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DIVERSITY OF FIELD WEEDS WITHIN NADNIDZIAŃSKI LANDSCAPE PARK, ITS CONDITIONS AND PROTECTION

PART I – WEED SPECIES COMPOSITION IN THE ROOT CROPS DEPENDING ON HABITATS CONDITIONS

ABSTRACT

In the years 1997 – 1999 a field research was carried out on distribution of field weeds of the *Nadnidziański* Landscape Park (50°18'–50°34' N and 20°29'–20°49' E). With the use of Braun-Blanquet method 149 phytosociological records were made. These records were made on fields with root and fodder cultivations. A soil investigation was carried out in order to determine the influence of soil on diversification of weed communities. The paper describes 4 associations occurring in the area, as well other truncated communities that cannot be assigned to any association due to absence of typical species. *Lamio-Veronicetum politae* is an association that occurs most frequently in the area of research although it is hardly ever observed in its typical from, as some of the typical species of the association are threatened by extinction. Permanent and abundant occurrence of such species as *Chenopodium album* or *Galinsoga parviflora*, which are dangerous weeds that compete strongly with other species of a small ecological scale, were also observed.

Key words: habitat conditions, root and fodder crops, weeds species composition

INTRODUCTION

According to the Central Statistical Office (*Główny Urząd Statystyczny* in Polish) (2003), 52% of the country's area makes arable land out of which 78% is in fact farmland. As it results from the above, flora of arable fields plays an important role in the Polish landscape. Becoming familiar with the field vegetation and its dynamics constitutes a significant element of the knowledge of nature of the Nadnidziański Landscape Park (Nadnidziański LP) – area where the research has taken place.

A need to get to know the foregoing issues based on a specific survey area constituted an inspiration to take up a study that would present a variety of field weeds within the Nadnidziański Landscape Park; this is a so-called „land of old farming"

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(Szafer, Zarzycki, 1972). One of the oldest farming lands in Poland are located within the above area. Arable crops prevail in this landscape also these days.

Man has attempted to eradicate weeds for many years as an unwanted element in crops; hence it seems a paradox to talk about weed protection, however the situation has currently changed (Hammer *et al.*, 1997). In the Netherlands, as in other European countries, created were gene banks with old varieties of crop plants and weeds threatened by extinction. Such a bank exists also in Poland, but in this country it is still possible to preserve the population of such species *in situ*, in crops. Preservation of these species in form of living, functioning populations constitutes preservation of a part of the Polish nature and the Polish culture.

SURVEY AREA

The surveys covered the area of the Nadnidziański Landscape Park, one of the group of the Ponidzie Region Landscape Parks. The Park's surface area amounts to 10.358 ha, while together with the protective zone the survey area covers 13.880 ha (Walczak *et al.*, 1994). Boundary points of the park (without the protective zone) are delimited by the coordinates from 50°18' – 50°34' N and 20°29' – 20°49' E. Phytosociological records were conducted on arable fields within the Park.

According to physicogeographical conditions (Zając, 1995) the Nadnidziański Landscape Park is situated in the central part of the Niecka Nidziańska macro region. Parts of three mesoregions constitute its components, namely – the Nida Valley, Niecka Solecka and Garb Pińczowski. However, according to the geobotanical classification, the Park's area is situated within the Miechowsko-Pińczowski District, which constitutes a part of the Central Upland Zone (Pas Wyżyn Środkowych) (Szafer, Zarzycki, 1972). In relation to the limits of administration units of the new division of Poland the area is situated in the Świętokrzyskie Voivodship within the Pińczów and Busko districts. According to the phenological-and-climatic regionalization of the area of the upper Vistula Basin (Obrębska-Starklowa, 1977) the area of the Nadnidziański Landscape Park is situated within the temperate zone climate, within the climate marked by increasing continental influence, with predominant phenological-and-climatic regimes of intrabasin high plains in the warm belt.

Typological development of soils within the Nadnidziański Landscape Park denotes a clear relation with the properties of the basement complex's rocks. The soils within the survey area (due to their high abundance in plant nutritive elements) belong to the most valuable ones in terms of their agricultural suitability. The high quality soils are predominant on surface within the arable land soils. For this reason it has been a traditional area of agriculture predomination.

The Ponidzie area has been populated for a very long time. The oldest traces of settlement go back to the Neolithic Age. Even today, in the village of Kopernia, one can find flint and horn tools testifying to the presence of man a few thousand years before Christ (Plit, 1994). For more than a thousand years one method of land management has been predominant within Niecka Nidziańska – namely agricultural method. A state of balance between man's activity and the natural environment has been preserved.

SURVEY METHODS

Phytosociological records and analysis of gathered material

In order to learn about weed communities in cereal crops conducted were phytosociological records using the Braun-Blanquet method (Braun-Blanquet 1964; Szafer, Zarzycki, 1972) during vegetation seasons of 1997, 1998 and 1999. Species content, quantity and sociability were assigned to each phytosociological record. Then surveys of the same community were juxtaposed in a table to calculate the phytosociological stability of each species. Research was performed in plantations where herbicides were used; the exception was the 8 fields of the community with *Stellaria media* and *Taraxacum officinale*, where herbicides were not applied. Each phytosociological record made in surface of 100 m^2. Soil reaction was measured with a soil acidimeter at a depth of 0-5 cm. Type of soil was also described; furthermore, slope's exposure and inclination were determined in degrees. Furthermore, farmers were interviewed in terms of use of herbicides.

