ballota nigra* are the characteristic species of *Leonuro-Arctietum tomentosi* in Bielsko-Biala. Other characteristic species mentioned for *Leonuro-Arctietum tomentosi* (Kornaś, 1952; Tüxen, 1950; Weber, 1961) either do not occur at all in Bielsko-Biala (*Leonurus cardiaca*, *Conium maculatum*), or belong to rarities (*Nepeta cataria*, *Aethusa cynapium*). Lack of a set of characteristic species proves the pauperization and fragmentary development of the patches of association. Similar pauperization is to be observed in Łódź

Fig. 6. Presence diagrams of ruderal plant communities

A — *Leonuro-Arctietum tomentosi*; B — *Sisymbrietum sophiae*; C — community of *Chenopodium bonus-Henricus*; D — *Asplenietum rutae-murariae-trichomanis*; E — community of *Urtica dioica-Rumex obtusifolius*

(Sowa, 1964) where in some patches (5 per 12) only one characteristic species is present — *Arctium tomentosum*. Mainly large perennial and biennial plants such as *Arctium tomentosum*, *Ballota nigra*, *Artemisia vulgaris*, *Urtica dioica* form the association at Bielsko-Biała. They constitute the highest layer of vegetation there. *Arctium tomentosum* is the dominant and most common species as it grows in all patches. *Ballota nigra* occurs in 3 records only. In the lower layer there occur among others: *Galinsoga parviflora*, *Plantago maior*, *Poa annua*, *Taraxacum officinale*, *Ranunculus repens* which penetrate from the neighbouring fields and meadows. The presence degree of species presented in the phytosociological table (Table V) is illustrated on diagram (Fig. 6A).

The facies of association with *Aegopodium podagraria* is of particular interest in the area. It develops in more humid and shaded sites. Its characteristic species are: *Aegopodium podagraria*, *Dactylis glomerata*, *Achillea millefolium* and *Lolium perenne*. *Ballota nigra* occurs only in these patches.

The presence of facies with *Aegopodium podagraria* connects *Leonuro-Arctietum tomentosi* with *Balloto-Arctietum* (Br.-Bl. et de Leeuw, 1936) Sissingh 1946 of Western, Europe, within which Sissingh (1950) has described from Holland a facies with *Aegopodium podagraria*, *Urtica dioica*, *Lamium album* and *Rumex obtusifolius* with large amount of *Dactylis glomerata* and *Lolium perenne*. The area of *Leonuro-Arctietum tomentosi* embraces warmer and more arid parts of Eastern and South-Eastern Europe (Tüxen, 1950). *Balloto-Arctietum* occurs in the west of Europe (Sissingh, 1950) showing its eastern boundary in Central Europe (Kornaś, 1952). The likeness between *Leonuro-Arctietum tomentosi* and *Balloto-Arctietum* is proved by the same ecological requirements and large number of common species. Nevertheless, there exist considerable differences in geographical distribution and presence of characteristic species. Some of them, e.g. *Arctium tomentosum* do not occur in *Balloto-Arctietum* and instead there is *Chenopodium bonus-Henricus* (Kornaś, 1952; Sissingh, 1950). The association *Arctio-Chenopodietum* described by Oberdorfer (1957) from the Danube river in which occur with *Arctium tomentosum* and *Chenopodium bonus-Henricus* shows affiliations to both above mentioned associations and constitutes a transitional link between them.

Leonuro-Arctietum tomentosi has developed at Bielsko-Biała in site of previous initial communities consisting of nitrophilous species such as *Urtica dioica*, *Potentilla anserina*, *Chenopodium album*, *Ch. polyspermum*, or as a successive stage after *Tanaceto-Artemisietum arctietosum*. The association in question keeps in one station through several years. Undergrowth of trees and bushes suggest that its farther development is toward a community of scrub type.

Leonuro-Arctietum tomentosi was first described in Poland from

rural areas in the Cracow Jura (K o r n a ś, 1952). Later on it was distinguished in the Białowieża Forest (F a l i ŋ s k i, 1966) and in the district of Rypin (K o r n i a k, 1966). It is mentioned also from towns in which it occupies sites beyond areas densely covered by buildings. These are: Łódź (S o w a, 1964), Lublin (F i j a ł k o w s k i, 1967), and Chełm (F i j a ł k o w s k i, 1963). It is supposed that this association is widely distributed in Southern and Eastern Poland.

Table V — record sites are given in Fig. 5.

Accidental species:

II. *Arctium lappa* 5, 10; *Epilobium adnatum* 4; *Malva silvestris* 12.

III. *Cirsium lanceolatum* 1, 5; *Erigeron canadensis* 1.

IV. *Bidens cernuus* 6; *B. tripartitus* 11 (1.1); *Chenopodium polyspermum* (SV) 8, 14; *Convolvulus arvensis* 14; *Erysimum cheiranthoides* (SV) 9; *Euphorbia helioscopia* (SV) 14; *Galeopsis pubescens* 3, 14; *Galinsoga quadriradiata* (SV) 12 (1.1), 14 (1.1); *Impatiens parviflora* 2; *Lamium purpureum* (SV) 5; *Lapsana communis* (SV) 5, 14; *Polygonum Brittingeri* 1; *P. convolvulus* (SV) 1, 14; *P. cuspidatum* 3, 13 (1.1); *P. hydropiper* 3, 9; *Senecio vulgaris* 1; *Sisymbrium altissimum* 6, 8; *Sonchus arvensis* (SV) 14; *Veronica persica* (SV) 14.

V. *Achillea ptarmica* 3; *Aesculus hippocastanum* 5; *Agrostis alba* 10; *Alchemilla* sp. 5, 13; *Antriscus nitida* 5; *Arrhenatherum elatius* 6, 11; *Campanula trachelium* 14; *Cerasus avium* 1; *Cirsium oleraceum* 4, 11; *Crepis biennis* 7; *Daucus carota* 14; *Deschampsia caespitosa* 3, 13 (1.1); *Epilobium* sp. 1; *Epilobium roseum* × *E. sp.* 5; *Festuca pratensis* 8; *Galeopsis* sp. 9, 10; *Geum urbanum* 5; *Medicago falcata* 14; *M. lupulina* 14; *M. sativa* 14; *Plantago lanceolata* 14; *Poa compressa* 7, 9; *P. palustris* 3, 13; *Prunella vulgaris* 5; *Rubus idaeus* 1; *Salvia verticillata* 7, 14; *Salix fragilis* 5; *Solanum tuberosum* 1, 13; *Solidago serotina* 1, 11; *Stachys silvatica* 5; *Trifolium pratense* 6, 14; *Tropaeolum maius* 14; *Tussilago farfara* 7 (1.1), 14; *Verbascum nigrum* 10.

Chenopodium bonus-Henricus community (Table VI)

This community develops at Bielsko-Biała in sites rich in nitrogen, and first of all rich in humus substances, in old neglected gardens or directly on compost heaps. Usually it occupies sites near fences and walls along which it develops in narrow belts never exceeding 0.5 m in width. Analysis of patches of *Chenopodium bonus-Henricus* clearly shows that this community requires shaded sites protected from heavy rains and too high temperature. Taking into consideration all the ecological factors one must say that its habitat is most similar to that of *Leonuro-Arctietum tomentosum*. It should be mentioned however, that the *Chenopodium bonus-Henricus* community never appears on overmanured sites (e.g. edges of dungpits) preferred by *Leonuro-Arctietum tomentosum*. At Bielsko-Biała it is not common. Despite of 8 phytosociological records done, the representative patches are grouped in three points of the investigated area. In all these points they develop beyond the urban area, in sites of small ground floor buildings surrounded by old gardens.

Chenopodium bonus-Henricus is the dominant species in the commu-

nity. It attains almost maximal cover and density in all patches. *Urtica dioica*, *Arctium minus* and *Aegopodium podagraria* take part in the association as well. Many plants pass from patches of contact communities, i.e. meadows and roadsides (on which most common is *Plantagini-Lolietum* -

Class: Rudero-Secalietae
Order: Onopordetalia
Alliance: Arction lappae

Table VI.
Community of *Chenopodium bonus - Henricus*

Table number of record	1	2	3	4	5	6	7	8	Presence %	Presence degree
Field number of record	43	37	92	93	94	95	97	98		
Date	3.8 1968	2.8 1968	8.8 1968	8.8 1968	8.8 1968	10.8 1968	10.8 1968	10.8 1968		
Exposure	NW	SW	W	S	S	W	S	SE		
Total plant cover %	90	110	130	130	110	100	120	110		
Height	max. cm.	...	70	110	60	70	...	...		
average	40	50	50	50	40	40	30	40		
pH of soil	7,0	7,5	8,0	8,0	7,0	7,0	7,0	...		
Area of sample plot /m ² /	1,2	2	2	3	3	3	2,5	10		
I. Dif. loc. Community of										
<i>Chenopodium bonus - Henricus</i> :										
<i>Chenopodium bonus - Henricus</i>	4.4	5.5	5.5	4.5	4.4	4.4	5.5	5.5	100	V
II. Ch. Arction lappae i Onopordetalia:										
<i>Sisymbrium officinale</i>	.	+	+	.	+	+	+	+	75	IV
<i>Arctium minus</i>	+	.	.	2.2	1.1	.	.	1.1	50	III
<i>Rumex obtusifolius</i>	.	.	.	.	+	1.1	.	.	25	II
III. Ch. Rudero - Secalietae (SV = Secali - Violetalia):										
<i>Plantago maior</i>	+	.	+	+	+	1.1	+	+	87,5	V
<i>Poa annua</i>	1.1	+	.	.	+	.	1.1	+	62,5	IV
<i>Matricaria discoidea</i>	.	.	+	+	+	+	+	.	62,5	IV
<i>Polygonum aviculare</i>	+	.	+	.	.	.	.	.	25	II
<i>Galinsoga quadriradiata</i> (SV)	.	.	.	.	+	+	.	.	25	II
<i>Euphorbia peplus</i> (SV)	.	1.1	1.1	.	.	.	.	.	25	II
<i>Potentilla anserina</i>	.	.	.	.	+	.	+	.	25	II
IV. Other spp.:										
<i>Urtica dioica</i>	.	.	2.1	2.2	1.1	1.1	+	.	62,5	IV
<i>Taraxacum officinale</i>	.	.	+	.	+	+	+	.	62,5	IV
<i>Aegopodium podagraria</i>	.	.	1.1	.	1.1	.	2.2	.	37,5	II
<i>Trifolium repens</i>	.	+	+	.	.	+	.	.	37,5	II
Number of spp.										
Total	7	7	11	6	16	11	9	14	10,1	
Accidental spp.	2	2	1	1	4	2	0	8	2,5	

tum). Out of garden weeds *Euphorbia peplus* is worth of mention (records 2 and 3). Influence of meadows is strongest in record 8, in which there were noted among others: *Phleum pratense*, *Poa compressa* and *Dactylis glomerata*. Species of *Plantagini-Lolietum* such as *Plantago maior*, *Poa annua*, *Matricaria discoidea* penetrate equally to each patch of the community in question. The presence degree diagram of species in the community is irregular which may suggest fragmentary development of the patches (Fig. 6C). The systematic position of this community cannot be determined with certainty because of its pauperized state. It is possible that it is a fragment of one of other associations. Its appurtenance to the alliance of *Arction lappae* is undoubtful. Among the asso-

ciations with *Chenopodium bonus-Henricus* described in the phytosociological literature, the community in question stands closest in its floristic composition to *Balloto-Arctietum* (Br.-Bl. et de Leeuw 1936) Sissingh 1946, described by Gutte (1966), Sissingh (1950) and Tüxen (1950).

The investigated community with *Chenopodium bonus-Henricus* lasted in the same site for 2 or 3 years. Its stability depends on biological properties of dominant species among which *Chenopodium bonus-Henricus*, *Urtica dioica*, *Aegopodium podagraria* are perennial plants and *Arctium minus* is biennial. The remaining plants being of lesser importance in the community do not show high presence degree; they are mostly annual.

Farther development of the community goes in two directions. In sites exposed to trampling it tends to wards *Plantagini-Lolietum*, and in those off the roads—as it may be supposed—to *Leonuro-Arctietum tomentosum*.

Table VI—record sites are given in Fig. 5d.

Accidental species:

II. *Arctium tomentosum* 6.

III. *Atriplex patulum* 1; *Bidens tripartitus* 8; *Capsella bursa-pastoris* 3; *Chenopodium album* 5; *Galinsoga parviflora* (SV) 5; *Lolium multiflorum* 8; *Mentha arvensis* (SV) 2.

IV. *Alchemilla* sp. 6; *Campanula trachelium* 8; *Dactylis glomerata* 8; *Glechoma hederacea* 8 (1.1); *Heracleum sphondylium* 5 (1.1); *Lamium maculatum* 1; *Lolium perenne* 8 (1.1); *Phleum pratense* 8; *Phlox* sp. 4; *Poa compressa* 8; *P. pratensis* 2; *Ranunculus repens* 5.

Urtica dioica-Rumex obtusifolius community (Table VII)

Concentrations of stable vegetation which occupy sites rich in nitrogen, very humid and always shaded belong to this community in Bielsko-Biała. All records at Bielsko-Biała were done in patches of northerly exposure (in one case—north-easterly).

The community is characterized by the dominance of two nitrophilous perennial plants: *Urtica dioica*, and *Rumex obtusifolius*. They attain very large cover and density, leaving little place to other less expansive plants. In few free places left by the characteristic species grow *Ranunculus repens*, *Aegopodium podagraria*, *Poa annua*, *Plantago maior* and *Potentilla anserina* which do not exceed 15 cm in height. As it is shown in phytosociological records given in Table VII, the community is rather poor floristically, although the number of species present in the patch is 11–25; large percentage of accidental species (even up to 40%) occurs there often. The plotted presence degree diagram (Fig. 6E) shows regular scheme with a minimum in II and III degree. Kornaś (1968c) has described similar community from Gorce Mts. from sites very rich in

nitrogen situated near mountaneers sheds. Comparison of his floristic lists with those from area under investigation reveals numerous similarities of both communities.

Class: Rudero - Secalietea
Order: Onopordetalia
Alliance: Arction lappae

Table VII.

