Original Research

Ecological Characteristic of Pesticide Tomb in the Warmia Region on the Basis of Index Numbers of Vascular Plants

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Abstract

An ecological characteristic of the surrounding of the pesticide tomb in the Warmia Region was prepared on the basis of index numbers of Poland's vascular plants in May and June 2002. The results lead to the conclusion that indicators of tropism, the organic matter content of the soil and nitrophylity denote high soil poverty, which are inconsistent with the history of this location. This area used to be a waste disposal site of residues generated in the process of managing post-slaughter waste and carcasses. Presumably some other factor determines such low values of the indicators mentioned above. The indicators analyzed were: lower than expected tropism indicator and a low indicator of organic matter content and particularly the dispersion of values of the nitrophylity indicator denote the existence of a new factor, which modifies the content of species in the communities that we analyzed.

The humidity indicator and the indicator of soil mechanical composition confirm the presumed direction of rainwater flow and probable leakage from the pesticide tomb. The flow stays in agreement with the topographic features and the characteristics of the soils that occur in the analyzed area. Soil acidity ranges from: 5.5 to 6.5 pH.

Climatic indicators are quite stable, the continentality indicator in particular, and they are typical of North-Eastern Poland. The diversity of the thermal indicator is caused by surface features. A large participation of weeds from the upper plant layer and topographic diversity, both influence the diversity of the luminous indicator.

Further research is recommended in order to exclude or confirm the emerging hypothesis of the modifying influence of pesticides deposited in the tomb on the characteristics of the flora and the fauna of the nearby ecosystems.

Keywords: environmental pollution, pesticide tomb, Poland, index numbers, bioindication

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Introduction

Due to the economic boom in the 1970s, all sorts of chemicals came onto the market, inter alia and plant protection chemicals and toxic substances e.g.: phenol, uranyl, lead acetate, mercury chloride, potassium ferrocyanide, silver nitrate, zinc acetate, ammonium rhodanate and many others. State-owned and co-operative agricultural and horticultural combines kept dynamic agricultural and commercial production. These combines were engaged in complex plant protection. As large amounts of the substances were used, in a short time they became a serious threat [24]. Next, the Central Union of Agricultural Co-operatives issued Instruction no. 1/71, and on the basis of this instruction tombs were built, into which plant protection chemicals that exceeded an expiry date [24]. The survey of the disposal sites of expired plant protection chemicals in Poland is carried out by the Institute of Plant Protection in Poznań. At the moment we have 330 tombs, 297 out of them are officially registered [14].

A threat to the environment by the substances deposited in the tombs is mainly caused by the faulty location of the tombs and the bad technical condition of the chambers [22, 27]. When objects of this kind were located in the 1960s and 1970s, threats resulting from a short distance from open waters, watercourses and potable water intakes were not taken into consideration. Even preliminary data about their location indicate a serious threat to the environment. A hundred tombs are located at a distance shorter than 1 km from potable water intakes, 75 near rivers and lakes, and 138 not far from residential areas. The tombs have no owners. Most of them are in poor overall condition.

The total amount of poisonous substances deposited in the tombs is difficult to evaluate. Values that come from different sources range from 3,140 to 6,000 tons [17].

It has been noted that in favourable hydro-geological conditions contamination may considerably spread out over an area [22]. The first necessity for life and health protection is constant control of the existing areas and looking for new endangered areas and the evaluation of the existing threat to the environment [10, 21, 24, 27].

Plant communities were formed as a result of long selection, both endogenous (which results from the possibility of adaptation of given species) and exogenous (which depends on all environmental conditions). In other words, geographical conditions: climate, surface features, substratum and human activities developed plant communities from the material, the flora that they had at their disposal. Very subtle systems were formed, systems that reflect occasionally hardly perceptible differences occurring in external conditions. All, even slight changes in the environmental state, are almost immediately reflected in these systems. The structure of a community is subjected to deformation, the floral composition of these community changes, new combinations of species are formed.