Division into particular phytosociological units and species characteristic for specific vegetation communities was based on "Poland's plant cover" (*Szata roślinna Polski* in Polish) (Szafer, Zarzycki 1972). Distribution of conducted records has been described below. Names of species have been given according to Flora Europaea (Tutin *et al.* 1964–1980).

Phytosociological records were entered into the TURBOVEG data base, then grouped and numerical classifications were carried out (Hill, Gauch, 1980), using the SYNTAX V software (Podani, 1990). Similarities between the records were identified following creation of two types of dendrograms for the communities of cereal crops and for the communities of root crops. Thanks to the above two classifications for each of the crops type were obtained.

The first type of dendrogram allows for quantitativity of individual species; in this case, calculations were performed following the Ruzicka formula, which is an equivalent of the Jaccard formula for quantitative data (Podani 1995; Dzwonko 1986). Ruzicka formula:

$$S = I - \frac{\sum_i \min\left(x_{ij} x_{ik}\right)}{\sum_i \max\left(x_{ij} x_{ik}\right)}$$

where
i=species
j,*k*=record number**.**

Such a dendrogram makes it possible to determine dominant species, however it does not allow classifying specific phytosociological records to specific associations.

The second type of dendrogram is a result of comparisons carried out upon allowing for exclusively presence or absence of species. It shows the ratio of the number of common species to the number of all species in comparable records;

calculations were performed applying the Jaccard formula (Dzwonko 1977). Jaccard formula**:**

$$S = \frac{1-a}{(a+b+c)}$$

where:
a = number of species in the first record;
b = number of species in the second record.
c = number of common species;

The above dendrogram allowed classifying individual groups of phytosociological records to specified associations or other syntaxonomic units.

To group all records used was a non-weighted couple-group method with application of arithmetic averages – UPGMA (Sneath, Sokal, 1973). Grouping via the foregoing method gives the results most similar to those of grouping via the classic method (Dzwonko, 1977, 1986). In the above method similarities between the groups are equal to the average similarity between all objects belonging to the two groups under comparison thanks to which each record that constitutes a part of compared groups has an identical influence onto the value of the intragroup similarity (Dzwonko, 1977). Based on these two types of dendrograms identified were individual communities and associations of arable field weeds of root crops – 2 dendrograms.

In order to analyze the material in relation to variability of the slope exposure, the data were put in the following order: 1 – NE; 2 – E; 3 – SE; 4 – S.

Soil tests

Tests over soils of field weed communities were conducted in the end of the vegetation season in 1998 and 1999. The conducted tests aimed at obtaining basic pedologic documentation within selected 14 most typical communities of field weeds. In the above investigations we also made use of the criteria contained in Systematics of Soils in Poland (*Systematyka Gleb Polski* in Polish) (Królikowski, 1989). It was assumed that in further interpretation of floral data, values of the above indices might be suitable for relevant statistical calculations oriented to determine the force of relationships between the properties of tested soils and properties of the community growing on a given soil.

RESULTS

Results of soil tests

Rendzinas and pararendzinas:

These soils has been identified within 5 stands designed for surveys. Diversity of this unit embraces the following subtypes: proper rendzinas noted on stands no. 6 (Krzyżanowice) and no. 8 (Skowronno); humus rendzinas noted on stands no. 3 (in Łatanice), no. 4 (near the Reserve of Skorocice), no. 5 (Bogucice) and Kopernia (no. 13).

Black earths:

The order of semi-hydrogenic soils in the tested set of soils is represented by proper black earth (Szczerbaków no. 1), degraded black earth (Skotniki Dolne no. 11) and gley black earth (Zakrzów no. 9).

Fluvisols – delluvial and alluvial soils:

Delluvial soils are documented by two profiles: Szczerbaków (no. 2) and Krzyżanowice (no. 7). Fluvial soil type is, however, represented by humus alluvial soil in the Nida Valley (Kowala – no. 12) and alluvial soil in Nowy Korczyn (no. 14) as a characteristic unit for the Vistula Valley.

Brown soils:

This unit is represented within the survey area by grey-brown proper brown soil noted on the stand in Chrobrze (no. 10). Loess is a parent rock of this soil.

Results of phytosociological records – description of root and fodder crops communities

The association *Lamio-Veronicetum politae* (51 phytosociological records) is an association whose patches are the most frequent within the Nadnidziański Landscape Park. There are also other associations of the alliance *Eu-Polygono-Chenopodion*, and namely: *Galinsogo-Setarietum* (33 records) and *Oxalido-Chenopodietum polyspermi* (9 records), which is represented very rarely. *Echinochloo-Setarietum* (32 records) is the only association, which represents the alliance *Panico-Setarion*. Furthermore, there are communities which became clearly ruderal and which are difficult to classify to any of the aforementioned associations; they are usually composed of: *Stellaria media* and *Taraxacum officinale.* Therefore, one of the groups was classified to the community containing *Stellaria media* and *Taraxacum officinalle* (8 records) and 16 records were classified only to alliance *Eu-Polygono-Chenopodion*.