Community of <i>Urtica dioica</i> - <i>Rumex obtusifolius</i>												
Table number of record	1	2	3	4	5							
Field number record	8	24	25	90	91							
Date	31.7 1968	1.8 1968	1.8 1968	8.8 1968	8.8 1968							
Exposure	N	N	N	N	NE							
Total plant cover %/	150	120	100	150	120	Presence / %	Presence accid.					
Height max. cm.	150	110	100	120	160							
Height average	100	50	50	100	120							
pH of soil	6,5	6,5	6,5	6,5	6,5							
Area of sample plot m ²	23	70	50	8	15							
I. Dif.loc. Community of												
<i>Urtica dioica</i> - <i>Rumex obtusifolius</i> i												
<i>Urtica dioica</i>	5.5	5.5	4.4	3.3	1.1	100	V					
<i>Rumex obtusifolius</i>	3.2	2.1	1.1	3.3	5.5	100	V					
II. Ch. Arction leppae:												
<i>Sisymbrium officinale</i>	+	+	.	.	.	40	II					
<i>Arctium tomentosum</i> (juv.)	.	+	1.1	.	.	40	II					
<i>Armoracia lapathifolia</i>	.	.	.	2.2	+	40	II					
III.Ch. Onopordetalia:												
<i>Potentilla anserina</i>	.	+	+	.	+	60	III					
IV. Ch. Rudero - Secalietea (SV= Secali - Violetalia):												
<i>Plantago maior</i>	+	+	+	.	+	80	IV					
<i>Poa annua</i>	+	.	.	2.2	1.1	60	III					
<i>Polygonum nodosum</i>	1.1	+	+	.	.	60	III					
<i>Lapsana communis</i> (SV)	+	+	.	.	.	40	II					
V. Other spp.:												
<i>Ranunculus repens</i>	2.1	+	1.1	2.2	1.1	100	V					
<i>Aegopodium podagraria</i>	1.1	+	.	1.1	1.1	80	IV					
<i>Prunella vulgaris</i>	+	.	.	.	+	40	II					
<i>Agrostis alba</i>	.	+	+	.	.	40	II					
<i>Lolium perenne</i>	.	.	1.1	.	+	40	II					
<i>Deschampsia caespitosa</i>	.	.	.	+	+	40	II					
<i>Lamium maculatum</i>	1.1	.	.	.	+	40	II					
<i>Dactylis glomerata</i>	+	.	.	+	.	40	II					
Number of spp.												
Total	25	14	12	11	20	16,4						
Accidental spp.	13	3	3	3	8	6,0						

The role of *Urtica dioica* and *Rumex obtusifolius* is more remarkable at Bielsko-Biała, that of *Poa annua* and *Ranunculus repens* is equally large both in Gorce Mts. and Bielsko-Biała. The analogy of exposure of the patches of those communities is striking as in both cases they are exposed toward north and northeast. Differences may be observed in

occurrence of *Alchemilla crinita*, *A. pastoralis* and *Chaerophyllum hirsutum* in Gorce Mts., while at Bielsko-Biała there is a greater number of common species from the class *Rudero-Secalietae*. This difference in composition depends probably on height above sea level (records from Bielsko-Biała were done on about 300 m a.s.l., and in Gorce Mts. between 980 and 1025 m a.s.l.), and on the difference in both cases in contact communities. At Bielsko-Biała this is most frequently *Plantagini-Lolietum* in wet variety with *Potentilla anserina* and in Gorce Mts. the community borders mainly highland meadows and communities of the alliance *Adenostylion alliariae*. The facts mentioned above together with list of species suggest to place the community *Urtica dioica-Rumex obtusifolius* from Bielsko-Biała within the alliance *Arction lappae*.

The community of *Urtica dioica-Rumex obtusifolius* is stable at Bielsko-Biała. The patches which were under observation from 1966 to 1969 were stable during that period and showed a tendency to spread their surface. It was, therefore, impossible to trace the direction of succession of this community.

Table VII — record sites are given in Fig. 7a.

Accidental species:

II. *Arctium minus* 1.

III. *Melilotus albus* 2; *Sonchus oleraceus* 1.

IV. *Agropyron repens* (SV) 4 (1.1); *Atriplex patulum* 1; *Bidens tripartitus* 5; *Chenopodium album* 1; *Chenopodium opulifolium* 1; *Epilobium rubescens* 1; *Galeopsis bifida* 1; *Galeopsis pubescens* 1; *Galinsoga parviflora* (SV) 1; *G. quadriradiata* (SV) 5; *Mentha arvensis* (SV) 5; *Oxalis stricta* (SV) 1; *Polygonum hydropiper* 5; *P. tomentosum* (SV) 1.

V. *Achillea millefolium* 2; *Alchemilla* sp. 3; *Ampelopsis quinquefolia* 1; *Chaerophyllum* sp. 4; *Crepis biennis* 5; *Daucus carota* 2; *Festuca pratensis* 3; *Glechoma hederacea* 4; *Heracleum sphondylium* 5 (1.1); *Ranunculus lanuginosus* 5; *Rubus* sp. 1; *Trifolium pratense* 3; *T. repens* 5.

Sisymbrietum sophiae Kreh 1935 (Table VIII)

Favourable sites of *Sisymbrietum sophiae* are strongly insolated, moderately rich in nitrogen heaps of rubble and railway areas of exposure at least partly southern (Faliński, 1966; Fijałkowski, 1963, 1967; Sowa, 1964; Oberdorfer, 1957; Tüxen, 1950; Weber, 1961). At Bielsko-Biała the association is rare as it shows only one site connected with railway area. Nine well developed patches were distinguished there. The most typical concentrations of *Sisymbrietum sophiae* can be found along rails, on slopes of rail-road embankments dipping 20 - 30°, of exposure E, WW, NE, NW. Substratum usually consists of mixture of stones, loam, sand and dross, hence substratum poor or moderately rich in nutritive substances. The exposure, not typical for *Sisymbrietum sophiae*, is conditioned here by the direction of rails, hen-

Class: Rudero - Secalietea
Order: Onopordetalia
Alliance: Onopordion acanthii

Table VIII.
SISYMBRIETUM SOPHIAE

Table number of record	1	2	3	4	5	6	7	8	9		
Field number of record	80	81a	81b	83	104	103	85	84	64		
Date	7.8 1968	7.8 1968	9.8 1968	9.8 1968	10.8 1968	10.8 1968	9.8 1968	9.8 1968	6.8 1968		
Exposure	W	N	E	E	WNW	WNW	NW	W	NE		
Total plant cover %/	130	160	85	60	120	120	60	70	70		
Height max.	120	180	100	120	110	100	110	130	100		
average cm.	100	120	70	70	80	80	80	80	70		
pH of soil	6,5	6,5	6,5	7,0	7,5	7,5	7,5	8,0	7,5		
Area of sample plot m ²	15	4	3	7	25	30	8	3	10		
Slope	...	...	20°	25°	30°	30°	25°	20°	30°		
I. Ch. Sisymbrietum sophiae:											
Sisymbrium Loeselii	5.5	5.5	3.3	2.2	3.3	3.3	2.2	+	.	88,8	V
Sisymbrium altissimum	.	.	.	.	3.3	2.2	2.2	3.3	2.2	55,5	III
II. Ch. Onopordion acanthii:											
Lactuca serriola	.	.	+	.	1.1	+	.	.	2.2	44,4	III
III. Ch. Onopordetalia:											
Artemisia vulgaris	+	2.2	.	2.2	1.1	+	.	+	.	66,6	IV
Erigeron canadensis	+	+	3.3	1.1	.	.	+	.	.	55,5	III
Melandrium album	+	+	.	+	.	+	.	.	.	44,4	III
Rumex obtusifolius	+	+	.	.	+	+	.	.	.	44,4	III
Cichorium intibus	+	.	.	.	+	.	.	.	.	22,2	II
IV. Ch. Rudero - Secalietea (SV = Secali - Violetalia):											
Tripleurospermum inodorum (SV)	+	1.1	+	.	1.1	1.1	+	+	.	77,7	IV
Galinsoga parviflora (SV)	.	+	.	+	.	+	+	+	+	66,6	IV
Erysimum cheiranthoides (SV)	.	.	.	+	1.1	1.1	1.1	+	.	55,5	III
Senecio viscosus	.	.	.	.	1.1	1.1	.	+	2.2	44,4	III
Bidens tripartita	.	+	.	.	+	2.2	.	.	+	44,4	III
Sonchus oleraceus	.	.	.	.	+	+	.	.	+	33,3	II
Senecio vulgaris	.	.	.	.	.	.	+	+	+	33,3	II
Polygonum convolvulus (SV)	.	.	.	1.1	.	+	+	.	.	33,3	II
Equisetum arvense	.	.	.	+	+	.	+	.	.	33,3	II
Poa annua	.	+	.	.	.	.	+	+	.	33,3	II
Chenopodium album	.	.	.	1.1	.	.	1.1	1.1	.	33,3	II
Polygonum persicaria (SV)	.	.	.	1.1	.	.	+	+	.	33,3	II
Oxalis stricta (SV)	.	.	.	+	+	.	+	.	.	33,3	II
Galeopsis pubescens	.	+	.	+	.	.	.	.	.	22,2	II
Matricaria discoidea	.	.	.	+	.	.	+	.	.	22,2	II
Plantago maior	.	.	.	.	+	+	.	.	.	22,2	II
Polygonum hydropiper	.	.	.	.	+	+	.	.	.	22,2	II
V. Other spp.:											
Achillea millefolium	+	+	1.1	+	+	+	+	1.1	+	100	V
Tussilago farfara	.	2.2	+	+	.	+	1.1	1.1	+	77,7	IV
Aegopodium podagraria	.	1.1	.	.	+	+	.	.	1.1	44,4	III
Lolium perenne	1.1	2.2	1.1	.	+	.	.	.	.	44,4	III
Taraxacum officinale	+	+	.	.	+	+	.	.	.	44,4	III
Trifolium repens	+	.	+	.	+	.	.	+	.	44,4	III
Arrhenatherum elatius	.	.	.	.	1.1	+	.	.	+	33,3	II
Agrostis alba	2.2	+	.	.	+	.	.	.	.	33,3	II
Medicago lupulina	.	.	.	+	.	.	+	+	.	33,3	II
Dactylis glomerata	.	.	.	.	.	+	.	.	+	22,2	II
Phleum pratense	+	+	.	.	.	.	.	.	.	22,2	II
Daucus carota	.	.	.	+	+	.	.	.	.	22,2	II
Verbascum nigrum	.	.	.	+	.	.	+	.	.	22,2	II
Linaria minor	.	.	.	.	.	.	+	+	.	22,2	II
Arabis arenosa	.	.	.	.	+	+	.	.	.	22,2	II
Scrophularia nodosa	.	.	.	.	+	+	.	.	.	22,2	II
Bryophytes	2.2	.	2.2	.	.	.	.	.	.	22,2	II
Number of spp.											
Total	15	21	11	29	35	28	23	17	13	21,3	
Accidental spp.	1	4	2	11	10	5	4	1	1	4,3

Fig. 7. Distribution of phytosociological records

a — community of *Urtica dioica*-*Rumex obtusifolius*; b — *Sisymbrium sophiae*; c — *Echio-Melitotetum albi*; — d *Sagino-Bryetum*; e — *Chenopodium glauco-rubri*; f — community of *Bidens melanocarpus*

ce — of the embankment slopes which is from south to north. The association is thermophilous because its patches occupy one of the warmest areas in Bielsko-Biała.

Out of species mentioned as characteristic for *Sisymbrietum sophiae* in Poland and GDR and GFR (Tüxen, 1950; Oberdorfer, 1957; Weber, 1961; Sowa, 1964) only the presence of *Descurainia sophia*, was not noted. It is rare in Bielsko-Biała (only two stations beyond patches of the community). Characteristic species in the area are: *Sisymbrium Loeselii* and *S. altissimum*, out of which only the first one reveals high presence degree and is present in 8 patches. *Sisymbrium altissimum* accompanies it in 4 phytosociological records. Five patches are characterized by one of the species mentioned above (only in one case it is *Sisymbrium altissimum*). 10 - 35 species were found in the records.

This diversity is caused by penetration of a large number of meadow and field plants to some patches from the vicinities. Such expansion is facilitated by the structure of the community which is mosaic often. The community in question usually consists of several layers of vegetation. The highest one attains over one meter in height and consists of dominant species of the genus *Sisymbrium* and of *Artemisia vulgaris*. In lower layers there is a lot of *Tripleurospermum inodorum*, *Erigeron canadensis*, *Erysimum cheiranthoides*, *Senecio viscosus* and *Tussilago farfara*. In two cases large amount of *Bryophyta* was noted in the lowest layer. Data concerning the presence degree distribution are given in diagram (Fig. 6B).

Sisymbrietum sophiae appears at Bielsko-Biała as initial plant community in rail-road areas. Its development seems to run toward *Tanacetum-Artemisietum*.

The works published so far do not allow to draw the extent of this association. It is known from Central Poland (Sowa, 1964), Lublin district (Fijałkowski, 1963, 1967), the Białowieża Forest (Faliński, 1966) and from the northern part of the Białystok region (Faliński, and Bartel, 1965). The most widely distributed is *Sisymbrium sophiae* in Łódź where it occupies hundreds of square metres. The ecological conditions there seem highly favourable for it. The data about the occurrence of *Sisymbrium sophiae* at Bielsko-Biała are the first ones from Southern Poland. This association was observed by the authoress also in Cracow in 1969 during the construction of the Press Printing Office (Drukarnia Prasowa) on the loamy earth heaps and on railroad areas near the Bonarka railway station. Its distribution in Poland is probably much wider. Few publications point to its occurrence in the Western Europe (Tüxen, 1950; Weber, 1961).

Table VIII — record sites are marked in Fig. 7b.

Accidental species:

II. *Berteroa incana* 4; *Echium vulgare* 4; *Melilotus albus* 3.

- III. *Linaria vulgaris* 5; *Sisymbrium officinale* 4; *Tanacetum vulgare* 7.
- IV. *Anagallis arvensis* (SV) 4; *Arctium* sp. (seedlings) 2; *Atriplex patulum* 6; *Cap-sella bursa-pastoris* 7; *Cirsium lanceolatum* 1; *Convolvulus arvensis* 6; *Galin-soga quadriradiata* (SV) 2; *Lapsana communis* (SV) 7; *Lolium multiflorum* 2 (1.1); *Polygonum aviculare* 8; *P. nodosum* 9 (1.1); *Potentilla intermedia* 3; *Ru-mex crispus* 2; *Setaria glauca* (SV) 4; *Sonchus arvensis* (SV) 5; *Viola arven-sis* (SV) 4.
- V. *Arabis arenosa* 7; *Barbarea vulgaris* 5; *Carex hirta* 4; *Centaurea oxylepis* 5; *Cerastium vulgatum* 4; *Deschampsia caespitosa* 6; *Galium mollugo* 5; *Glech-oma hederacea* 5 (1.1); *Hypericum perforatum* 5; *Inula britannica* 6; *Mentha longifolia* subsp. *spicata* 5; *Poa compressa* 4; *Prunella vulgaris* 5; *Ranunculus repens* 4; *Saponaria officinalis* 6; *Silene inflata* 5 (1.1); *Urtica dioica* 4.