Plant communities are irreplaceable indicators anywhere the knowledge of the general habitat conditions is required, as they are influenced by all environmental factors and that is why they reflect them.

An ecological characteristic of habitats on the basis of the analysis of flora was first carried out by Ellenberg [7]. In Poland this issue was raised by Borowiec and his cooperatives in West Pomerania [2, 3, 4, 5], in Beskid Niski by Wójcik [25, 26], in Pojezierze Iławskie by Hołdyński [11, 12, 13]. The authors of these studies confirm the usefulness of bio-indicative data of plants processed by Ellenberg [7] in evaluating the field habitants in climatic and soil conditions of our country. In 1984 Zarzycki verified and adapted the list of index numbers for Poland [28]. The studies that have just been undertaken are mainly based on the index numbers given by Zarzycki [28]. Ellenberg's nitrophytic indicator was also used in these studies [8].

In the light of the presented facts one might put forward the hypothesis that xenobiotics, which were contained in a pesticide tomb (containing about 9.5 tons, mainly DDT) in Warlity Wielkie for 30 years, migrated to the surroundings of the tomb, and that this fact has had a modifying impact on the flora of the local ecosystems. This influence is also indicated by the ∑DDT content in the liver fat of the cormorants nesting in the neighbourhood of Warlity; in the years 1993-1996 in some of these birds the mentioned xenobiotic was noted in the amount of 15.457 to 30.745 mg/kg of wet mass [10]. Furthermore, it was noted that in 1993 the average ∑DDT content in grey heron on Lake Szeląg Wielki was 5.6 times higher when compared with the same species from the neighbourhood of Lake Giełądzkie [21]. The results of the research considering the increased content in cormorants in the neighbourhood of Warlity when compared with the birds from the neighbourhood of Lake Giełądzkie confirm the previous results. The aim of this study is to evaluate the habitat/biotopic conditions of the surrounding of the tomb in Warlity Wielkie on the basis of index numbers of vegetation.

There is also a risk that the object will contaminate Lake Szeląg Wielki, because of the leakage from the disposal site to its direction.

Material and Methods

The examined storage of expired plant protectants owed by Agency of Agricultural Property of Treasury is localized in Ostróda Commune near Warlity Wielkie. It is approximately 500 m to the west from the country. These are wastelands on the edge of the mixed forest that are situated on a small hill. The border of storage is approximately 2 m from the wall of a deep heading, exploitation of which was discontinued because of the neighbourhood of the pesticide tomb. It is localized 750 m from the source of drinking water, 800 m from Szeląg Wielki lake and several hundred meters from the breeding ponds which belong to the Fishery Farm in Warlity Wielkie. The described area belongs to the catchments area of Szeląg Wielki Lake.

This includes fenced and marked with plaques area of 0.1 ha. Near the pesticide tomb is the closed site of a closed slaughterhouse with free access.

The object consists of 9 wells built from concrete circles 800-1500 mm in diameter and 3.0 m deep. They are covered with concrete covers and soil. The pesticide tomb is filled in 78.5%.

In pesticide tomb in Warlity Wielkie there were 9.5 tons of expired plant protectants in the years 1972-1986 [19].

Eleven surfaces that included the tomb together with its closest surroundings were marked out within the examined area. Surfaces 1-5 are pits left after gravel extraction on the south side of the tomb, 6 and 7 are steep slopes on the south side of the tomb with clearly marked landslides, which expose the skeleton forming the heap that is uplifting the eminence with the tomb, surfaces 8 and 9 include the area where the reed grows at the foot of the hill, on which the tomb is located, surface 10 includes the area of the hill on which the tomb is set, surface 11 includes the immediate surrounding of the tomb, with an initiating slope towards the reed area.