Overview of communities

CLASS: *Rudero-Secalietea* (Br.Bl. 1936)
ORDER: *Secali-Violetalia arvensis* [Siss. (1943 ap. Br. Bl. et R. Tx.) 1946]
SUBORDER: *Polygono-Chenopodietalia* [(R.Tx.et Lohm.1950) J.Tx. 1961]
ALLIANCE: *Eu-Polygono-Chenopodion* Siss. 1946
ASSOCIATION: *Lamio-Veronicetum politae* Kornaś 1950

Lamio-Veronicetum politae typicum

Lamio-Veronicetum politae depleted form with predominance of *Galinsoga parviflora*
Lamio-Veronicetum politae depleted form with predominance of *Chenopodium album*
ASSOCIATION: *Galinsogo-Setarietum* (R. Tx. et Beck. 1942) R. Tx. 1950
Galinsogo-Setarietum typicum
Galinsogo-Setarietum with constant share of *Echinochloa crus-galli*
ASSOCIATION: *Oxalido-Chenopodietum polyspermi* Siss. 1950

COMMUNITY with *Stellaria media* and *Taraxacum officinale*
COMMUNITY of the alliance *Eu-Polygono-Cenopodion*
ALLIANCE: *Panico-Setarion* (Siss. 1946)
ASSOCIATION: *Echinochloo-Setarietum* Krusem. et Vlieg. (1939) 1940
Echinochloo-Setarietum typicum
Echinochloo-Setarietum depleted

Lamio-Veronicetum politae

This association is the most frequent community in root crops within the Nadnidziański Landscape Park. Its patches occur on fields on which in previous year had developed patches of the association *Lathyro-Melandrietum* or *Caucalido-Scandicetum* in their depleted form, i.e. on habitats located away from xerothermic reserves where rendzina was deeper, on flat or slightly inclined areas.

The above association belongs to the alliance *Eu-Polygono-Chenopodion*, for which the characteristic species are: *Lamium purpureum* ("phytosociological stability" S= II), *Sonchus oleraceus* (S= III) as a region-specific species for the alliance and *Veronica persica* (S=V).

A typical form of the association *Lamio-Veronicetum politae* is represented on the tested area by phytosociological records in which a total of 101 species were defined – from 23 to 42 in one record, 29 on average.

Patches of the above association occur on humus rendzinas and pararendzinas These soils are usually highly basic (pH= 7.0–7.5). *Lamio-Veronicetum politae* sometimes occurs on fields located on gently inclined slopes of southern, southwestern and western exposure.

Floral composition of the above association is marked by the following species: *Euphorbia helioscopia, Lamium amplexicaule, Sonchus asper* and *Veronica polita;* all achieve constancy level V (S= V), however in records their quantitativity does not exceed 2. Other species characteristic for the above associations, such as *Veronica agrestis* and *V. opaca* were not noted within the said area. In relation to other associations occurring in root crops on the tested area, this association is represented by florally rich patches.

Lamio-Veronicetum politae – depleted form with predominance of *Galinsoga parviflora* is represented on the tested area by 11 phytosociological records where 47 species were found in total – from 14 to 20 in one record, 18 on average.

Galinsoga parviflora is a species, which achieves here a very high constancy (S = V) and coverage level from 4 to 5. As a result of the numerical classification (Fig. 1) distinguished was a group in which *Galinsoga parviflora* constantly occurs, although sporadically occurring weed species of the association *Lamium-Veronicetum politae*: *Euphorbia helioscopia* (S = IV), *Lamium amplexicaule* (S = III), *Sonchus asper* (S= II) and *Veronica polita* (S = II).

Lamio-Veronicetum politae – depleted form with predominance of *Chenopodium album* is represented by 12 phytosociological records. A total of 70 species were noted, from 16 to 33 in one record, 23 on average.

The said form of the association is marked by *Chenopodium album*, which achieves here high coverage level (from 2 to 4) and constancy level V (S = V). Despite the above, patches with abundant contribution of *Chenopodium album* were