Echio-Melilotetum albi Tx. 1942 (Table IX)

This association occurs at Bielsko-Biała in railway areas where it selects upper parts of embankments close to the rails, less frequently between the tracks. Such sites, of substratum formed mainly of stones, dross and sand, are extremely arid and strongly insolated. Such conditions eliminate less resistant species from the community. Large number of plants of the family *Papilionaceae* explains the occurrence of *Echio-Melilotetum albi* in sites poor in nitrates. It is a well known fact that the majority of papilionaceous plants uses nitrogen taken from the air through symbiotic bacteria of the genus *Rhizobium*. It has been calculated that *Melilotus* sp. is able to collect 131 kg of nitrogen in the area of 1 ha during one year, similarly as species of *Medicago* (Erdman, 1948 after Schaeede, 1967). The activity of fixing nitrogen from the air by symbiotic bacteria is inversely proportionate to nitrogen content in the substratum (Schaeede, op. cit.). Investigations have shown that the leguminous plants positively influence other vegetal individuals in mixed cultures, which is explained by Schaeede (op. cit.) by accelerated process of decay of litter enriched in albumen.

Increased traffic of passenger and freight trains causes a lack of sites suitable to development of *Echio-Melilotetum albi* in Bielsko-Biała, such sites as are known from Łódź (Sowa, 1964) and the Białowieża Forest (Faliński, 1966), the latter being place of insignificant railway traffic.

The negative influence of train traffic is reflected by destruction of plants in mechanical way, by hot vapour, exhaust gases, and frequent fire. Removal of plants by using mechanical and chemical factors during cleaning up the rails bear a negative effect on the community. All those factors cause fragmentary development of patches of *Echio-Melilotetum albi* at Bielsko-Biała. The plants of the community are frequently mutilate, dwarfed or even teratological. Because of those reasons there were difficulties in selection of patches, hence only four phytosociological records represent the community in Table IX.

Many authors, among others Oberdorfer (1957), Sowa (1964), Tüxen (1950) and Weber (1961) mention four characteristic species of this association: *Echium vulgare*, *Melilotus albus*, *M. officinalis* and

Class: Rudero - Secalietea
Order: Onopordetalia
Alliance: Onopordion acanthii

Table IX.
ECHIO - MELILOTETUM ALBI

Table number of record	1	2	3	4.
Field number of record	72	35	101	100
Date	7.8 1968	2.8. 1968	10.3 1968	10.8 1968
Exposure	E	SW	N	SW
Total plant cover %/	...	85	120	120
Height max.	130	100	180	120
Height average cm.	...	50	150	...
pH of soil	7,5	...	6,5	7,5
Area of sample plot m ²	4	6	10	10
I. Ch. Echio - Melilotetum albi:				
Melilotus albus	2.2	2.2	5.5	5.5
Melilotus officinalis	3.2	.	.	.
Echium vulgare	.	1.1	.	.
II. Ch. Onopordetalia:				
Linaria vulgaris	.	1.1	.	.
Erigeron canadensis	1.1	.	.	.
Artemisia vulgaris	+	.	.	.
III. Ch. Rudero - Secalietea (SV = Secali-Violetalia):				
Equisetum arvense	.	+	+	+
Oxalis stricta (SV)	.	+	+	.
Tripleurospermum inodorum (SV)	+	.	+	.
Senecio viscosus	+	.	+	.
Convolvulus arvensis	.	.	+	+
IV. Other spp.:				
Medicago lupulina	1.1	2.2	+	.
Taraxacum officinale	+	+	+	.
Daucus carota	.	+	1.1	1.1
Achillea millefolium	1.1	1.1	.	.
Hieracium sp.	.	1.1	+	.
Aegopodium podagraria	.	+	+	.
Leontodon autumnalis	+	.	.	+
Heracleum sphondylium	.	.	1.1	1.1
Arrhenatherum elatius	.	.	1.1	1.1
Bryophyte:	3.2	.	.	.
Number of spp.				
Total	17	20	16	8
Accidental spp.	6	9	3	1
				15,25 4,5

Oenothera biennis. In the patches of Bielsko-Biała there is lack of *Oenothera biennis*, and *Echium vulgare* and *Melilotus officinalis* were noted only in one record. The most stable diagnostic species is *Melilotus albus*, which occurs abundantly in all stations. An important role as components of the community play *Medicago lupulina* and *Daucus carota*. The

amount of meadow and segetal plants as well as of *Bryophyta* is insignificant. Beyond Bielsko-Biała along the Bielsko—Cieszyn railway where traffic is smaller the association in question freely develops in similar sites, with all characteristic species. As a result of succession *Echio-Melilotetum albi* may develop into *Tanaceto-Artemisietum*.

In Poland *Echio-Melilotetum albi* is known so far from Łódź (Sowa, 1964), Lublin (Fijałkowski, 1967), the Białowieża Forest (Faliński, 1966) and the Białystok (Faliński, 1965; Faliński and Bartel, 1965).

Most probably it is common along all railways. Distinct attachment to railway areas exhibits this association in GDR (Gutte, 1966; Oberdorfer, 1957) and in Finland (Suominen, 1969), whereas in the Netherlands (Sissingh, 1950) and in Belgium (Lebrun and others, 1949) it occurs on arenaceous sea coast dunes. In Switzerland it occupies sites on stony river banks (Moor, 1958).

Table IX — record stations given in Fig. 7e.

Accidental species:

- III. *Aethusa cynapium* 2; *Epilobium adenocaulon* 1; *Galinsoga parviflora* (SV) 1; *Poa annua* 1; *Sonchus arvensis* (SV) 2; *Tussilago farfara* 3; *Vicia hirsuta* (SV) 2.
- IV. *Agrostis alba* 1; *Arabis arenosa* 2; *Arenaria serpyllifolia* 1; *Brassica* sp. (seedlings) 2; *Cirsium oleraceum* 3; *Hypericum perforatum* 2; *Lotus corniculatus* 2; *Pimpinella maior* 4; *Poa compressa* 1; *Rumex acetosella* 3; *Vicia cracca* 2.

Plantagini-Lolietum Beger 1930 (Table X)

Plantagini-Lolietum appears along paths, and roads in rural and urban settlements and near industrial buildings. It develops as initial association or in result of succession of communities of various degree of organization. Permanent trampling and kneading of soil (by men, vehicles, etc.) is the main cause of its origin and stabilization. This permanent compaction of substratum influences unsatisfactory aeration of soil, paucity of bacterial flora (Sissingh, 1950), bad water conditions disclosing in drowning of vegetation in rain and excessive drying up in case of its lack. These difficult conditions have caused the fact that only most resistant species of great ecological plasticity build the *Plantagini-Lolietum*. Numerous adaptations and morphological changes allowed to distinguish many lower systematic units within the species of *Plantagini-Lolietum* (Faliński, 1963).

The following species of this association are characteristic at Bielsko-Biała: *Plantago maior*, *Matricaria discoidea* and *Lepidium rudemale*. *Coronopus procumbens* mentioned as characteristic in *Plantagini-Lolietum* from the Cracow Jura (Kornaś, 1952), noted also in Skorocice near Busko (Medwecka-Kornaś, 1959) and in Łódź (Sowa, 1964), does not occur in the investigated area. *Lolium perenne* and *Poa annua*

Order: Potentillo - Polygonetalia avicularis

Alliance: Polygonion avicularis

Table X.
PLANTAGINI - LOLIETUM

Table number of record	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Field number of record	1	71	80	99	34	50	42	87	31	7	20	48	57	47	96	44	39	44	38
Date	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968	1968
Exposure	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.	max.
Total plant cover %	70	80	50	50	80	95	70	90	90	80	90	80	80	90	90	120	120	120	120
Height	40	30	20	25	10	15	15	15	25	25	25	25	25	25	25	25	25	25	25
pH of soil	7.5	8.0	8.0	7.0	7.5	8.0	8.0	7.5	7.0	7.0	7.0	7.5	6.5	7.0	7.0	7.5	7.5	7.5	7.5
Area of sample plot m ²	4	80	20	8	7.5	9	9	12	16	16	18	15	10	10	10	10	10	10	10

I. Ch. Plantagini - Lolietum:

Plantago maior
Matricaria discoidea
Lepidium ruderaie

III. Ch. Polygonion avicularis i Potentillo
- Polygonetalia avicularis:

Polygonum aviculare
Poa annua
Potentilla anserina

III. Ch. Onopordetalia:

IV. Ch. Rudero-Secalieta (SV=Secali-Violetalia):

Capsella bursa - pastoris
Tripleurospermum inodorum (SV)
Polygonum hydropiper

V. Other spp.:

Lolium perenne
Taraxacum officinale
Trifolium repens
Daucus carota
Plantago lanceolata

Number of spp.

Total
Accidental spp.

Accidental spp.

Presence /%/
degree

100
95,4
26,5

84, 8	V
79, 5	IV
37, 1	III

58,3 III

47, 7	III
31, 8	III
21, 2	II

95,4	V
63,6	IV
47,7	III
31,8	II
21,2	I

12,1
3,6

Fig. 8. Distribution of phytosociological records of *Plantagini-Lolietum*

play an important role as components of the association in question. The differences in floristic composition in the particular patches of *Plantagini-Lolietum* shown on phytosociological table (Table X), may be explained by different degree of humidity of substratum and its nitrogen content. The records presented in the table were ordered according to the type of sites, from most arid to more humid ones. In dry, strongly insolated sites, frequently between the flagstones the *Plantagini-Lolietum* develops with abundance of *Lepidium ruderae*. Near rural buildings, poultry houses, on humid sites, usually contaminated with poultry fecals, hence in places very rich in nitrogen a facies with *Potentilla anserina* may be distinguished, which is similar to that one described from Gorce Mts. by Kornaś (1968c). By their floristic content these facies approximate to *Lolio-Potentilletum anserinae* Knapp 1946 known from the Białowieża Forest (Faliński, 1966). The last mentioned unit is classified to the alliance *Agropyro-rumicion crispis* Nordh. 1940 which stands in the system aside of the alliance *Polygonion avicularis* Br.-Bl. 1931, to which *Plantagini-Lolietum* is classified as well. According to Kornaś, (1968c) the facies with *Potentilla anserina* forms a transition between the above mentioned alliances. In intermediate sites (between extremely dry and very humid), mainly along roadsides there is lack of *Lepidium ruderae* and *Potentilla anserina*. Communities are formed there by *Plantago maio*, *Matricaria discoidea* and *Lolium perenne* with large amount of *Polygonum aviculare* and *Poa annua*. In patches of *Plantagini-Lolietum* at Bielsko-Biała chiefly main characteristic species dominate attaining the largest cover and density. Role of segetal and meadow plants is sporadic. Distribution of presence degrees in the table is illustrated on diagram (Fig. 4B).

Numerous elaborations (Faliński, 1963, 1966; Faliński and Bartel, 1965; Fijałkowski, 1963, 1967; Kornaś, 1952, 1968c; Korniak, 1966; Medwecka-Kornaś, 1959; Sowa, 1964) demonstrate that *Plantagini-Lolietum* is the most frequent ruderal community in Poland. It is common in the whole of Europe as well (Kornaś, 1952; Tüxen, 1950; Sissingh, 1950) excluding the Mediterranean area where it is replaced by the *Sclerochloa dura-Coronopus procumbens* association (Braun-Blanquet, 1949).

Table X — record station are presented in Fig. 8.

Accidental species:

- II. *Rumex crispus* (seedlings) 1, 12.
- III. *Arctium tomentosum* 3; *Artemisia vulgaris* 3, 7; *Atriplex patulum* 1, 12, 18; *Chrysanthemum parthenium* 15; *Erigeron canadensis* 4 (1.1), 9; *Malva silvestris* 9; *Rumex obtusifolius* (seedlings) 10, 16.
- IV. *Arctium* sp. 9; *Chenopodium album* 1, 13, 15; *Cirsium lanceolatum* 13, 15; *C. arvense* 5; *Crepis capillaris* 17; *Erysimum cheiranthoides* (SV) 13; *Galinsoga parviflora* (SV) 5 (1.1), 7, 18; *G. quadriradiata* (SV) 4, 13; *Juncus macer* 4, 7,

- 10; *Mentha arvensis* (SV) 15; *Polygonum nodosum* 1; *P. tomentosum* (SV) 1; *Potentilla reptans* 5.
- V. *Aegopodium podagraria* 12, 15; *Achillea millefolium* 9; *Agrostis* sp. 4; *Alchemilla* sp. 15; *Calystegia sepium* (seedling) 18; *Carex hirta* 19 (1.1); *Cerastium vulgatum* 10; *Crepis biennis* 11, 12; *Dactylis glomerata* 8; *Erigeron acer* 1; *Festuca pratensis* 13; *Geum urbanum* 12; *Lamium maculatum* 12; *Linaria minor* 1; *Poa compressa* 19; *Polygonum* sp. 13, 17; *Prunella vulgaris* 15, 16; *Senecio jacobaea* 4; *Ranunculus repens* 5 (1.1), 10, 12; *Rorippa palustris* 1, 4, 9; *Rumex* sp. 13; *Symphytum officinale* 8; *Trifolium pratense* 9, 10; *Urtica dioica* 7, 10, 12.

Sagino-Bryetum Diem., Siss. et Westhoff 1940

The pioneer association *Sagino-Bryetum* penetrates fissures of wet, stony or brick walls and pavements. It selects shaded and moderately rich in nitrogen sites and tolerates trampling.

Among species mentioned as characteristic in this association (Oberdorfer, 1957; Tüxen, 1950) at Bielsko-Biała occur: *Sagina procumbens* and *Bryum argenteum*. There is lack, however, of *Spergularia rubra*. *Sagino-Bryetum* is rare in the investigated area. It is represented by only one record in this paper. *Sagina procumbens* and *Bryum argenteum*, give the characteristic appearance to the patch of the association together with other mosses: *Ceratodon purpureus* and *Funaria hygrometrica*. The presence of *Ceratodon purpureus* makes *Sagino-Bryetum* of Bielsko-Biała closer to a subassociation from Leipzig (Gutte, 1966), in which also occur *Stellaria media* and *Webera nutans*. According to some authors (Oberdorfer, 1957; Tüxen, 1950) the association in question is transitional toward the alliance *Nanocyperion*.

Sagino-Bryetum has been described from many sites in GDR (Gutte, 1966; Oberdorfer, 1957; Passarge, 1957; Tüxen, 1950; Weber, 1961), where it occurs most frequently on shaded pavements of less frequented streets and backyards. It is also known from Switzerland (Braun-Blanquet, 1949). In Poland it is known so far only in the Białowieża Forest (Faliński, 1966).

Record No. 46: Lipnik, Podgórna street (Fig. 7d), paved drain; 3 (8) 1968; exposure E; surface 70 sq.cm; cover 40%; Number of species = 10.