On the surfaces that were marked in that way phytosociological relevés were taken using the Braun-Blanquet method [1]; Jansen scale [16] was used as a measure of quantity. The nomenclature of vascular plants was taken from Rutkowski [20], of moss from Coxley, Crundwell [6]. The relevés provided material for further studies on the basis of index numbers characterizing edaphic conditions: humidity (W), tropism (Tr), acidity (R), mechanical soil content (D), organic matter content (H), nitrophylity (N), and climatic indicators: luminous (L), thermal (T) continental (K), salinity indicator (S), heavy metal indicator (M), treading and corroding indicators (P) were also taken under consideration.

The results were set in a table in alphabetical order (Table 1). For each of the observed species a corresponding indicatory value was given. Average values of coefficients for particular surface were calculated according to the following formula:

$$X = \frac{\sum X_n \times i_n}{\sum i_n}$$

where:
X stands for coefficients W, Tr, R, D, H, N, L, T, K respectively, for the whole research surface,
X_n assumes values of coefficients W, Tr, R, D, H, N, L, T, K individually for each taxon n,
i – the quantity of each species on the studied surface according to Jansen scale [16].

Furthermore, average values for the whole research area were calculated (Table 2).

Results and Discussion

On the analyzed surfaces the presence of 100 taxa of vascular plants was noted (Table 1), and the presence of nine species of moss that were not registered in the phytosociological list:
Ceratodon purpurens Hedw. – dominant,
Brachytecium albicans B., S.&G.,
Brachytecium campestre (C. Mull.) B., S.&G.,
Pleurozium schreberi (Brid.) M.& H.,
Funaria hygrometrica Hedw.,
Bryum argenteum Hedw.,
Bryum caespidatum Hedw.,
Dicranum scoparium Hedw.,
Hypnum cupressiforme Hedw.

Indicatory value of moss was not estimated. Generally, *Ceratodon purpurens*, *Brachytecium albicans, Pleurozium schreberi,* and *Dicranum scoparium* are the species which are typical for a forest and occur in habitats with low amounts of nitrogen and high levels of acidity, even below 5 pH. The rest of the noted species of moss are typical of ruderal habitats.

Climatic Indicator of the Flora of the Pesticide Tombs in the Warmia Region

The analyzed climatic indicator should be examined as average values from all the studied surfaces due to the small surface of the occupied area. Nevertheless, the diversity of topographic features may cause some crucial differences that are helpful in understanding the functioning of the tomb area.

The values of the luminous indicator in the examined surfaces range from 3.4 to 4.3 (Table 2). Except for surface 11 they are not lower than 4, the average value in the studied area amounts to 4.1. The results indicate that the habitats are set in full light but only periodically or temporarily evaluated. Furthermore, it was noticed that weeds of upper layer predominate in the examined communities (Table 1), such as: *Tripleurospermum inodorum, Galium aparine*, etc. their light requirements are higher than the requisites of the trailing/creeping plants such as *Viola tricolor, Myosotis arvensis, Agropyron repens*. The correlation between the calculated value of the solar light exposure and the landscape, as well as the exposure and insolation was observed.

The average value of the thermal coefficient equals 3.6 (Table 2), which is characteristic of lowland for moderate climatic conditions. The diversity of the values of the temperature indicator is mosaic. Phytocoenoses with different values of this indicator are next to each other. Low values from 3.2 to 3.4 were noticed; they are closer to cool moderate climatic conditions, characteristic of a division of the northern lowland. Values ranging from 3.5 to 4.0 were also noticed; they are typical of warm moderate climatic conditions characteristic of the major part of lowland. The fluctuations of the values of indicator T are caused by irregular surface features, a factor that even on a small area may cause quite significant variability.

The most stable values among climatic indicators are assumed by the continental indicator, which equals 2.9 twice, and 3.0 nine times (Table 2), a characteristic which

Table 1. Index numbers of the flora from the surrounding of the pesticide tomb in the Warmia Region.