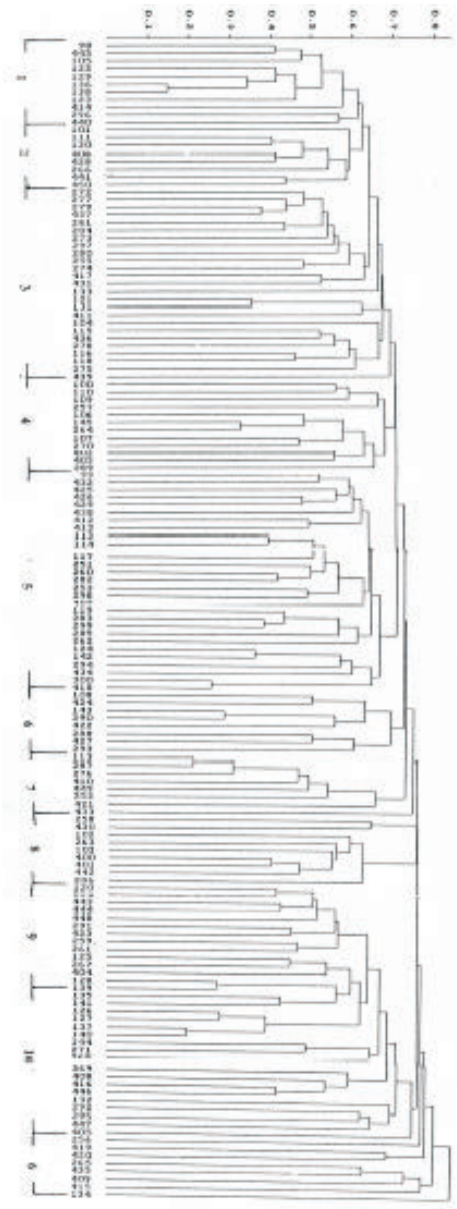

Fig 1. Numerical classification of the phytosociological records conducted in root and fodder crops in the Nadnidziański Landscape Park – dendogram based in a non-weighted couple-group method, based in a presence or absence of the species. Legend: Communities: 1. *Lamio-Veronicetum politae* depleted form with predominance of *Galinsoga parviflora*; 2. *Galinsogo-Setarietum* with constant share of *Echinochloa crus-galli*; 3. *Galinsogo-Setarietum typicum*; 4. *Lamio-Veronicetum politae* depleted form with predominance of *Chenopodium album;* 5. *Lamio-Veronicetum politae typicum;* 6. Community of the alliance *Eu-Polygono-Chenopodium;* 7. Com. with *Stellaria media* and *Taraxacum officinale*; 8. *Oxalido-Chenopodietum polyspermi*; 9. *Echinochloo-Setarietum* depleted; 10. *Echinochloo-Setarietum typicum.*

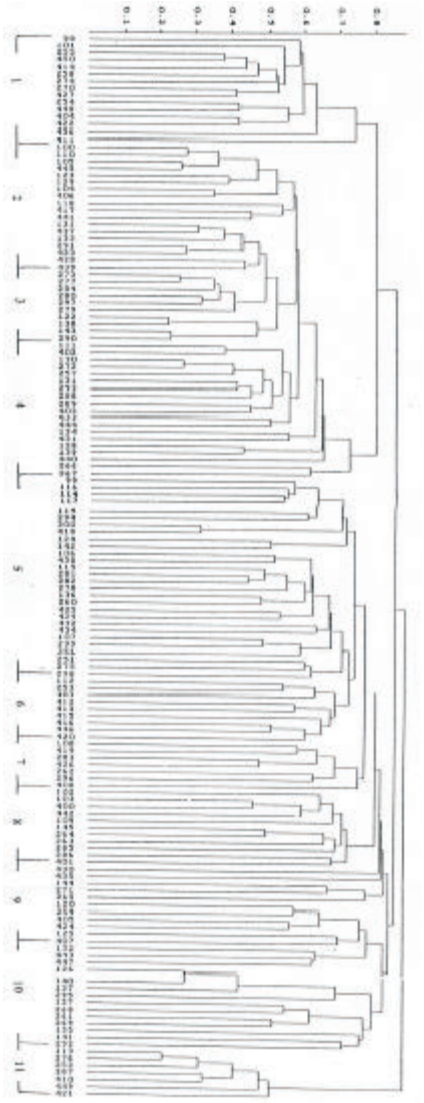

Fig 2. Numerical classification of the phytosociological records conducted in root and fodder crops in the Nadnidziański Landscape Park – dendogram based in a non-weighted couple-group method, based in a quantitativity of individual species. Legend: Communities: 1. Patches (*Galinsogo-Setarietum* i *Lamio-Veronicetum politae*) with predominance of *Chenopodium album;* 2. Patches (*Galinsogo-Setarietum* i *Lamio-Veronicetum politae*) with predominance of *Galinsoga parviflora* and ; 3. Patches of *Galinsogo-Setarietum* with predominance of *Chenopodium album* and *Galinsoga parviflora*; 4. (*Galinsogo-Setarietum* i *Lamio-Veronicetum politae*) with predominance of *Echinochloa crus-galli* and *Galinsoga parviflora;* 5. Pathes (*Galinsogo-Setarietum* i *Lamio-Veronicetum politae*) with predominance of *Amaranthus retroflexus* and *Galinsoga parviflora;* 6. Patches of *Lamio-Veronicetum politae* with predominance of *Chenopodium album* and *Convolvulus arvensis*; 7. Patches of *Lamio-Veronicetum politae* with predominance of *Echinochloa crus-galli;* 8. Patches of *Oxalido-Chenopodietum polyspermi;* 9. Patches of *Echinochloo-Setarietum* with predominance of *Amaranthus retroflexus;* 10. *Echinochloo-Setarietum;* 11. Com. *with Stellaria media* and *Taraxacum officinale*

classified to the aforementioned association, because nearly all species characteristic for it occur here, although with relatively low quantitativity usually limited to below 5% of coverage. The most frequent was *Euphorbia helioscopia* (S = IV), also present were *Sonchus asper* (constancy level III), *Lamium amplexicaule* (S = III) and *Veronica polita* (S = II).

Galinsogo-Setarietum

Within the tested area patches of this association develop on rendzinas and pararendzinas with high humus content. They occur on fields usually located in the vinicity of buildings (to 200 m) in soils enriched by organic fertilization.

Galinsogo-Setarietum typicum within the tested area is represented by 25 phytosociological records in which a total of 77 species were noted – from 16 to 32 in 1 record and 20 on average. In phytocenoses of this association *Galinsoga parviflora* is predominant, and *Galinsoga ciliata* occurs very rarely. The foregoing species probably has not yet entered into field crops of the surveyed area; it however may be spotted within some ruderal habitats. In the first year of records its rare occurrence was observed, while it is more abundant at present, although it is still rare in crops.