Ch. *Sagino-Bryetum*: *Sagina procumbens* 4.5, *Bryum argenteum* 2.2. Ch. *Potentillo-Polygonetalia avicularis*: *Poa annua* + Other spp. *Lolium perenne* +, *Taraxacum officinale* +, *Trifolium repens* +, *Potentilla reptans* 1.1, *Ranunculus repens* 1.1. Bryophytes: *Ceratodon purpureus* +, *Funaria hygrometrica* +.

Chenopodietum glauco-rubri Lohm. 1950 (Table XI)

Aggregations of ruderal vegetation of Bielsko-Biała are seldom found on strongly overmanured sites (e.g. aside of old cloacs), wet, with traces of stagnant rain water.

Taking into account their floristic composition with dominant *Che-*

nopodium glaucum, *Polygonum nodosum* and *Echinochloa crus-galli*, and kind of site they may be reckoned to be fragmentarily developed patches of *Chenopodietum glauco-rubri*. They are pauperized when compared to those of GDR and GFR (Gutte, 1966; Oberdorfer, 1957) and those of Poland (Faliński, 1966; Fijałkowski, 1963, 1967). There is no *Chenopodium rubrum*. *Chenopodium glaucum* is very rare at Bielsko-Biała and its sites in patches of *Chenopodium glauco-rubri* are the only ones within the town.

Class: Rudero - Secalietea
Order: Bidentetalia
Alliance Bidention

Table XI.
CHENOPODIETUM GLAUCO - RUBRI

Table number of record	1	2
Field number of record	76	77
Date	7.8 1968	7.8 1968
Exposure	E	NE
Total plant cover %/	100	120
Height max.	120	120
average cm.	100	70
pH of soil	8.0	7.5
Area of sample plot m ²	6	5
I. Ch. <i>Chenopodietum glauco - rubri</i> :		
<i>Chenopodium glaucum</i>	2.2	2.2
II. Ch. Bidention i Bidentetalia:		
<i>Polygonum nodosum</i>	4.4	3.3
III. Ch. Rudero - Secalietea: (SV = Secali - Violetalia):		
<i>Echinochloa crus - galli</i> (SV)	2.2	2.2
<i>Polygonum aviculare</i>	2.2	1.1
<i>Tripleurospermum inodorum</i> (SV)	+	1.1
<i>Poa annua</i>	+	1.1
<i>Bidens melanocarpus</i>	+ ^o	+
<i>Sonchus oleraceus</i>	+	+
<i>Erysimum cheiranthoides</i> (SV)	+	.
<i>Chenopodium album</i>	.	+
<i>Senecio viscosus</i>	.	+
<i>Erigeron canadensis</i>	.	+
<i>Artemisia vulgaris</i>	.	+
<i>Cirsium lanceolatum</i>	.	+
<i>Sisymbrium altissimum</i>	.	+
<i>Galinsoga quadriradiata</i> (SV)	.	+
IV. Other spp.:		
<i>Achillea millefolium</i>	+	+
Number of spp.		
Total	10	16

In Poland this association is known from Lublin, where it occupies surfaces of several hectares on subsiders near sugar factory (Fijałkowski, 1967), from few sites in Chełm (Fijałkowski, 1963) and from the Białowieża Forest (Faliński, 1966). In GDR and GFR it is

no more frequent, in some cases in shape of fragments, chiefly in villages, on wet sites aside of dungpits and silos (Gutte, 1966; Oberdorfer, 1957).

Table XI — record sites are marked in Fig. 7e.

Bidens melanocarpus community (Table XII)

Tracing the dynamic spread of *Bidens melanocarpus* in Bielsko-Biała during last two years it was noted that this species grows in association with always the same other species in sites where it shows maximal number of plants and occupies largest surfaces. Because of uniformity of such patches and their repetition, those communities may be described as community with *Bidens melanocarpus*. Stabilized heaps of rubble, sufficiently wet, of westerly or easterly exposure are the sites on which it preferably grows.

Bidens melanocarpus is the dominant species. There are also *Polygonum nodosum*, *P. tomentosum*, *Chenopodium album*, *Ch. cfr. opulifolium* and *Calystegia sepium*. Terophytes of families *Chenopodiaceae* and *Polygonaceae* are abundant in the investigated patches. Sporadically one may find also cultivated and wilding plants such as *Solanum tuberosum*, *Apium graveolens*, *Brassica nigra*. As the species dominant in the patches in large per cent are characteristic for order *Bidentetalia* Br.-Bl. et Tx. 1943, it seems justified to classify the described community to this order.

It is worth of mention that the records done at Bielsko-Biała (Nos. 1 and 2) do not differ in their floristic content from record No. 3, noted at Czechowice, about 10 km from the investigated area. Limited number of records does not allow to more precise characterization of the community. It seems, however, that the analysis of phytosociological relations of similar patches from other regions of Poland might furnish more detailed information in this respect.

Table XII — record sites are marked in Fig. 7 f

Species occurring only in one record:

- III. *Capsella bursa-pastoris* 1; *Erigeron canadensis* 3; *Galinsoga parviflora* 1; *Mentha arvensis* (SV) 3; *Odontites rubra* 3; *Plantago maior* 2; *Polygonum aviculare* 3; *Rumex crispus* 2; *Setaria glauca* (SV) 3; *Tanacetum vulgare* 2; *Vicia hirsuta* 1.
- IV. *Acer pseudoplatanus* 2; *A. tataricum* 2 (1.1); *Apium graveolens* 1; *Brassica cfr. nigra* 1; *Carum carvi* 3; *Daucus carota* 1; *Glechoma hederacea* 1 (1.1); *Hera-cleum sphondylium* 1; *Lolium perenne* 2; *Poa pratensis* 1; *Prunella vulgaris* 3; *Ranunculus repens* 2 (1.1); *Scrophularia nodosa* 1; *Solanum tuberosum* 2; *Symphytum officinale* 2; *Taraxacum officinale* 3; *Trifolium pratense* 3.

3. EDAPHIC CHARACTERISTIC OF SITES OF RUDERAL COMMUNITIES

The term "soil" was used several times in this paper to determine the substratum, on which live the described ruderal communities. The surface layer of earth on which they grow is strongly diversified. Human

Class: Rudero - Secalietea
 Order: Bidentetalia
 Alliance: Bidention

Table XII.
 COMMUNITY of BIDENTS MELANOCARPUS

Table number of record	1	2	3
Field number of record	55	56	...
Date	5.8 1968	5.8 1968	30.8 1969
Exposure	W	W	E
Total plant cover %/			
Height max. cm.	160	130	...
average	130	110	...
pH of soil	7,0	7,0	...
Area of sample plot m ²	30	50	40

I. Dif. loc. Community of *Bidens*
melanocarpus:

<i>Bidens melanocarpus</i>	3.3	3.2	3.3
----------------------------------	-----	-----	-----

II. Ch. *Bidentetalia*:

<i>Polygonum nolaeum</i>	2.2	.	3.3
<i>Polygonum hydropiper</i>	+	.	.
<i>Rorippa palustris</i>	.	.	1.1

III. Ch. Rudero - Secalietea: (SV = Secali -
Violetalia):

<i>Polygonum tomentosum</i> (SV)	1.1	1.1	1.1
<i>Chenopodium album</i>	1.1	1.1	+
<i>Galinsoga quadriradiata</i> (SV)	1.1	2.2	+
<i>Atriplex patulum</i>	+	1.1	+
<i>Potentilla anserina</i>	+	1.1	+
<i>Tripleurospermum inodorum</i> (SV)	+	+	+
<i>Artemisia vulgaris</i>	.	+2	1.1
<i>Chenopodium</i> cfr. <i>opulifolium</i>	1.1	1.1	.
<i>Cirsium arvense</i>	+	.	+
<i>Erysimum cheiranthoides</i> (SV)	+	+	.
<i>Lolium multiflorum</i>	+	+	.
<i>Sonchus oleraceus</i>	+	+	.
<i>Senecio vulgaris</i>	+	+	.
<i>Sisymbrium officinale</i>	+	1.1	.
<i>Matricaria discoidea</i>	+	.	+

IV. Other spp.:

<i>Urtica dioica</i>	2.2	2.2	.
<i>Calystegia sepium</i>	2.2	1.1	.
<i>Solidago serotina</i>	+	+	.
<i>Stachys palustris</i>	+	+	.
<i>Aegopodium podagraria</i>	+	+	.
<i>Galium aparine</i>	+	+	.
<i>Achillea millefolium</i>	.	+	+
<i>Trifolium repens</i>	.	+	+
<i>Tussilago farfara</i>	.	+	+

Number of spp.

Total	33	32	24	29,6
Accidental spp.	10	9	9	9,3

activity was and is the basic factor controlling its origin. In natural conditions the origin of soil is a result of action of many factors such as climate, kind of mother rock, morphology, influence of flora and fauna, etc. (Dobrzański, 1962; Musierowicz, 1968). The soil

Table XIII
Mechanical soil composition of ruderal plant communities

Name of community	Number of sample	Stones and gravel	Earth part	% of mechanical fractions (diameter in mm)					
				1—0.1	0.1—0.05	0.05—0.02	0.02—0.006	0.006—0.002	below 0.002
<i>Sisymbrium sophiae</i>	1	67.7	32.3	73	8	6	5	2	6
	4	65.3	34.7	57	9	12	9	4	9
	14	70.9	29.1	75	5	4	7	2	7
Community of <i>Chenopodium bonus-Henricus</i>	2	34.0	66.0	55	10	13	10	4	8
	5	33.3	66.7	53	6	14	9	6	12
	7	9.5	90.5	40	8	19	11	7	15
<i>Leonuro-Arctietum tomentosifarfara</i>	3	30.2	69.8	48	10	19	10	5	8
	8	54.8	45.2	60	10	12	8	3	7
	15	9.6	90.4	51	9	15	11	5	9
Community of <i>Tussilago farfara</i>	6	0.0	100.0	20	7	26	23	7	17
	9	18.2	81.8	16	7	25	28	8	16
	11	0.0	100.0	14	7	29	25	8	17
<i>Tanaceto-Artemisietum</i>	10	69.7	30.3	65	8	9	8	3	7
	12	62.5	37.5	61	10	10	9	3	7
	13	52.7	47.3	65	8	8	8	3	8
<i>Plantagini-Lolietum</i>	16	62.2	37.8	89	4	4	1	1	1
	17	28.3	71.7	50	9	21	9	3	8
	18	21.6	78.4	71	10	7	4	2	6

developed in such a way exhibits a characteristic profile and its properties point to its origin. The substratum in ruderal sites is completely different. It is almost completely artificial. Although its basic part is the soil developed in natural conditions, it does not show major connections with the rock substratum.

Building works, various excavations, levelling of rubble heaps, transplantation of earth, considerable admixture of alien organic substances (production waste, garbage), mineral substances such as sand, rubble, gravel or dross, and considerable dusting and penetration of various substances with rain water are decisive factors in the specificity and differentiation of the superficial soil layer in colonized areas. Adamczyk and Komornicki (1970) use term anthropogenic soils to define natural soils changed by man in result of cultivation—or in the case of wood soils—after introduction of artificial culture, e.g. spruce. Ruderal soils are another example in this domain.

Only one Polish paper deals with the content of some elements in soils of ruderal sites (Korniak, 1966). Korniak has presented the results of his investigations of the nitrogen, potassium and phosphorus contents in the superficial layer. The research concerned four associations in some villages of Rypin district (Bydgoszcz province). The substratum there was much less disturbed than that at Bielsko-Biała, then a possibility existed to describe the whole profile and to carry out chemical analyses of all layers. Some information about substratum of ruderal association may be obtained from foreign publications, as e.g. the research in Göttingen (Grosse-Brauckmann, 1953) which deals with other associations than those occurring at Bielsko-Biała. A paper by Aellen and Grüll (1969) gives some numerical data characterizing soils of ruderal sites of Brno, which refer to two associations known at Bielsko-Biała, namely *Tanaceto-Artemisietum* and *Plantagini-Lolietum*. The above authors have studied pH, percentage of nitrogen and carbon and CaO. The pH, nitrogen and CaO values are similar to those noted at Bielsko-Biała although their dispersion is greater. The organic carbon content is much greater in samples from Brno than in those of Bielsko-Biała. A closer comparison was impossible because the authors did not cite phytosociological records of patches from which the samples have been taken.

In order to investigate edaphic conditions of the ruderal vegetation 18 soil samples were taken from six most common communities. Mechanical analysis has revealed large content of skeletal parts—about 60% in average—in the substratum of *Sisymbrietum sophiae* and *Tanacetum-Artemisietum* (Table XIII). It seems to be a general regularity as these associations grow usually on stony substratum. Two samples from the *Tussilago farfara* community revealed complete lack of skeletal parts, i.e., fraction over 1 mm. In the third sample there was about 18% of

Table XIV

Some chemical soil features of ruderal plant communities

Name of community	Number of sample	pH in H ₂ O	pH in KCL	C %	Organic matter %	N %	C/N	mg/100g P ₂ O ₅	mg/100g K ₂ O	CaCO ₃ %	mg/100g SO ₄
<i>Sisymbrium sophiae</i>	1	7.6	7.0	0.35	12.4*	0.274	45.3	16	23	1.55	22
	4	7.7	7.2	4.31	7.44	0.125	34.1	15	13	1.40	43
	14	7.7	7.2	4.38	7.56	0.103	42.0	12	8	1.16	22
Community of <i>Chenopodium bonus-Henricus</i>	2	7.6	7.1	6.65	11.46	0.274	24.2	53	66	5.30	15
	5	7.2	6.6	5.94	10.25	0.263	22.5	65	41	2.27	68
	7	7.5	6.9	6.34	10.95	0.309	20.5	60	32	4.02	42
<i>Leonuro-Arctietum tomentosi</i>	3	7.5	7.2	5.73	9.87	0.389	14.9	30	85	3.10	9
	8	7.5	7.0	6.52	11.26	0.297	21.9	37	110	1.50	47
	15	7.6	7.0	6.73	11.61	0.252	26.3	34	14	1.55	14
Community of <i>Tussilago farfara</i>	6	7.3	6.8	1.70	1.93	0.068	25.0	11	22	1.74	71
	9	7.5	6.9	0.71	1.22	0.057	12.4	7	9	0.54	29
	11	7.5	6.2	1.72	1.97	0.057	30.2	7	27	—	25
<i>Tanaceto-Artemisietum</i>	10	7.7	7.5	6.58	11.40	0.582	11.5	34	35	2.97	13
	12	7.5	7.1	6.80	11.70	0.228	29.9	22	28	2.28	41
	13	7.6	7.2	3.56	6.14	0.081	40.4	16	22	1.70	9
<i>Plantagini-Lolietum</i>	16	7.8	7.5	2.67	4.60	0.100	26.7	16	9	0.86	—
	17	7.8	7.4	4.85	8.36	0.230	21.1	23	16	3.68	—
	18	7.7	7.3	4.54	7.83	0.230	19.7	32	8	2.28	—

* Analysis made in the Department of Wood Soil Science, College of Agriculture, Cracow.

skeletal parts. An average content was noted in *Chenopodium bonus-Henricus*, and in the case of *Leonuro-Arctietum tomentosum* and *Plantagini-Lolietum* no regularity could be established. In earthy fraction the individuality of *Tussilago farfara* is even more accentuated. There is rather not much coarse and medium sand, and more fine sand and silt, thus such soils should be classified as heavy and medium loams. The share of the particular fractions is of great importance for the permeability of soils. Such ones containing many skeletal parts and sand, e.g., soils of *Sisymbrietum sophiae* and *Tanaceto-Artemisietum* belong to the most dry ones. Quite reverse situation is in sites of *Tussilago farfara* where permeability is poor and soils are wet.