Phytosociological releves												Indicators											
Data	12.06	12.06	12.06	13.06	12.06	12.06	12.06	12.06	13.06	13.06	13.06	edaphic						climatic			other		
SSM of a releves in m2	25	40	20	30	30	30	20	40	100	30	30												
Degre of coverage in %	60	100	70	90	100	50	60	100	60	100	60												
Examination surface number	1	2	3	4	5	6	7	8	9	10	11	W	Tr	R	D	H	N	L	T	K	S	M	P
Plant name:																							
Acer platanoides	0	0	0	0	0	0	0	1	0	1	0	3	3.5	4	4	3	0	4	4	3	.	.	.
Agropyron repens	0	0	0	7	0	0	0	0	0	0	7	3	3.5	4	4	2.5	8	3	3.5	3	I	.	.
Agrostis capillaris	0	0	0	0	0	0	0	0	0	2	0	2.5	3	3.5	3.5	2.5	3	4	3	3	I	.	II
Alnus glutinosa c	1	0	0	0	0	0	0	0	0	0	0	5	3.5	4	5	4	0	3	4	3	.	.	.
Alnus incana b	0	3	0	0	3	0	0	0	0	0	0	4	4	4	3	3	0	4	3	3	.	.	.
Alopecurus geniculatus	0	2	2	2	0	0	0	0	0	0	0	5	4	4	5	2	7	4	3.5	3	I	.	.
Anchusa arvensis	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	.	.
Anthriscus sylvestris	0	0	1	3	0	0	0	0	0	0	0	3	4.5	4	4	3	8	4	3.5	0	.	.	.
Arrhenatherum elatius	0	0	2	2	0	0	5	9	0	0	0	3	4	4.5	4	3	7	4	4	3	I	.	I
Artemisia arvensis	2	0	0	0	0	0	0	0	0	0	0	2	2	3.5	3.5	2	0	5	4.5	3	.	.	.
Artemisia campestris	0	0	2	0	0	5	5	3	0	0	0	2	2	3.5	3.5	2	2	5	4.5	3	.	.	.
Artemisia vulgaris	2	0	2	2	0	2	2	2	3	2	0	3	4	4.5	4	3	8	4	4	3	.	.	.
Berula erecta	0	0	0	0	0	0	0	3	1	0	0	6	4	5	3.5	2	7	4	4	3	.	.	.
Calamagrotis epigejos	0	0	0	0	8	0	0	0	0	0	0	3	3	3	3	3	7	4	3.5	3	I	I	.
Campanula patula	0	0	0	0	0	0	0	0	5	0	0	3	3.5	4	4	3	4	5	3	3	.	.	.
Capsella bursa-pastoris	2	0	0	0	0	0	0	0	0	0	0	3	4	4	4	2.5	7	4	3	3	I	.	I
Carduus crispus	0	2	0	5	3	2	0	0	0	0	0	4	4	5	4.5	3	9	4	4	3	.	.	.
Chenopodinum album	5	2	0	0	0	0	0	0	0	0	0	3	4.5	4	4.5	3	7	4	3.5	3	I	.	.
Cirsium decussatum	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	5	.	.	.
Convovulus arvensis	0	0	0	3	0	2	0	0	3	2	0	2.5	3	4	4.5	2	0	5	4.5	3	.	.	.
Conyza canadensis	7	2	2	5	0	2	2	1	0	2	0	3	3	3.5	3.5	2	4	5	3.5	3	I	.	.

Table 1 continues on next page...