The species that usually accompanies *Galinsoga parviflora* is *Setaria glauca*, deemed distinctive here – it achieves constancy level V (S = V). In patches of this association abundant were such species as: *Amaranthus retroflexus, Bilderdykia convolvulus, Capsella bursa-pastoris*, *Chenopodium album, Convolvulus arvensis* and *Stellaria media*. The species belonging to the alliance *Eu-Polygono-Chenopodion* also occurred here, but they were marked however by definitely lower coverage level than in patches of the association *Lamio-Veronicetum politae*.

Galinsogo-Setarietum with share of *Echinochloa crus-galli* is represented in the gathered material by 8 phytosociological records in which a total of 43 species were noted, from 14 to 19 in one record and 18 on average. The patches were found on very fertile soils abundant in humus, the pH reaction of these soils ranged from 7.0 to 7.5.

Within the above form of the said association the predominant species is *Galinsoga parviflora* (coverage level = 4 or 5 and S = V). *Echinochloa crus-galli* also occurs with a relatively high coverage level= from 1 to 3 (and S = V). A relatively high coverage level of *Setaria glauca* denotes very big resemblance to the ruderal form of *Echinochloo-Setarietum*. Apart from the two latter species, no species characteristic for *Panico-Setarion* were noted, while species representing the alliance *Eu-Polygono-Chenopodion* occurred more often, such as: *Euphorbia helioscopia* (S = II), *Sonchus asper* (S = IV) and *Veronica persica* (S = V). Presence of the above species and the fact that the pH of soil is neutral or basic here determined classifying this group to the association *Galinsogo-Setarietum*, and not *Echinochloo-Setarietum*, whose patches occur on less fertile soils with lower pH value. The numerical classification based on presence or absence of a species confirms classifying these records to the association *Galinsogo-Setarietum*. Patches of this association are also very poor in floral terms; all of them are located near buildings (within 200 m).

Oxalido-Chenopodietum polyspermi

Within the tested area the above association is represented by 9 phytosociological records in which a total of 64 species were found – from 15 to 27 in one record and 25 on average.

Patches of this association occur on humus alluvial soils, in particular in the southern part of the area, in Nowy Korczyn near the Vistula River. Furthermore, patches of this association were noted in 1998 and 1999 in Kowala on the Nida River, while in Nowy Korczyn they developed every year on a very small area. A relatively rare occurrence of patches of the said association resulted in a small number of phytosociological records for analyses. Both characteristic species occur in tested patches: *Chenopodium polyspermum* and *Oxalis stricta*, as well as a distinctive species: *Lapsana communis*. *Chenopodium polyspermum* was not found in Kowala only, while in Nowy Korczyn, where the above species achieved constancy level V (S = V), it showed a rather low coverage level (+ or 1). Species characteristic for the alliance *Eu-Polygono-Chenopodion*, also occur here.

Groundwater level in the two above villages is very high, water can be found at the depth of 94 cm, therefore many hygrophilous species occur here, consequently patches of this association have been enriched with such species as: *Juncus bufonius, Mentha arvensis, Potentilla anserina* and *Stachys palustris.*

Community with Stellaria media and Taraxacum officinale

The above community is represented by 8 phytosociological records in which a total of 44 species were noted – from 16 to 19 in one record and 18 on average.

These patches were dominated by Stellaria *media* and *Taraxacum officinale*; they occurred in crops of *Medicago sativa*. The listed species were marked by constancy level V (S = V), while the coverage level usually amounted to 3 (from 1 to 3). Other species, which occurred here were: *Chenopodium album, Capsella bursa-pastoris, Polygonum aviculare.* Presence of *Euphorbia helioscopia* (S= V) and *Veronica persica* (S= V) denotes affiliation of this community to the alliance *Eu-Polygono-Chenopodion.* The following species occurred in individual specimens only: *Lamium amplexiacaule, L. purpureum, Sonchus asper* and *Veronica polita*.

Communities of the alliance Eu-Polygono-Chenopodion

Some of the records made in root crops could not be included in any of the associations due to the lack of characteristic species. Therefore a trucated–topped – plant community belonging to the alliance *Eu-Polygono-Chenopodion* was distinguished. Sixteen phytosociological records were included in the community; totally 90 species were noted – from 16 to 34 in one record, and 20 on average.

These are depleted patches that most probably should make a part of the association: *Lamio-Veronicetum politae* or *Galinsogo-Setarietum*, but due to the lack of characteristic species they grouped together. The following are present as the characteristic species of the alliance: *Lamium purpureum* (S = III), *Euphorbia helioscopia* (S = II) and *Veronica persica* (S = IV).

Echinochloo-Setarietum

In root crops of the Nadnidziański Landscape Park it is not a common association; it is represented by 32 phytosociological records (per 149 records taken in root crops on the tested area). It is present on delluvial humus soils (light clay) and on brown soils in Chrobrze and Żurawniki. It also appears on proper black earth. However, it basically occurs in Zakrzów and in Skrzypiów on black gley soils where the pH is much lower and ranges from 5.0 to 6.0.

This association belongs to the plant alliance *Panico-Setarion*, where the characteristic species are: *Setaria glauca, S. viridis, Rumex acetosella, Spergula arvensis* and *Scleranthus annuus.* Apart from the last two species, others were present practically in all the patches (S = IV or V). Occurrence of *Spergula arvensis* and *Scleranthus annuus* was limited to Zakrzów, where the soil on fields has more acid reaction.

Echinochloo-Setarietum typicum is represented on the tested area by 18 phytosociological records; totally 80 species where noted there – from 19 to 35 in one record**;** 26 on average.