The acidity of all analysed soils in ruderal sites at Bielsko-Biała appeared to be constant and balanced. The soils are very weakly basic (alkaline), almost neutral within pH values in H₂O from 7.2 to 7.8 and for pH in KCl from 6.2 to 7.5. Comparing the results obtained for *Leonuro-Arctietum tomentosum* (7.2: 7.0: 7.0) with corresponding data presented by Korniak (1966) (pH in KCl in 0-10 cm layer: 6.4; 5.3; 6.9; 6.6) it may be stated that the soils at Bielsko-Biała are slightly more alkaline. Such pH values are probably connected with the CaCO₃ content in the investigated samples. Small diversification of pH in the ruderal soils of Bielsko-Biała could point to influence of a certain common factor but the small quantity of analyses does not allow to draw more precise conclusions.

The content of organic carbon in samples is given in Table XIV. The humus content has been calculated from these figures (assuming that there is in average about 58% of C). The *Chenopodium bonus-Henricus* community and *Leonuro-Arctietum tomentosum* show the largest content of organic matter. The soil of *Tussilago farfara* contain very little humus which is connected with the fact that this community grows usually on substratum derived from deeper layers, considerably below the humus layer and exhibits initial character. There was no time to develop new humus bed. The figures given in the table for *Tanaceto-Artemisietum* and *Sisymbrietum sophiae* seem to suggest large content of organic carbon, which almost equals those found in *Chenopodium bonus-Henricus* and *Leonuro-Arctietum tomentosum*. This is an apparent convergence because the percentage of organic carbon is calculated taking earthy parts as 100 and in *Tanaceto-Artemisietum* and *Sisymbrietum sophiae* skeletal parts constitute large percentage. *Plantagini-Lolietum* shows considerable variability in carbon and humus contents which is probably connected with the fact that it grows in all site types in the town and trampling is the decisive factor in the development of patches.

The soils of the investigated communities abound in organic compounds as compared to those of natural ones (Musierowicz, 1958,

1968). They contain twice as much of these compounds, e.g. in the same layer (0 - 20 cm) as in tsernozem and/or rędzina (marly soil).

The quantity of total nitrogen in the soils of ruderal communities in the investigated area varies greatly. It ranges from 0.057 up to 0.582%. The maximal content is almost ten times greater than the minimal one. Small content of nitrogen is characteristic in *Tussilago farfara* community. This is mainly caused by the lack of humus in the substratum. This interrelation may be easily noted comparing the content of humus and nitrogen in the particular communities. Other communities exhibit lesser diversity in nitrogen content. There is respectively not enough this element in the soils of *Sisymbrium sophiae*, which is proved by two samples containing 0.125 and 0.103% of N (the third sample contains 0.274% of N with minimal humus content. This fact cannot be explained using available data). The soil of *Plantagini-Lolietum* contains an average nitrogen content. The results obtained cannot be directly compared to those of K o r n i a k (1966), because he studied the content of hydrolytic nitrogen and not the total one as it was done by the authoress. The last mentioned author has obtained more distinct differences in nitrogen content in *Leonuro-Arctietum tomentosum* and in *Plantagini-Lolietum* than those in Bielsko-Biała although even his results concerning nitrogen were slightly smaller in the latter association.

The C:N ratio is a very characteristic feature in the biology of soils. Its value in cultivated soils is about 10 as a rule, and under such circumstances there exist relations between microorganisms and vascular plants which are favourable for the latter. Bad or even very bad C:N ratio was observed in the investigated ruderal soils. In extreme cases it is 44 and is not connected with the kind of community. Possibly it is a general property of ruderal sites caused by penetration of large quantities of fresh organic matter not changed into humus or an admixture of coal and soot.

The soils of the particular ruderal communities considerably differ one from another in their phosphorus content (Fig. 9). The community of *Chenopodium bonus-Henricus* is the richest one in this respect. The next one is *Leonuro-Arctietum tomentosum* but its soils contain only half of that of the first one. In both these communities the data from all samples of a given unit are very equalled. Larger variability is noted in *Tanaceto-Artemisietum* and *Plantagini-Lolietum* in which the maximal content is close to that of *Leonuro-Arctietum tomentosum*. Insignificant contents of phosphorus are known to occur in the soil of *Sisymbrium sophiae* and *Tussilago farfara* community, but the former one shows larger quantities. As compared to data by K o r n i a k (1966), the quantities of phosphorus at Bielsko-Biała are larger and more balanced in the soils

of *Leonuro-Arctietum tomentosum* while those of *Plantagini-Lolietum* are considerably smaller.

The potassium content is similar to that of phosphorus (Fig. 9). The soils of *Leonuro-Arctietum tomentosum* are the richest and those of *Chenopodium bonus-Henricus* are next, with slightly smaller quantities. Soils of *Sisymbrietum sophiae* are the poorest and those of *Tanaceto-*

Fig. 9. Potassium and phosphorus contents in the upper layer of soil of the particular ruderal plant communities

I — *Leonuro-Arctietum tomentosum*; II — community of *Chenopodium bonus-Henricus*; III — *Tanaceto-Artemisietum*; IV — community of *Tussilago farfara*; V — *Sisymbrietum sophiae*; VI — *Plantagini-Lolietum*

Artemisietum and *Tussilago farfara* show similar values. The data cited by Korniak (op. cit.) show similar values to those of Bielsko-Biała.

The quantity of calcium carbonate was determined in the ruderal soils as well. The most calcareous substratum was stated in the community of *Chenopodium bonus-Henricus* and the least — in that of *Tussilago farfara*. Mean CaCO_3 content was observed in samples from *Leonuro-Arctietum tomentosum* and *Tanaceto-Artemisietum*. The CaCO_3 content of soils of *Plantagini-Lolietum* varies greatly.

The data about SO_4^{2-} are difficult to establish as no comparison can be made. Medwecka-Kornaś (1959) mentioned the SO_3 content only for gypsum rędzina soils. The data presented in Table XIV were obtained in order to make a direct interpretation of results revealed during execution of analyses.

Summing up the information obtained due to analyses of the substratum, the following characteristic of soils may be given:

The most fertile habitats are occupied by community of *Chenopodium bonus-Henricus*. They contain large quantities of phosphorus, potassium, and calcium. Similar relations occur in the soils of *Leonuro-Arctietum tomentosum* but the above mentioned elements occur in smaller quantities (except potassium) and show greater deviations. The soils of *Tanaceto-Artemisietum* show mean quantities of these elements and differ from the above mentioned ones in their mechanical composition because they contain large quantities of skeletal fraction. The mechanical composition of soils of *Sisymbrietum sophiae* is similar but they are always poorer in main nutritive components. The community of *Tussilago farfara* is extremely poor and that of *Plantagini-Lolietum* shows considerable variability of all analysed elements. This seems to suggest that the amount of nutritive components is not a decisive factor in the origin of this association.

Generally speaking the soils of ruderal sites at Bielsko-Biała are richer in nutritive components than those of natural and seminatural associations of submontane areas. Their structure, however, is worse and the relations between microorganisms and higher plants are unfavourable (C:N). Nitrogen content, although high in some cases, is not particularly characteristic for the communities in question. The phosphorus, potassium and calcium contents are better distinguishing indicators. The quantities of carbon and organic matter are fairly good indicators of sites of the described communities but not as good as the components mentioned above. It should be kept in mind however, that the ruderal sites are characterized by a great variability of the particular elements within different patches of the same community, much greater than that of natural sites. Fortuity in contamination of soil by man is probably of importance as well. As the ruderal substratum is continuously exposed to human interference, the probability of finding a

strongly disturbed site during sampling, e.g. in result of presence of decomposing organic matter or rubble pieces is fairly high. Thus larger number of samples should be taken during such investigations and the extreme values should be eliminated. Due to all those difficulties the soil research in ruderal communities shows little progress. More detailed recognition of the substratum of those communities and its changes will throw new light on the problems of the succession and recultivation of the ruderal sites.

4. SHARE OF APOPHYTES AND ANTROPOPHYTES IN THE RUDERAL COMMUNITIES OF BIELSKO-BIALA

Two hundred and twenty six species of vascular plants were found in the patches of the ruderal communities in question within the boundaries of Bielsko-Biala. All the species were subdivided into groups using geographical-historical classification of synanthropic plants modified by Kornaś (1968a). Papers by Kornaś (1968b), Kornaś and

Fig. 10. Percent share (P) of apophytes and total different groups of antropophytes in ruderal plant communities of the Bielsko-Biala area

a — apophytes; b — archeophytes; c — epoekophytes; d — agriophytes; e — ergaslophytes and ephemerophytes

Medwecka-Kornaś (1968) and Schwarz (1967) were of great help in differentiation of the particular groups of species. The following results were obtained for all the vascular plants of ruderal communities at Bielsko-Biala: apophytes 150 species = 66.4%; antropophytes 76 species = 33.6%. Within antropophytes: archeophytes 31 species = 13.7%;

epoekophytes 20 species = 8.8%; agriophytes 9 species = 4.0% and ergasiophytes 16 species = 7.1 % (one ephemerophyte sensu stricto is involved in this group; Fig. 10).

The value 33.6% for the antropophytes of Bielsko-Biała seems to be small taking into consideration the fact that in the whole area of Poland there are c. 300 foreign species permanently naturalized which is over 10% of all Polish flora and the conditions of naturalization of antropophytes within the town are particularly favourable. Similar calculation made in the case of synanthropic flora of the city of Gdańsk point to a considerably greater number of antropophytes (52.5% — S c h w a r z, 1967). The difference lies in point that the data from Bielsko-Biała do not concern the whole flora but only the species registered in the phytosociological records. There is a great difference in the character of both cities: Gdańsk, a great industrial city with enormous possibilities in immigration of foreign species (great percentage of ephemerophytes!) and vast ruderalized areas rendering excellent conditions to accept foregin species, and Bielsko-Biała a town cramped at the foots of the Beskides Mts., of relatively small area in relation to its population, with smaller possibility of acclimatization of antropophytes.

The period of investigations at Bielsko-Biała (2 years) seems to be too short to catch the sporadic occurrences of efemerophytes.

The synanthropization degree was calculated for the particular communities of the investigated area (K r a w i e c o w a, 1968).

$$R(\%) = \frac{\text{antp}}{\text{ap}} \cdot 100$$

in which

R — synanthropization degree;
antp — number of antropophytes;
ap — number of apophytes.

The results are presented in Table XV where the communities are arranged from the lowest to the highest synanthropization degree (not taking into account *Sagino-Bryetum*). The lowest synanthropization degree (R) and domination of native species have been observed in the *Tussilago farfara* community, *Plantagini-Lolietum*, and *Urtica dioica-Rumex obtusifolius* community. These are communities which occur in natural and slightly ruderalized sites in similar floristic composition. A comparison of the obtained data with those by K r a w i e c o w a (1968) carried out in the Opawskie Mts. (Eastern Sudetes), shows that the minimal values of synanthropization degree (R) are similar, whereas considerable differences may be noted in maximum: 112.5% at Bielsko-Biała and 253.8% in the Opawskie Mts. (Table XV). The synanthropization degree (R) calculated from all ruderal communities of Bielsko-Biała is 50.6%.

Table XV

Number of species and the degree of synanthropization (R) in particular ruderal plant communities in Bielsko-Biala

Name of community	Total number of records in table	Total number of species	Apophytes	Anthropophytes	The degree of synanthropization R (%)
Community of <i>Urtica dioica</i> - <i>Remex obtusifolius</i>	5	49	38	11	28.9
Community of <i>Tussilago farfara</i>	7	67	51	16	31.4
<i>Plantagini-Lolietum</i>	19	58	44	14	31.8
<i>Echio-Melilotetum albi</i>	4	37	28	9	32.1
Community of <i>Chenopodium bonus-Henricus</i>	8	35	25	10	40.0
<i>Sisymbrietum sophiae</i>	9	80	56	24	42.8
<i>Tanacetum-Artemisietum</i>	26	155	108	47	43.5
<i>Asplenietum rutae-murariae-trichomanis</i>	8	32	22	10	45.4
<i>Leonuro-Arcietum tomentosum</i>	14	96	66	30	45.5
Community of <i>Bidens melanocarpus</i>	3	56	34	22	64.7
<i>Hordeetum murini</i>	1	14	7	7	100.0
<i>Chenopodietum glauco-rubri</i>	2	17	8	9	112.5

The composition of the investigated plant communities was analyzed taking into account the amount of apophytes and antropophytes and considering separately for the latter group the number of archeophytes, epoekophytes, agriophytes (without subdivision into naturalized species

Fig. 11. Total share (G) of the apophytes and particular antropophytes group in the ruderal plant communities in Bielsko-Biala

a — apophytes; b — archeophytes; c — epoekophytes; d — agriophytes; e — ergasiophytes and ephemeroophytes

I — *Asplenietum rutae-murariae-trichomanis*; II — *Tanaceto-Artemisietum*; III — *Leonuro-Arctietum tomentosum*; IV — *Hordeetum murini*; V — community of *Tussilago farfara*; VI — community of *Chenopodium bonus-Henricus*; VII — community of *Urtica dioica-Rumex obtusifolius*; VIII — *Sisymbrietum sophiae*; IX — *Echio-Mellilotetum albi*; X — *Plantagini-Lolietum*; XI — *Chenopodietum glauco-rubri*; XII — community of *Bidens melanocarpus*

in natural and subnatural communities) and ergasiophytes. For the particular groups of species were calculated:

- percentage of species of a given group (P);
- total share of a given group (G);
- group value (D).