Coronilla varia	2	0	0	0	0	0	0	0	0	0	0	2	3	4.5	3	2.5	3	5	4.5	3	.	.	.
Corynephorus canescens	2	0	0	0	0	2	3	0	0	0	0	2.5	2	3.5	3	2	2	4	4	2	.	.	.
Dactylis glomerata	0	2	0	0	0	0	0	0	0	0	5	3	4.5	4.5	4	3	6	4	3	3	I	.	I
Deschamphsia flexuosa	2	5	3	0	0	2	0	2	0	0	3	3	2	2.5	3.5	3.5	0	2.5	2.5	3	.	.	.
Epilobium parviflorum	5	5	0	0	3	0	0	2	0	0	0	4.5	4	4	4.5	3	5	4	3.5	3	.	.	.
Equisetum arvense	5	5	2	0	3	2	1	2	0	3	0	3.5	3.5	3.5	3.5	3.5	3	4	3.5	3	I	I	.
Equisetum palustre	0	0	0	0	0	0	0	2	0	0	0	4	3.5	4	4	3.5	3	4	3	3	.	.	.
Erodium cicutarium	0	0	1	0	3	0	0	2	0	0	0	2.5	3	3.5	3	2	0	5	4	3	.	.	.
Eupotarium cannabinum	0	0	0	0	0	0	0	0	2	0	0	4	4.5	4.5	4	3	8	3.5	3.5	3	I	.	.
Festuca ovina	2	0	2	2	0	5	2	0	0	3	0	2	2	4	4	2	0	4	3.5	3	I	I	.
Galium aparine	0	0	0	5	0	0	0	0	5	2	2	4	4.5	4	4.5	3	9	4	3.5	3	.	.	.
Galium mollugo	0	0	0	0	3	0	0	2	0	0	0	3	4	4	4	3	0	4	3.5	3	.	.	.
Geum urbanum	1	0	0	0	0	0	0	0	0	0	0	2.5	4.5	4.5	4	3	7	2	3.5	3	.	.	.
Helichrysum arenarium	0	0	0	0	0	3	7	0	0	0	0	2	2	4	3	1.5	1	5	4.5	3	.	.	.
Hieracium pilosella	2	0	0	0	0	3	0	3	0	0	0	2	2	3.5	3	2.5	2	4	3.5	3	.	.	.
Jasione montana	2	2	0	0	0	5	0	2	0	0	0	2	2	4.5	3	2	2	4	3.5	3	.	.	.
Juncus articulatus	1	5	0	0	5	0	0	0	0	0	0	4.5	3.5	5	4.5	4	2	5	3.5	3	I	.	.
Knautia arvensis	0	0	0	2	0	0	2	2	0	2	0	3	3.5	4	4	3	3	5	4	3	.	.	I
Lactuca serriola	1	0	0	0	0	0	0	0	0	0	0	3	3	5	4.5	2	4	5	4	3	I	.	.
Lathyrus pratensis	0	0	0	0	0	0	0	2	0	0	0	3.5	4	4	4	3	6	4	3.5	3	.	.	.
Lycopus europaeus	0	3	0	0	2	0	0	0	0	0	0	5	4	4	4.5	3.5	7	3	3.5	3	I	.	.
Lythrum solicaria	0	0	0	0	0	0	0	1	0	0	0	4.5	4	4	4.5	3.5	0	4	3.5	0	I	.	.
Medicago lupulina	2	5	2	0	2	0	0	0	0	0	0	2.5	3.5	5	4	2.5	0	4	4.5	3	.	.	.
Melilotus alba	2	9	2	0	3	0	0	2	0	0	0	2.5	3	5	3	2	3	5	4	3	I	.	.
Melilotus officinalis	2	0	2	0	3	0	0	2	0	5	0	2	3	5	4	2.5	0	5	4	3	I	.	.
Myosotis arvensis	1	2	0	0	0	0	0	0	0	0	0	3.5	4	4.5	4	3	7	2	3.5	3	.	.	.
Oenothera biennis	7	0	7	0	0	7	3	2	0	0	0	2.5	3	4	2.5	2	4	5	3.5	3	.	.	.
Padus racemosa	0	0	0	0	0	0	0	2	0	1	0	4	4	4.5	4.5	3	0	3	3.5	3	.	.	.

Table 1 continues on next page...