Between the characteristic species the following are commonly represented: *Echinochloa crus-galli* and *Setaria glauca* (S= V); they also achieve a high level of coverage. *Raphanus raphanistrum*, *Spergula arvensis* and *Scleranthus annuus* also have the constancy level V (S = V), whereas it shows lower level of coverage.

The typical form of this association is present mostly in Zakrzów and sometimes also in Szczerbaków. Soils are sandy here and low-clayey. In the tested patches a significant role is played by *Equisetum arvense* and *Erodium cicutarium* that almost always are present. In Zakrzów the level of groundwaters is very high, this is a consequence of occurrence the following hygrophilous species: *Juncus bufonius, Gnaphalium uliginosum, Phragmites communis, Stachys palustris, Mentha arvensis, Potentilla anserina, Gypsophila muralis;* they proved a high constancy level here from III to IV. Whereas in its ruderal form these species are rather not present.

Depleted *Echinochloo-Setarietum* is represented by 14 phytosociological records; totally 61 species were found – from 15 to 30 in one record, and 22 on average. It mostly spreads in built-up areas (within 200m) in strongly fertilized places with a significant share of *Galinsoga parviflora*, the species that whenever present always with a high level of coverage 4 or 5 (from 60 to 90%). Sometimes species that prefer humid habitat occurred but mostly the ruderal species predominated such as: *Chenopodium album*, *Stellaria media*, *Capsella bursa-pastoris*, *Erigeron canadensis*, *Convolvulus arvensis* and others. Here also *Equisetum arvense* and *Erodium cicutarium* were always present.

Comparative analysis of plant communities and associations

Communities of cereal crops were classified to specific plant associations, and in case it was impossible due to the depleted form of the given association – to an alliance. The following 6 syntaxonomic units has been defined: 1 – *Lamio-Veronicetum politae*, 2 – *Galinsogo-Setarietum*, 3 – *Echinochloo-Setarietum*, 4 – *Oxalido-Chenopodietum polyspermi*, 5 – community with *Stellaria media* and *Taraxacum officinale*, 6 – community from the alliance *Eu-Polygono-Chenopodion*. Such division enabled to verify

particular syntaxonomic units with the type of soil, soil's reaction, exposure, and slope inclination.

Exposure and inclination had barely any influence on the root crop weeds classification in any of the cases; most of the root and fodder crops fields are located on flat areas or with a slight inclination of the slope. Whereas the type of soil and pH value have a great meaning for formation of the patches of given associations.

Root crops communities are diversified depending on soil pH, which confirmed the performed analysis of variance, where $p<0.000$. Patches of the association *Echinochloo-Setarietum* occur on soils with low pH, all below 7.0 (Table 1). In patches of the association *Oxalido – Chenopodietum polyspermi*, pH is diversified, from low values up to pH amounting to 7.0. While soils of other communities (*Lamio-Veronicetum politae, Galinsogo-Setarietum, Eu-Polygono-Chenopodion*) have a basic (tab. 1 and fig. 3) or neutral pH. Exposition and slope had no significant impact on the diversity of communities as most of the fields were located in flat areas. Exposition did not prove significant difference with $p< 0.663$, and slope with $p< 0.245$.

Table 1

Influence of pH of soil on formation of weed communities of root crops

Dependent variable	Communities						
	1	2	3	4	5	6	Σ
1. pH:							
≤ median	26	29	32	9	8	14	118
> median	25	4	0	0	0	2	31
2. Slope:							
≤ median	38	28	25	8	5	14	118
> median	13	5	7	1	3	2	31
3. Exposure:							
≤ median	38	28	25	8	5	14	118
> median	13	5	7	1	3	2	31
Σ (observation)	51	33	32	9	8	16	149

Explanation: Variables: 1.pH: Chi-squared= 107,20 and $p< 0,000$; 2.Slope: Chi-squared= 5,40 and $p< 0,369$; 3.Exposure: Chi-squared= 5,40 and $p< 0,369$. Σ: number of phytosociological surveys in each community. Communities: 1. *Lamio-Veronicetum politae;* 2. *Galinsogo-Setarietum;* 3. *Echinochloo-Setarietum; 4. Oxalido-Chenopodietum polyspermi;* 5 – community with *Stellaria media* and *Taraxacum officinale*; 6. community of the alliance *Eu-Polygono-Chenopodion*

Patches of the association *Lamio-Veronicetum politae* are most often present on humus rendzinas or pararendzinas (medium and light-stony clay), with the pH 7.0-7.6 (Fig.3). Patches of the association *Galinsogo-Setarietum* mostly occur on pararendzinas although they can be spotted on almost any soil excluding the sandy ones (with low pH value, mostly with the pH 7.0). Patches of the association *Echinochloo-Setarietum* occur mostly on black gley earth (sandy soils with a low pH) or on black gypsum soils and sometimes on proper brown soils (loess); pH of these soils oscillates between 5.0 and 6.8. Patches of the association *Oxalido-Chenopodietum polyspermi* within the limits of the tested area occurred

only on alluvial soils with the pH from 6.0 to 7.0 (Fig. 3). The trucated plant community belonging to the alliance *Eu-Polygono-Chenopodion* was present on all soil types of the Nadnidziański LP, the only exception was black gley earth (sandy, acid soils in Zakrzów); pH reaction oscillated between 6.6 and 7.0.