Table
The values characterizing the participation

Name of community	Number of record in table	Percental share of quantity of species of this group (P)					Total of the	
		A	B	C	D	E	A	B
<i>Asplenietum</i>								
<i>rutae-murariae-trichomanis</i>	8	69	12	16	3	0	69	7.4
<i>Tanaceto-Artemisietum</i>	26	69.6	13	9	4.5	3.9	79.7	9.3
<i>Leonuro Arctietum tomentosii</i>	14	68.7	14.6	9.4	3.1	4.2	73.9	13.7
<i>Hordeetum murini</i>	1	50	28.6	14.3	0	7.1	50	28.6
Community of <i>Tussilago farfara</i>	7	76.1	14.9	7.5	1.5	0	83.3	11.1
Community of <i>Chenopodium bonus-Henricus</i>	8	71.4	14.3	11.4	0	2.9	65.5	22.2
Community of <i>Urtica dioica-Rumex obtusifolius</i>	5	77.5	10.2	8.2	0	4.1	84.2	7.3
<i>Sisymbrietum sophiae</i>	9	70	16.2	13.8	0	0	64.7	15.8
<i>Echio-Melilotetum albi</i>	4	75.7	10.8	10.8	2.7	0	81	8.6
<i>Plantagini-Lolietum</i>	19	75.9	13.8	6.9	1.7	1.7	71.1	16.4
<i>Chenopodietum glauco-rubri</i>	2	47.1	29.4	17.6	5.9	0	46.2	34.6
Community of <i>Bidens melanocarpus</i>	3	60.7	19.6	10.7	3.6	5.4	55.1	24.7

A — apophytes; B — archeophytes; C — epoekophytes; D — agriophytes; E — ergasiophytes

These three values were taken into account because comparable results were wanted and because they were applied in phytosociological calculations many times.

The group value was put into a formula by Tüxen and Ellenberg (1937, see Pa w ł o w s k i, 1959):

$$D(\%) = \frac{G \cdot S}{100}$$

in which

D — group value;

S — average presence degree of group;

G — total share of group,

$$S(\%) = \frac{\sum g}{z \cdot n} \cdot 100,$$

$$G(\%) = \frac{\sum g}{\sum t} \cdot 100,$$

in which

n — number of records in the table;

z — number of species in group;

g — sum of occurrences of species of a given group in the table;

t — sum of occurrences of all species in the table.

XVI

of the particular group of the species

share group in % (G)			The group value (D) in %					The group value (D) with regard to apophytes				
C	D	E	A	B	C	D	E	A:A	B:A	C:A	D:A	E:A
17.6	6	0	19.6	1.1	5.3	3	0	1	0.06	0.27	0.15	0
6	3.7	1.3	15.4	1.1	0.7	0.4	0.1	1	0.07	0.04	0.02	0.006
9.3	1.4	1.7	17.2	2.8	2	0.1	0.2	1	0.16	0.12	0.006	0.012
14.3	0	7.1	50	28.5	14.3	0	7.1	1	0.57	0.29	0	0.14
4.9	0.7	0	27	2.5	1	0.1	0	1	0.09	0.04	0.004	0
11.1	0	1.2	17.3	10	2.4	0	0.2	1	0.58	0.14	0	0.012
6.1	0	2.4	30.6	1.8	1.5	0	0.5	1	0.06	0.05	0	0.016
19.5	0	0	15.8	4	7.3	0	0	1	0.25	0.46	0	0
8.6	1.8	0	34	2.8	2.8	0.4	0	1	0.08	0.08	0.012	0
10.7	1.3	0.5	13.6	4	3.4	0.2	0.02	1	0.29	0.24	0.015	0.001
11.5	7.7	0	34.6	31.1	5.8	7.7	0	1	0.89	0.14	0.22	0
11.2	5.6	3.4	26.4	16.5	5.2	4.7	1.1	1	0.62	0.20	0.178	0.042

and ephemerophytes.

Using group value (D) we obtain a result which is the nearest to the real relation of the investigated groups of species within a given community, first of all due to introduction of the total share (G) of a given plant group to the formula, in result of which the usually long list of sporadic species is of smaller importance.

In order to compare D value of the particular groups of species in the investigated ruderal communities it was related to the group value of apophytes of each community (Figs. 12, 13, 14). All the values described above are presented in the table (Table XVI) and some of them in diagrams.

Only some of the investigated communities were covered by a satisfactory number of phytosociological records as usually accepted in such a research (at least 5 records). To make the results more complete even these not representative data are presented and the number of record

on which the calculations were based is mentioned in the tables (Tables XV and XVI).

The executed calculations point out that the native species (apophytes were treated generally without any internal subdivision) attain the highest share in the communities of *Urtica dioica-Rumex obtusifolius* and *Tussilago farfara*, as well as in the associations *Echio-Melilotetum albi* and *Tanaceto-Artemisietum* in which the total share of group G — is 79.7 up to 84.2% (Fig. 11), and P from 69.6 up to 77.5% (Table XVI). Also in the most remaining ruderal communities of Bielsko-Biała the native species exceed the antropophytes. Only in one case the G value drops below 50%, i.e. in *Chenopodietum glauco-rubri* (Fig. 11). The majority of apophytes existing in the investigated associations of Bielsko-Biała are probably remnants of natural vegetation. These species as the most resistant ones remained in their old sites. Other apophytes have penetrated to these ruderal communities from the surrounding meadows, woods and gravel fields.

The most important of all groups of antropophytes occurring in the ruderal communities are archeophytes (species brought before 16th century).

It is a well known fact that this group dominates in segetal associations, which led even to a conclusion that large per cent of archeophytes differs the associations of cultivated fields from ruderal communities (Wójcik, 1968).

In the area of Bielsko-Biała archeophytes commonly occur in *Chenopodium glauco-rubri*, *Hordeetum murini*, and communities: *Chenopodium bonus-Henricus* and *Bidens melanocarpus*. The distinctness of these four communities is marked by high G values (22.2 - 34.6%) and P ones (14.3 - 29.4%) for archeophytes (Fig. 11, Table XVI). The share of archeophytes in segetal communities is known only from Mazowsze in Central Poland (Wójcik, 1968), in which P is 25.5 - 54.5%. In the ruderal communities of Bielsko-Biała P value for archeophytes is not so high, nevertheless, it fits the limits for field communities. Large share of archeophytes in segetal communities and in a part of ruderal ones may suggest the old age of these communities, which might have been the first synanthropic sites of vegetation connected with the early beginnings of agriculture and human colonization. The young community *Bidens melanocarpus* is undoubtedly of different character; its floristic composition is still in its development stage. Most archeophytes of this community are species of segetal associations (*Atriplex patulum*, *Tripleurospermum inodorum*, *Sonchus oleraceus*, *Setaria glauca*). They endured in ruderalized sites and found their place among expansive, young newcomer.

The ruderal communities are of particular importance in the expansion of species brought in recent times (kenophytes). Among them the most common are epoeophytes, i.e. species occurring only in ruderal and segetal communities.

Fig. 12. The group values of archeophytes in relation to apophytes in the ruderal plant communities of Bielsko-Biala

1 — *Asplenietum rutae-murariae-trichomanis*; 2 — *Tanaceto-Artemisietum*; 3 — *Leonuro-Arctietum tomentosum*; 4 — *Hordeetum murini*; 5 — community of *Tussilago farfara*; 6 — community of *Chenopodium bonus-Henricus*; 7 — community of *Urtica dioica-Rumex obtusifolius*; 8 — *Sisymbrietum sophiae*; 9 — *Echio-Mellilotetum albi*; 10 — *Plantagini-Lolietum*; 11 — *Chenopodietum glauco-rubri*; 12 — community of *Bidens melanocarpus*; A — apophytes

Epoeophytes together with archeophytes make the specific character of the synanthropic communities. In the communities under investigation two associations are distinctly separated from all others due to their large content of epoeophytes. The associations in which epoeophytes are characteristic and dominant in patches are: *Sisymbrietum sophiae* with prevalence of *Sisymbrium Loeselii* and *S. altissimum* and *Asplenietum rutae-murariae-trichomanis* with *Linaria cymba-*

laria and *Corydalis lutea*. Only in these associations epoekophytes found so favourable conditions that they constitute the bulk of the community. In all other communities their presence is distinct, but to a lesser degree (Figs. 11, 13).

Fig. 13. The group values of epoekophytes in relation to apophytes in ruderal plant communities of Bielsko-Biala

1 — *Asplenietum rutae-murariae-trichomanis*; 2 — *Tanaceto-Artemisietum*; 3 — *Leonuro-Arctietum tomentosum*; 4 — *Hordeetum murini*; 5 — community of *Tussilago farfara*; 6 — community of *Chenopodium bonus-Henricus*; 7 — community of *Urtica dioica-Rumex obtusifolius*; 8 — *Sisymbrietum sophiae*; 9 — *Echio-Melilotetum albi*; 10 — *Plantagini-Lolietum*; 11 — *Chenopodietum glauco-rubri*; 12 — community of *Bidens melanocarpus*; A — apophytes

Foreign plants naturalized in natural and subnatural associations (agriophytes), play but minor role in the ruderal communities in the investigated area (Figs. 11, 14). Their role in the *Bidens melanocarpus* community, *Chenopodietum glauco-rubri* and *Asplenietum rutae-murariae-trichomanis* is greater. In all these cases species occurring in subnatural sites such as: *Solidago serotina* known from disturbed river-bank willow brakes and *Bidens melanocarpus* growing in similar humid

sites are the representatives of agriophytes. These two species decide about a relatively high per cent of agriophytes in the three above mentioned communities (Figs. 11, 14).

Ephemerophytes and ergasiophytes are of little importance in the ruderal communities of Bielsko-Biala. Only one ephemerophyte was noted from all phytosociological records. This is probably due to small possibility of bringing (relatively small quantity of imported raw

Fig. 14. The group values of agriophytes in relation to apophytes in ruderal plant communities

1 — *Asplenietum rutae-murariae-trichomanis*; 2 — *Tanaceto-Artemisietum*; 3 — *Leonuro-Arctietum tomentosum*; 4 — *Hordeetum murini*; 5 — community of *Tussilago farfara*; 6 — community of *Chenopodium bonus-Henricus*; 7 — community of *Urtica dioica-Rumex obtusifolius*; 8 — *Sil-symbrietum sophiae*; 9 — *Echio-Melilotetum albi*; 10 — *Plantagini-Lolietum*; 11 — *Chenopodietum glauco-rubri*; 12 — community of *Bidens melanocarpus*; A — apophytes

materials with which the seeds are carried in), lack of larger trans-shipment places and storehouses, lack of vast open areas not occupied by ruderal communities in which sharp competition other plants would be eliminated, and submontane climate unfavourable for newcomers.

Lack of cultivated areas, particularly in sites in which the phytosociological investigations were carried out, has caused that the quantity of ergasiophytes at Bielsko-Biała is small.

It comes from the calculation of the group value D, for each of communities (Table XVI) that in relation to the particular species groups one to another there is no common regularity in the ruderal communities, and these values are different for each community. All the ruderal communities of Bielsko-Biała exhibit large share of antropophytes and within them a particular domination of archeophytes and epoeophytes. In many cases archeophytes and epoeophytes constitute the bulk of the association and this is probably the main cause of lability of these ruderal communities.

VI. DISTRIBUTION OF SOME SYNANTHROPIC SPECIES IN BIELSKO-BIAŁA

Plotting of distribution maps to small scale for ruderal species foreign to Polish flora has its own long history and serves to know the means and directions of their expansion and to determine their probable country of origin. Investigations of detailed distribution of synanthropic species in small areas covered with natural vegetation, or in smaller or larger urban complexes are hardly advanced.

A paper by Saarisalo-Taubert (1963) presents an interesting elaboration concerning the distribution of synanthropic plants in urban areas. The authoress researched the synanthropic flora of three Finnish towns (Hamina, Loviisa and Porvoo), has established some cultural areas there corresponding to the development stages of the towns and studied the connections between them in the distribution of the ruderal plants.

The population of each of those three Finnish towns was about 10 000 and their surface is in average about 20 sq.km. When compared to Bielsko-Biała these are small settlements, about ten times smaller in population and 2-3 times smaller in surface. The villa-type of buildings stretched over large surface, in some case semirural in character was entirely different than that of Bielsko-Biała. The possibilities of comparison of the distribution of the particular species are small because of the great distance between the Finnish towns and Bielsko-Biała which is about 1200 km, which renders great differences in the geographic and ecological character and in flora. Because of all these reasons other species (with two exceptions) were selected for the investigation of distribution of synanthropic plants at Bielsko-Biała than those taken by Saarisalo-Taubert (1963). She mapped 42 species and at Bielsko-Biała the distribution of 18 species was plotted. The approach to the ruderal flora was different as well. The Finnish authoress has

Fig. 15. Distribution of *Galinsoga parviflora* Cav. in the Bielsko-Biala area

Fig. 16. Distribution of *Galinsoga quadriradiata* Ruiz et Pav. in the Bielsko-Biala area

subdivided species into groups taking into account their stations in sites of various intensity of cultural influences. A geographic-historical subdivision of synanthropic species by Thellung with modification by Kornaś (1968a) was used to classify the ruderal plants of Bielsko-Biała. The latter better explains the character of distribution of the particular species within the town. The selected species belong to various groups in this classification. In most cases these are epoekophytes: *Berteroa incana*, *Bunias orientalis*, *Cardaria draba*, *Corydalis lutea*, *Datura stramonium*, *Descurainia sophia*, *Galinsoga parviflora*, *G. quadriradiata*, *Linaria cymbalaria*, *Sisymbrium altissimum*, *S. Loeselii*.

Others are hemiagriophytes (*Bidens melanocarpus*, *Impatiens Royleii*, archeophytes *Ballota nigra*, *Chenopodium bonus-Henricus*, *Geranium dissectum*, *Solanum nigrum*), and one apophyte (*Asplenium ruta-muraria*). More than half of them are species characteristic for the ruderal communities at Bielsko-Biała. The choice of species was not optional. Only those were selected which in preliminary observations revealed some interesting regularities in their distribution. This list may be enlarged in any future research works although the basic regularities have been already checked. In order to know better the ecological character of the described species, their natural sites and history of distribution were studied as much as possible.