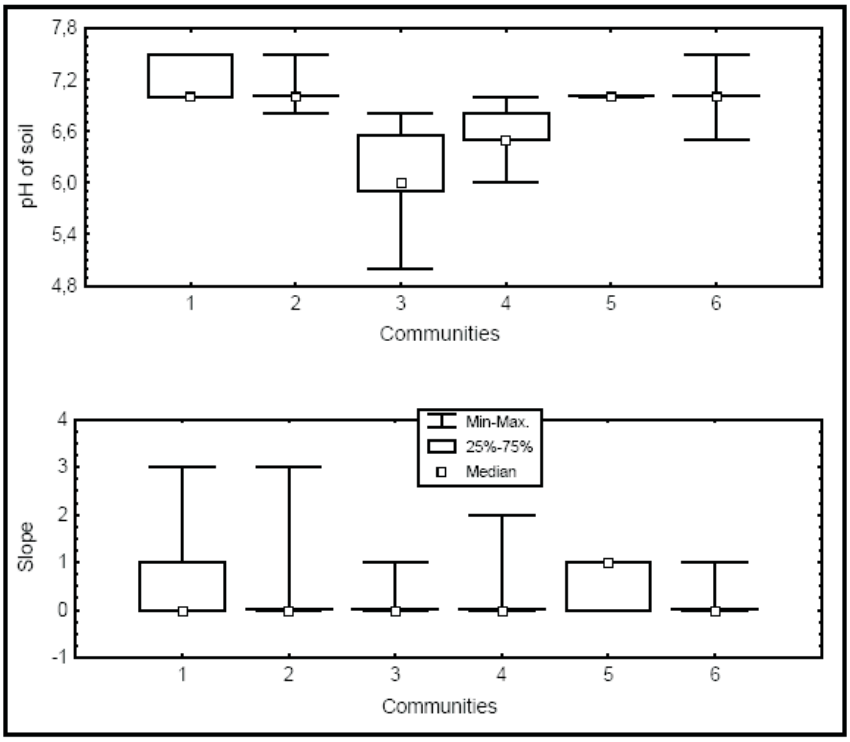

Fig. 3. Influence of habitat conditions on formation of root and fodder weeds communities
Legend: Communities: 1. *Lamio-Veronicetum politae*; 2. *Galinsoga-Setarietum*; 3. *Echinochloo-Setarietum*; 4.*Oxalido-Chenopodietum polyspermi*; 5. com. with *Stellaria media* and *Taraxacum officinale*; 6. alliance *Eu-Polygono-Chenopodium*. Slope: 0 (no slope); 1 (1-4^0); 2 (5-9^0); 3 (10-14^0); 4 (15-19^0).

As already mentioned above, inclination of the slopes does not have a significant importance for diversifying the root crops weed communities. Practically, only the patches of the association *Lamio-Veronicetum politae* and the patches classified to the alliance *Eu-Polygono-Chenopodion* were located on areas marked by low inclined slopes.

DISCUSSION

Lamio-Veronicetum politae grows on rendzinas and sometimes on alluvial soils, which is confirmed by Warcholińska (1974) and Sałata (1965). This association was described by Kornaś (1950), as occurring on rich soils in root crops on heavy-clayey soils, rich in calcium compounds. As such soils are frequent in the

surveyed area it often happens that patches of this association can be spotted in the Nadnidziański LP.

Lamio-Veronicetum politae is an association frequently met in the south of Poland; its stands become more dispersed and not that dense towards north (Wnuk, 1987). According to this author the typical form of this association is frequent in the exposures S, SW, and SE – similarly as in the present survey.

Similarly as in the survey of Warcholińska (1974) and Siciński (1974), occurrence of *Veronica opaca or Veronica agrestis* mentioned by Kornaś (1950) as species characteristic of *Lamio-Veronicetum politae* was not confirmed. In the current survey the general total sum of the number of species in the typical form of the association reached 101 species. Siciński (1974) indicated a similar number of weed species i.e. 100 in Kotlina Szczercowska and this author believes that these are patches extremely rich as to its floral composition.

According to Wnuk (1987) depletion of this community is caused inter alia by deterioration of edaphic relations, lowering of pH, low content of nitrogen in soil, and other factors that may eliminate species of narrow ecological scale such as species characteristic of this association. In the present survey the factors that had a direct impact on the depletion of this association's patches were of different nature; these were constant and rich abundance of such species as *Chenopodium album* and *Galinsoga parviflora*, related to the high content of nitrogen, as a consequence of which they were strongly competitive. Siciński & Sowa (1980), mention *C. album* as one of the many dangerous weeds that may occur in the patches of this association.

Galinsogo-Setarietum most frequently grows in the vicinity of villages or settlements. This fact is confirmed by Warcholińska (1990). It mainly develops in the cultivations of *Solanum tuberosum* (Warcholińska, 1990) but, as it results from the present survey, it also develops well in other cultivations near buildings. Apart from *Galinsoga parviflora*, in the patches of this association also *Setaria glauca* is in abundance, it is characteristic for the association *Chenopodium album* and *Echinochloa crus-galli* (Warcholińska, 1990).

Galinsoga parviflora was quoted as a rare species occurring in the Niecka Nidziańska 15 years ago (Szwagrzyk, 1987). Since 1997, when the survey started, until 1999 it was clearly visible how the species increases the area of its habitat, particularly in arable fields.