Only two of the investigated species occur throughout the whole town namely *Galinsoga parviflora* and *G. quadriradiata* (Figs. 15, 16). The first mentioned one came to Poland at the beginning of 19th century, and the second one at the beginning of the 20th century (Majdecka-Zdziarska, 1929; Kornaś, 1959). Both species originate from South America. Little can be said about their natural sites. They changed their ecology in Europe. Here they are annual plants, whereas in their homeland — perennial plants. Temperate European climate does not disturb these subtropical plants in their generative propagation. Both species belong most to the common ruderal plants at Bielsko-Biała. They occur in cultures near the town as well. Exact data about bringing them to Bielsko-Biała are lacking but it is certain that *Galinsoga quadriradiata* did not grow there before 1939 (Kornaś — oral information). Submontane climate and altitude of Bielsko-Biała do not disturb the development of these plants. Both species are common in the foreland and the lower part of the forest zone of the Carpathians (Kornaś, 1957; Stuchlikowa and Stuchlik, 1962; Grodzińska and Pancer-Kotejowa, 1960). Their maximal altitude is 750 m a.s.l. in the Gubałówka Elevation. In the Polica and Gorce Mts. *Galinsoga parviflora* is more common. *G. quadriradiata* seems to be a newcomer — particularly in Gorce (Kornaś, 1957), which would coincide with the time of bringing in these two species to Poland. At Bielsko-Biała the situation is reverse as it is *Galinsoga quadriradiata* which is

Fig. 17. Distribution of two *Sisymbrium* species and *Descurainia sophia* in the Bielsko-Biala area
a — *Sisymbrium altissimum* L.; b — *Sisymbrium Loeselii* L.; c — *Descurainia sophia* (L.) Webb.

more common. This cannot easily be explained. Possibly it has found particularly favourable conditions there which allowed it to outnumber the other species. It is worth of mention that *Galinsoga parviflora* grows in ruderal communities whereas *G. quadriradiata* usually grows in monospecific communities. Their distribution proves that they are ubiquitous plants and grow in almost all types of sites in the area in question (with exception of *Plantagini-Lolietum*), hence they are of no importance in the differentiation of associations.

A rather large group of the mapped species occurs only in the northern part of the town, near the railway station. Part of them are species spreading along the railway, and the other ones find there the most favourable climatic conditions. The distribution of *Sisymbrium altissimum*, *S. Loeselii* and *Descurainia sophia* (Fig. 17) is very interesting. All three plants occupy sites near the railway. They are most common near the Bielsko-Biała Główna railway station. Some their stations are situated along the line connecting Bielsko-Biała Główna with the station Bielsko-Biała Wschód and near the crossing at Hałcnowska street. The last mentioned sites have probably developed in connection with an increased traffic caused by the construction of a factory. Lack of stations along other railways in the town such as Bielsko-Biała—Cieszyn, Bielsko-Biała—Żywiec and farther sector of the line Bielsko-Biała—Cracow, is probably caused by a relatively small traffic along those lines. It was frequently mentioned that there exist a paucity of newcomers in railway sites outside larger stations (Kornaś, Leśniewska and Skrzywanek, 1959; Zając E. U., and Zając A., 1969). The situation at Bielsko-Biała fully confirms it. In other parts of the country *Sisymbrium altissimum*, *S. Loeselii* and *Descurainia sophia* abundantly occur also in sites other than railway. In Bielsko-Biała climate is probably the main obstacle in their expansion southward. They are Irano-Turanian species. In Kazakhstan they grow on slopes of sandy hills and near roads (Vasil'eva, 1961). The date of their coming to Bielsko-Biała is difficult to establish. It seems that *Descurainia sophia* is a recent newcomer (only two specimens were found in two sites), so possibly it is in the stage of ephemerophyte. *Sisymbrium altissimum* and *S. Loeselii* (the first one is more common) seem to be naturalized since over a dozen of years.

Cardaria draba (Fig. 18e) occupies similar habitats at Bielsko-Biała to those of the *Sisymbrium* species. This Mediterranean-Iranian-Turanian species shows great affiliation to communication tracks. While both the *Sisymbrium* species are characteristic in the community formed by them, *Cardaria draba* occurs rather in single specimens on surfaces devoid of vegetation, e.g. freshly ballasted lines.

Datura stramonium may be an example of an accidentally imported species (Fig. 18d). It was brought into Poland in 17th century (Wein,

Fig. 18. Distribution of some species in the Bielsko-Biala area

a — *Berteroa incana* (L.) DC.; b — *Bunias orientalis* L.; c — *Balotianigra* L.; d — *Datura stramonium* L.; e — *Cardaria draba* (L.) Desv.

Fig. 19. Distribution of some species in the Bielsko-Biala area
a — *Asplenium ruta-muraria* L.; b — *Corydalis lutea* (L.) DC.; c — *Linaria cymbalaria* (L.) Mill.

Fig. 20. Distribution of *Chenopodium bonus-Henricus* L. in the Bielsko-Biala area

Fig. 21. Distribution of *Solanum nigrum* L. in the Bielsko-Biala area

1932; Kornaś, 1959). It was probably imported to Bielsko-Biała together with a transport of raw material, as it was found near a factory. Little is known about its sites in its homeland. In Poland it occupies insolated, rather rich in nitrogen sites. It never penetrates mountains thus it is little hope that it will spread widely at Bielsko-Biała. It was collected in the town in the Biała district in 1938 (herbarium of A. and J. Kornaś).

Bunias orientalis was observed in many sites beyond the northern boundary of the investigated area; it is abundant at Bielsko-Biała, but only in one station (Fig. 18b). This species came to Poland from Eastern Europe in 19th century (Kornaś, 1968b). It spread along railways and on stony roadsides.

Two submediterranean taxa *Ballota nigra* subsp. *ruderalis* and *Berteroa incana* (Fig. 18a, c) are limited to the warmer, northern part of the town. *Berteroa incana* occupies sites on near-railway gravels and railway embankments.

The species described so far connected their distribution with probably particular climatic conditions in the northern part of the town, or with the path of their distribution. Other group of species, limited to specific, constant habitats, shows a connection with the history of the colonization in the town. Native and foreign plants growing on old walls belong here. These are: *Asplenium ruta-muraria*, *Corydalis lutea*, and *Linaria cymbalaria* (Fig. 19). Their distribution marks almost exactly the old communication tracks crossing the town (Fig. 2). In the western part of the town their stations are located along the old track to Cieszyn and a local track connecting old castle with the Old Bielsko town, and across the river, at Biała, along the road from Bielsko to Lipnik. Both at Bielsko and Biała these species spread over greater complexes of cemetery walls and everywhere on remnants of old roads might be expected. *Asplenium ruta-muraria*, native rock species is frequent in artificial habitats. It may be supposed that it is more frequent as an apophyte (in sites where natural rocks are lacking), than in its natural habitats. *Linaria cymbalaria* and *Corydalis lutea* are rocky species of the Alps foreland, the latter even of middle montane altitudes. The date of their arrival to Poland is unknown.

They probably spread from a culture some time ago. At Bielsko-Biała nothing points to their escape from a garden. They were never observed in alpinariums here.

Two archeophytes are indicators of old sites of other type namely *Chenopodium bonus-Henricus* and *Solanum nigrum* (Fig. 20, 21). The former one occurs on fertile compost soils which are remains of gardening developed in old suburbs. Two such areas may be distinguished: one at Bielsko—in the Upper Suburb (Górne Przedmieście) between the Cieszyn road and the emperor's road and another one at Biała in area

Fig. 22. Distribution of *Geranium dissectum* L. in the Bielsko-Biala area

adhering to the starost's residence and along the Lipnik road. One isolated station occurs in the old dumping ground near the Biała river. *Solanum nigrum* is connected with areas in which organic waste such as manure etc. was laid down. At Biała the stations of *Solanum nigrum* occur in the dumping grounds between the old Biała periphery and the Bielsko-Biała Wschód railway station, and at Bielsko along the emperor's road where a way once existed along which cattle was driven to market place. Third weakly marked centre is the road to the suburban village of Kamienica.

Geranium dissectum is the fourth archeophyte the distribution of which was investigated at Bielsko-Biała. This is the weed of plough-land. All its stations occur around the town, far from compact buildings or on the boundary of buildings and fields (Fig. 22). Thus this species enters the ruderal sites only in places of direct contact with segetal communities.

Bidens melanocarpus and *Impatiens Royleii* are examples of foreign species adapted to sites of degraded natural communities. *Bidens melanocarpus* is an agriophyte which has come to Bielsko-Biała recently. The exact date is unknown but it is sure that it came in forties of this century. It is a North American species. Its distribution in Poland was investigated by Trzcicka (1961).

In its homeland it grows in riverine sites (Fernald, 1950; Abrams and Ferris, 1960). In Poland it occurs near rivers and in ruderal sites as well. At Bielsko-Biała *Bidens melanocarpus* occurs also in two types of sites, although it shows some interesting differentiation of its distribution in various parts of the town. It has spread in ruderal and riverine sites far from the mountains in the northern part of the town in areas near the railway station which are relatively flat. Farther south, the nearer the mountains where the river valley becomes narrower and narrower, its distribution consequently depends on the river course as all stations are situated near the river (Fig. 23). Thus, the conclusion may be drawn that *Bidens melanocarpus* came to Bielsko-Biała from the north and earlier has spread in sites similar to those of its homeland (river sides), and later on in the ruderal sites. This might be caused by climatic changes. Near the mountains this species occurs only near the river, and in some distance from them where more favourable climatic conditions exist, also in somewhat distanced sites. In ruderal sites *Bidens melanocarpus* grows most frequently in association of some definite species which was a basis for distinguishing a separate community.

Impatiens Royleii derives from the Western Himalayas. It was introduced to garden cultures in Europe in 1839 (Dauman, 1967; Ludwig, 1956). Then it spread to ruderal sites and from there to alluvial communities. It was first mentioned from the Polish territory, and from such sites by Jasnowski (1961). In Hungary (Priszter, 1965) and

Fig. 23. Distribution of *Bidens melanocarpus* Wiegand in the Bielsko-Biala area

Fig. 24. Distribution of *Impatiens Roylei* Walp. in the Bielsko-Biala area.

in Czechoslovakia (Lhotská and Kopecký, 1966) it spreads mostly along the rivers. At Bielsko-Biała the alluvial woods on the Biała river are destroyed completely within the compact building areas. In few remains of them *Impatiens Royleii* has spread considerably.

In the southern part of the town it approaches the very base of the mountains. It grows there luxuriantly and is very common (Fig. 24).

Information given by Professor Jan Kornaś was a good contribution to the knowledge of the time of coming of some mapped species to Bielsko-Biała. Up to the year 1939 he did not observe the following species within the town: *Bidens melanocarpus*, *Cardaria draba*, *Corydalis lutea*, *Descurainia sophia*, *Galinsoga quadriradiata*, *Impatiens Royleii*, *Linaria cymbalaria*, *Sisymbrium altissimum*, and *S. Loeselii*. Thus it may be reckoned that the distribution of the above species at Bielsko-Biała took place after 1939.

The above mentioned data concerning the distribution of the ruderal species in Bielsko-Biała show that it depends first of all on climate, ways of the distribution of the plants, existence of peculiar sites and spacial pattern of some architectonic elements connected with the town history. Usually several factors act simultaneously. Research of the local distribution of ruderal plants in other towns would present more prerequisites to find general rules and closer recognition of the character of sites in the areas strongly changed by man.

VII. RECAPITULATION OF INVESTIGATION RESULTS

1. Thirteen communities have been distinguished on the basis of 107 phytosociological records from the ruderal communities of Bielsko-Biała. Almost all of them belong to the class *Rudero-Secalieta*, and only one — *Asplenietum rutae-murariae-trichomanis* to *Asplenietea rupestris*. Nearly all communities show large presence degree in relation to a definite substratum.

2. The observations carried out during the years 1966 - 1969 allowed to draw a scheme of succession for most of the communities (Fig. 25). *Tanaceto-Artemisietum* and *Leonuro-Arctietum tomentosum* appeared to be most advanced in their development. They are most common of all at Bielsko-Biała aside from *Plantagini-Lolietum*. Their undisturbed further development leads to brushwood communities. Thus it may be reckoned that a process of natural recovery in ruderal sites in this town is rather advanced.

3. Distribution of 18 selected synanthropic species was investigated. It was found that it depended on climatic, edaphic and historical factors.

4. The submontane climate of Bielsko-Biała appeared to be one of the most important factors differentiating spacially and qualitatively the ruderal vegetation in the town.

It causes pauperization of associations in south-north direction (from the edge of the submontane area toward the mountains). The föhn effect which is responsible for the existence of a warmer enclave in the northern part of the investigated area is a favourable factor in settling of thermophilous vegetation there.

Fig. 25. Diagram showing the course of succession of the ruderal plant communities in the Bielsko-Biała area

5. Detailed soil research done in 6 communities in the area in question allowed to determine the characteristic features of their substratum.

The soils of the investigated sites exhibit among others a very inconvenient C:N ratio. The phosphorus and potassium content is the best feature distinguishing the soils of the particular communities. That of calcium carbonate is less indicative in this respect.

6. Statistic calculations of share of the particular groups of species distinguished on the basis of the geographical-historical classification of the synanthropic plants after Kornaś (1968a) allowed to state that native species comprise the bulk of the majority of communities found at Bielsko-Biała. Out of foreign plants archeophytes which are the oldest naturalized ones are most important in the structure of the communities.

7. The ruderal communities play important role in the distribution of epoeophytes, i.e. plants recently brought in to the environment. They find their sites there entering the previously formed ruderal communi-

ties, or form new ones (e.g. *Sisymbrietum sophiae* and community *Bidens melanocarpus*). Their distribution in the town depends, beside of factors mentioned in point 3, on the way and time of coming.

Department of Plant Taxonomy and Phytogeography
Jagiellonian University in Cracow

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ROŚLINNOŚĆ RUDERALNA MIASTA BIELSKA-BIAŁEJ

Streszczenie

W latach 1966 do 1969 przeprowadzono badania roślinności ruderalnej Bielska-Białej, przemysłowego miasta położonego w górnym biegu rzeki Białej na wąskim pasie Pogórza Śląskiego. Dzisiejszy organizm miejski powstał z dwóch urbanistycznie i historycznie różnych jednostek: miast Bielska i Białej. Początek osadnictwa Bielska przypada na przełom wieku XII i XIII, a Białej na wiek XVI. Kolejne etapy rozwoju terytorialnego miasta ilustruje ryc. 2. Od wieków sukiennictwo, a potem przemysł włókienniczy wyciskają największe piętno na rozwoju gospodarczym miasta. Rozwój przemysłu i budownictwa miejskiego w XX wieku spowodował gwałtowną ekspansję na tereny sąsiadujących z nim osiedli i wiosek. Spowodowało to duże zaburzenia w roślinności naturalnej i półnaturalnej. Ten czynnik umożliwił coraz szerszą inwazję roślin ruderalnych.

W Bielsku-Białej opisano 13 zbiorowisk ruderalnych należących do dwóch klas, a mianowicie *Asplenietea rupestris* (tylko *Asplenietum rutae-murariae-trichomanis*) i *Rudero-Secalieta* (pozostałe zespoły i zbiorowiska).