As it was mentioned before, *Galinsogo-Setarietum* develops in habitats subject to frequent and radical changes by man. Therefore, species with short development cycle and immense production of seeds prevail in the association, which enables their preservation in the habitats. (Warcholińska, 1974; Dostatny, 1999).

The described association denotes high similarity to the association *Echinochloo-Setarietum*, from which it is different in having no acidiphilous species such as *Rumex acetosella, Scleranthus annuus* and *Spergula arvensis* and such as *Veronica arvensis* and *Viola arvensi*s. The difference is also presence of species of the alliance *Eu-Polygono-Chenopodion*. *Euphorbia heliscopia, Lamium purpureum, Sonchus asper* and *Veronica persica*, are the characteristic species here, which was confirmed by the survey by Warcholińska (1974). On the other hand, due to the presence, even irregular, of the species like *Lamium amplexicaule*

and *Veronica polita*, these phytocenoses correspond to *Lamio-Veronicetum politae*. According to Warcholińska (1974), identification of this association *in situ* is very difficult. Therefore, *Galinsogo-Setarietum* is seldom mentioned in literature in Poland Fijałkowski (1967, 1978), Warcholińska (1974), Kapeluszny (1979), Pawlak (1981), Anioł-Kwiatkowska (1990), Warcholińska (1990). More frequently communities with similar floral composition are classified in Poland as lower units (ruderal variant) of *Echinochloo-Setarietum* (Kornaś, 1950; Wiśniewski, 1967). According to Anioł-Kwiatkowska (1990) this association is different from *Echinochloo-Setarietum* as it lacks *Echinochloa crus-galli* and has a great share of *Eu-Polygono-Chenopodion* species alliance. For this paper only the latter property is true.

Patches of *Oxalido-Chenopodetum-polyspermi* are best developed on fertile and damp alluvia in the valleys of bigger rivers (Wójcik, 1968, Matuszkiewicz, 1984, Anioł-Kwiatkowska, 1990). In the Nadnidziański LP it grows at the estuary of the Nida to Vistula River and in a small area of the Nida valley. This association is distinguishable by the presence of many hygrophilous species (Anioł-Kwiatkowska, 1990). For the present survey these were: *Juncus bufonius, Mentha arvensis, Potentilla anserina* and *Stachys palustris*.

No counterpart was found in the literature for the community with the constant share of *Stellaria media* and *Taraxacum officinalle*, that are noticeable in the cultivations of *Medicago sativa* in the area; however, this belongs to the alliance *Eu-Polygono-*C*henopodion,* which is proved by the occurrence of species of the association.

The association *Echinochloo-Setarietum* develops on sandy soils in root crops where *Vicietum tetraspermae* is spotted between the grains. According to Sałata (1965), reaction of soils on which *Echinochloo-Setarietum* grows is acidic (5.0 6.0). In the surveyed area soils' reaction was sometimes close to neutral. – 6.8.

This association was mentioned in Jura Krakowska (Kornaś, 1950), Chełm by Sałata (1965), and by many other authors: Nowiński (1965), Fijałkowski (1967), Siciński (1974), Siciński and Sowa (1980), Warcholińska (1974, 1990), Wnuk (1976). It is well spread in the whole Poland.

According to Wnuk (1987) the reason of supremacy of a weed species in the field of root crops might be the herbicide use. The author writes that in 1983 in Żuławy domination of *Echinochloa crus-galli* had been noted in some cultivations. A similar phenomenon was observed in 1984 in the fields owned by IUNG Wrocław, this concerned *Amaranthus retroflexus*. In 1986 in the fields of WOPR Boguchwała (Rzeszów region) herbicides were applied three times in the cultivation of faba bean and despite that fact *Veronica persica* achieved 80% of coverage (Wnuk, 1987). In the area of research some weed species yield, as it was noticed. This refers mostly to minor species with a small ecological scale that are replaced by strongly competitive species with short life cycle and plentiful of seeds, such as: *Galinsoga parviflora*, *Echinochloa crus-galli* or *Amaranthus retroflexus*.

CONCLUSIONS

1. *Lamio-Veronicetum politae* is an association that occurs in the *Nadnidziański* Landscape Park most frequently, it is present on opulent loamy sands, rich in calcium compounds. It is most frequent on southern, southeast, and southwest exposures.
2. *Galinsogo-Setarietum* occurs particularly in root cultivations but it also develops well in other cultivations near premises. *Galinsoga parviflora*, one of the typical species of the association, significantly intensifies its occurrence in the area.
3. Patches of *Oxalido-Chenopodietum-polyspermi* develop the best on fertile and humid alluvial soil at the estuary of Nida to Vistula.
4. Association *Echinochloo-Setarietum* develops on sandy soils, in root crops where in cereals *Vicietum tetraspermae* may be observed.
5. An interesting community such as *Stellaria media* and *Taraxacum officinale* was described in the cultivation of *Medicago sativa*. No counterpart was found in literature for this community that repeats frequently in the area of research.
6. A noteworthy influence of soil on diversification of weed communities was observed. As the results of the paper show, many weeds achieve the optimum of their occurrence solely in specific edaphic conditions, with appropriate air temperature, humidity, reaction, nitrogen and humus abundance.
7. Application of fertilizers and herbicides contributes to decay of some weed species of a small ecological scale and propagation of other, more resistant to different activities of modern agricultural technique.

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