Asplenietum rutae-murariae-trichomanis rozwija się w szczelinach murów na zaprawie wapiennej. Jest ono na badanym terenie rozwinięte fragmentarycznie, gdyż w żadnym płacie nie stwierdzono obecności wszystkich gatunków charakterystycznych. Występuje w dwóch facjach: jedna z *Linaria cymbalaria* rozwija się przy ekspozycji południowej, druga — z *Corydalis lutea* na stanowiskach lekko ocienionych o wystawie wschodniej lub południowo-wschodniej. Izolowane stanowisko zajmuje tu płat z *Sagina procumbens* i licznymi mszakami. Nawiązuje on swymi cechami do *Sagino-Bryetum*.

Hordeetum murini wykształcone jest w Bielsku-Białej także tylko fragmentarycznie; reprezentuje je jedno zdjęcie. Badany płat rozwinął się w bezpośrednim sąsiedztwie drogi, stąd oprócz gatunków charakterystycznych, takich jak *Hordeum murinum* i *Sisymbrium officinale* duży udział ma *Lolium perenne*. Zespół ten podawany z kilku miast Polski znajduje lepsze warunki na terenach o większej insolacji i o mniejszej liczbie opadów niż w Bielsku-Białej.

Zbiorowisko *Tussilago farfara* jest ugrupowaniem inicjalnym na siedliskach bardzo zróżnicowanych pod względem ekologicznym. Stąd jego często zmieniający się skład zależy przede wszystkim od zbiorowisk kontaktowych. Główny zrząd stanowią tu *Tussilago farfara* oraz występujący z dużą stałością na badanym terenie *Equisetum arvense*. *Epilobium adnatum* podawane przez Niemców (Gutte 1966) jako wyróżniające dla tego zbiorowiska występuje w Bielsku-Białej tylko w dwóch

płatach. Zdjęcia 6 i 7 (Tab. III) stanowią odrębną fację tego zbiorowiska z *Melilotus albus* i *M. officinalis*. Sukcesja w badanych płatach zmierza wyraźnie w kierunku *Echio-Melilotetum* i *Tanaceto-Artemisietum*.

Tanaceto-Artemisietum jest najczęściej spotykanym w Bielsku-Białej zespołem ruderalnym. Niezbyt wymagający pod względem siedliska rozwija się on na glebach suchych i wilgotnych o różnej zawartości piasku czy żwiru, ale mało zasobnych w azot. Jest to zbiorowisko wysokich bylin, przy czym zrząd tworzą *Tanacetum vulgare*, *Artemisia vulgaris*, *Rumex obtusifolius*, *Solidago serotina* i inne; wykazuje też duży udział gatunków łąkowych. W płatach występujących w sąsiedztwie wysypisk śmietnikowych na podłożu o większej zawartości azotu spotyka się duże ilości *Arctium minus*, *Rumex obtusifolius* i *Urtica dioica*. Wyróżniono je za Guttem (1966), Falińskim (1966) i Oberdorferem (1957) jako podzespół *Tanaceto-Artemisietum arctietosum*. Często występuje tu także *Arctium tomentosum*, co stawiałoby tę jednostkę jako pośrednią między zespołem typowym a *Leonuro-Arctietum tomentosum*. *Tanaceto-Artemisietum* jest zbiorowiskiem dość trwałym utrzymującym się przez kilka lat na jednym stanowisku. Sukcesja idzie w kierunku ugrupowań roślin typu zaroślowego; świadczą o tym obecne w płatach liczne podrosty drzew i krzewów.

Leonuro-Arctietum tomentosum spotyka się na terenach żyznych. W Bielsku-Białej rozwija się na peryferiach miasta na siedliskach o glebach z dużą zawartością substancji organicznej. Gatunkami charakterystycznymi są tutaj *Arctium tomentosum* i *Ballota nigra*. Brak natomiast *Leonurus cardiaca* i *Conium maculatum*, które wcale nie występują na badanym terenie, co świadczy o fragmentarycznym wykształceniu zespołu. Na siedliskach bardziej wilgotnych i ocienionych rozwija się oddzielna facja z gatunkami wyróżniającymi: *Aegopodium podagraria*, *Dactylis glomerata*, *Achillea millefolium* i *Lolium perenne*; tylko w tych płatach występuje *Ballota nigra*. Zespół ten jest pokrewny spotykanemu w Europie Zachodniej *Balloto-Arctietum*, od którego różni się jedynie obecnością *Arctium tomentosum* i brakiem *Chenopodium bonus-Henricus*. *Leonuro-Arctietum tomentosum* rozwija się jako następne stadium sukcesyjne po zbiorowiskach nitrofilnych lub też po *Tanaceto-Artemisietum arctietosum*. Dalsza sukcesja idzie w kierunku zbiorowiska typu zaroślowego.

Zbiorowisko *Chenopodium bonus-Henricus* zajmuje w Bielsku-Białej stanowiska ocienione, na glebach bogatych w substancje humusowe. Gatunkiem dominującym jest *Chenopodium bonus-Henricus*, duży udział mają też *Urtica dioica*, *Arctium minus* i *Aegopodium podagraria*. Wykres stałości (ryc. 6c) zdaje się wskazywać na fragmentarycznie wykształcone zbiorowisko. Utrudnia to ustalenie jego systematyki, gdyż być może stanowi tylko fragment któregoś z zespołów ze związku *Arction lappae*, do którego niewątpliwie należy. Dalsza sukcesja prowadzi prawdopodobnie do *Leonuro-Arctietum tomentosum*, a przy wzmożonym wydeptywaniu do *Plantagini-Lolietum*.

Ocienione i zasobne w azot siedliska zajmuje w Bielsku-Białej zbiorowisko *Urtica dioica-Rumex obtusifolius*. Podobne zbiorowisko zostało opisane z Górców przez Kornasia (1968c). Różni się ono od wyodrębnionego na badanym terenie obecnością *Alchemilla crinita*, *A. pastoralis*, *Chaerophyllum hirsutum* i *Rumex arifolius*. Ze względu na przewagę liczebną gatunków z *Arction lappae* zaliczono je do tego związku, podczas gdy opisane z Górców należy do *Chenopodion subalpinum*.

Sisymbrietum sophiae pojawia się w Bielsku-Białej tylko na północnym krańcu miasta, gdzie wpływy klimatu górskiego są mniejsze. Związane jest z terenami kolejowymi, gdyż gatunki rodzaju *Sisymbrium*, w głównej mierze budujące zbiorowisko, są niedawnymi przybyszami.

O ile *Sisymbrietum sophiae* zajmuje siedliska na zboczach nasypów, to na ich

górnej powierzchni, na zwirowym podkładzie rozwija się *Echio-Melilotetum albi*. Duży udział roślin z rodziny *Papilionaceae* można tłumaczyć sposobem, w jaki używają one azotu. W obrębie Bielska-Białej wykształcony jest fragmentarycznie, co spowodowane jest dużym ruchem kolejowym oraz oczyszczaniem torowisk w sposób chemiczny i mechaniczny.

Plantagini-Lolietum jest jednym z najbardziej rozpowszechnionych na badanym terenie zespołów ruderalnych. Występuje w trzech facjach: typowej, suchej z obfitym występowaniem *Lepidium ruderales* i wilgotnej z dużą ilością azotu w podłożu z udziałem *Potentilla anserina*.

Wilgotne i oświetlone szczeliny murów i bruków zasiedla pionierski zespół *Sagino-Bryetum*. Płat opisany z Bielska-Białej jest typowy, a obecność *Ceratodon purpureus* zbliża go do *Sagino-Bryetum* opisanego z Lipska (Gutte 1966), charakteryzującego się obecnością *Stellaria media* i *Webera nutans*.

Dwa zdjęcia reprezentują w Bielsku-Białej fragmenty stosunkowo rzadkiego w Polsce i Środkowej Europie *Chenopodietum glauco-rubri*. Rozwija się on na siedliskach wilgotnych i silnie nawożonych azotem. W płatach z badanego terenu brak jest *Chenopodium rubrum*, które w Bielsku-Białej w ogóle nie występuje.

Niedawnym, a ostatnio bardzo rozpowszechnionym gatunkiem w Bielsku-Białej jest *Bidens melanocarpus*. W miejscach, gdzie się zdomowił trwale, rośnie w towarzystwie powtarzających się gatunków. Skupiska te opisano jako zbiorowisko *Bidens melanocarpus*. Podobny płat znaleziono również w Czechowicach (Tab. XII, zdjęcie nr 3). Z analizy listy florystycznej wynika, że zbiorowisko to należy do rzędu *Bidentetalia*. Jego dokładna klasyfikacja będzie możliwa, jeżeli będzie można się oprzeć na zdjęciach z różnych obszarów.

Skład badanych zbiorowisk rozpatrywano także pod względem geograficzno-historycznym stosując klasyfikację Kornasia (1968a). Aby właściwie naświetlić udział poszczególnych grup roślin w budowie zbiorowiska, obliczono go na kilka sposobów. Podano mianowicie: stopień synantropizacji S (stosunek antropofitów do apofitów wyrażony w procentach), procentowy udział gatunków danej grupy P, udział zbiorowy grupy G, oraz wartość grupową D, powołując się przy wyznaczaniu tej ostatniej na Tüxena i Ellenberga (1937). Największą liczbę apofitów spotyka się w zbiorowiskach występujących w podobnym składzie na siedliskach naturalnych, tzn.: *Plantagini-Lolietum*, *Tanaceto-Artemisietum*, *Echio-Melilotetum albi*, oraz w zbiorowisku *Urtica dioica-Rumex obtusifolius* i zbiorowisku *Tussilago farfara*. Z antropofitów najliczniejszą grupę stanowią archeofity. Fakt ten znany był dla zbiorowisk segetalnych; okazuje się, że w zbiorowiskach ruderalnych też mają duży udział. Najwięcej archeofitów spotyka się na badanym terenie w *Chenopodietum glauco-rubri*, *Hordeetum murini*, w zbiorowiskach *Chenopodium bonus-Henricus* i *Bidens melanocarpus*. Obecność archeofitów w trzech pierwszych zespołach świadczyć może o ich starości, o tym, że mogły być pierwszymi skupiskami roślinności towarzyszącymi człowiekowi w początkach kultury rolnej i osadniczej. Zbiorowisko *Bidens melanocarpus* jest na pewno niedawnego pochodzenia.

Epekofity mają znaczny udział w trzech zespołach: *Sisymbrietum sophiae*, *Asplenietum rutae-murariae-trichomanis* i *Hordeetum murini*. Pozostałe dwie grupy antropofitów: agriofity i efemerofity nie mają większego znaczenia w budowie zbiorowisk ruderalnych na terenie Bielska-Białej. Udział agriofitów zaznacza się tylko w zbiorowisku *Bidens melanocarpus*, w *Chenopodietum glauco-rubri* i *Asplenietum rutae-murariae-trichomanis*. Znikoma liczba efemerofitów jest spowodowana wielkimi możliwościami zawleczenia, ostrą konkurencją ze strony osiedlonych już roślin i wpływem podgórskiego klimatu.

Dla lepszego poznania roślinności ruderalnej skartowano 18 gatunków występujących w Bielsku-Białej. Ich rozmieszczenie okazało się zależne od kilku czynników. W zasadzie gatunkami rozprzestrzenionymi na całym obszarze okazały się

Galinsoga parviflora i *G. quadriradiata*. Duża grupa roślin skupiła się w północnej części miasta; związana jest ona z terenami kolejowymi. Są to przeważnie epekofity takie jak *Sisymbrium altissimum*, *S. Loeselii*, *Descurainia sophia*, *Datura stramonium*, *Cardaria draba* i *Bunias orientalis*, oraz archeofit *Ballota nigra* subsp. *ruderalis*. Inne gatunki okazały się związane ze starymi siedliskami, którymi są stare mury czy dawne tereny kultur ogródkowych. Są to: *Linaria cymbalaria*, *Corydalis lutea*, *Chenopodium bonus-Henricus* i *Solanum nigrum*. Rozmieszczenie *Geranium dissectum*, chwastu polnego, wskazywałoby na to, że „dobre” gatunki zespolów segetalnych nie wchodzą na siedliska ruderalne. Na zdegradowanych siedliskach zbiorowisk naturalnych zdomowały się *Bidens melanocarpus* i *Impatiens Roylei*. O ile ten ostatni posiada swoje stanowiska tylko na siedliskach związanych ze zniszczonymi łąkami, to pierwszy — na północy miasta, gdzie wpływ klimatu podgórskiego jest mniejszy — rozprzestrzenił się także na siedliskach ruderalnych.

Charakterystyka zbiorowisk ruderalnych byłaby niepełna, gdyby nie zbadać własności podłoża, na którym rosną. Jest to przecież substrat bardzo różny od gleb naturalnych, bo stworzony przez działalność człowieka i bardzo często zanieczyszczony różnymi odpadkami. W związku z tym pobrano po trzy próbki gleby w sześciu wybranych zbiorowiskach. Ich analiza mechaniczna i chemiczna wykazała następujące prawidłowości: Różny jest stopień udziału frakcji szkieletowej w poszczególnych skupieniach roślinności, przy tym największy jest on w *Sisymbrietum sophiae* i *Tanaceto-Artemisietum*, a najmniejszy w zbiorowisku *Tussilago farfara*, które rozprzestrzenia się na gliniastych wysypiskach. Kwasowość utrzymywała się na stałym poziomie we wszystkich badanych zbiorowiskach, wahając się w H_2O między 7,2—7,8, a w KCl od 6,2—7,5. Ze składników chemicznych najlepiej charakteryzuje badane gleby obecność fosforu i potasu. Największe ich ilości są w zbiorowiskach *Chenopodium bonus-Henricus* i *Leonuro-Arctietum tomentosum*, średnie wartości osiągają w *Tanaceto-Artemisietum* i *Plantagini-Lolietum*, najmniej jest ich w *Sisymbrietum sophiae*. $CaCO_3$ też wykazuje charakterystyczne wahania co do zawartości w podłożu. Najwięcej jest go w zbiorowisku *Chenopodium bonus-Henricus*, najmniej w zbiorowisku *Tussilago farfara*. Ilość azotu w glebach zbiorowisk ruderalnych nie wydaje się być w większym stopniu charakterystyczna, ważniejsza jest raczej jego korelacja z zawartością w podłożu próchnicy. Biologicznie ważnym wskaźnikiem jest stosunek C : N, kształtujący się bardzo niekorzystnie dla badanych zbiorowisk. Może to być spowodowane obecnością w glebie świeżej materii organicznej lub węgla opałowego. Ogólnie biorąc siedliska ruderalne są bogatsze od naturalnych w składniki pokarmowe. Uwidacznia się to jeszcze bardziej w terenie podgórskim, gdzie gleby są z reguły ubogie. W badaniach tego rodzaju należy też brać pod uwagę dużą przypadkowość zanieczyszczeń, co jest powodem większego wahanía w wartościach badanych parametrów, niż to ma miejsce przy badaniu gleb naturalnych.

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Instytutu Botaniki U. J.