Papaver rhoeas	3	1	2	0	0	0	0	0	0	0	0	3	4	4.5	4	3	0	4	4.5	3	.	.	.
Phleum pratense	3	0	0	0	0	0	0	0	0	0	0	2.5	3.5	4.5	2	3	6	4	3.5	3	.	.	I
Phragmites communis	0	0	0	0	0	0	0	9	0	0	0	6	3.5	4	4	3	5	5	3.5	3	I	.	.
Pinus sylvestris	0	0	0	0	0	1	1	2	0	0	0	3	2	3	3.5	3	0	3	3.5	3	.	.	.
Plantago lanceolata	0	2	0	0	0	0	2	0	0	0	0	3	3.5	4	4	3	0	4	4	3	.	.	.
Plantago major	2	5	3	0	2	0	0	0	0	0	0	3	4	4	4.5	3	0	4	3	3	I	.	II
Poa annua	0	5	0	0	0	0	0	0	0	0	0	3	4	4.5	4.5	3	1	4	2.5	3	I	.	II
Polygonum amphibium f. terestre	2	0	0	0	0	0	0	0	0	0	0	4	4	4	5	3	6	4	3.5	3	I	.	.
Polygonum aviculare	2	0	0	0	0	0	0	0	0	0	0	3	3.5	4.5	4.5	2.5	0	4	3.5	3	I	.	II
Polygonum patulum	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	.	.
Potentilla argentea	0	2	0	0	0	0	0	1	0	0	0	2	3	5	3	2.5	1	5	4	3	.	.	.
Potentilla erecta	0	2	0	0	0	0	0	0	0	0	0	3.5	2.5	3	3.5	3	2	4	3	3	.	.	.
Quercus robur	1	1	1	0	0	0	2	2	0	0	0	3.5	3.5	3.5	4	3	0	4	3.5	3	.	.	.
Quercus rubra	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	.	.	.
Ranunculus acris	0	2	0	0	0	0	0	0	0	0	0	3.5	4	4.5	4	3	0	4	3	3	I	.	I
Ranunculus repens	0	3	0	0	3	0	0	0	0	0	0	3.5	4	4.5	4.5	3	0	4	3	3	I	.	I
Rhaphanus raphanistrum	2	0	0	0	0	0	0	0	0	0	0	3	3	3.5	3.5	3	5	4	3.5	3	.	.	.
Rosa rugosa	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	.	.	.
Rubus idaeus	0	0	0	0	0	0	0	2	0	0	0	3	3.5	4	4	3	8	3.5	3	3	.	.	.
Rumex acetosa	2	0	0	0	0	0	0	2	0	0	0	3.5	4	4	4	3.5	5	4	3.5	3	.	.	.
Rumex crispus	0	0	0	2	0	2	2	2	0	7	0	3.5	4	4.5	4	3	5	4	3.5	3	I	.	.
Salix caprea	0	0	0	0	2	0	0	0	0	0	0	3.5	4	3.5	4	3	0	3.5	3.5	3	.	.	.
Salix cinerea	0	0	0	0	2	0	0	0	0	0	0	4	3.5	4	4	3.5	4	4	3.5	3	.	.	.
Salix myrtilloides	0	2	0	0	0	0	0	0	0	0	0	5	3	2.5	0	5	0	5	3	4	.	.	.
Salix pentandra	0	0	0	0	2	0	0	0	0	0	0	4.5	3.5	4	4	0	4	4	3.5	3	.	.	.
Salix purpurea	0	3	0	0	0	0	0	0	0	0	0	4	4	4.5	3	2	0	4	3.5	3	.	.	.
Salix viminalis	0	0	0	0	5	0	0	0	0	0	0	4	4	4.5	3	2	0	5	3.5	3	.	.	.
Sambucuc nigra	0	0	0	0	0	0	0	1	0	0	2	3	4.5	4	4	3	9	3.5	3.5	3	.	.	.

Table 1 continues on next page...

Saponaria officinalis	1	0	0	0	0	2	2	0	0	0	0	3	3.5	4.5	3	2	5	4	3.5	3	.	.	.
Senecio erocifolius	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	4	4	4.5	3	.	.	.
Silene nutans	3	0	0	2	3	0	2	0	0	5	0	2	3	4	4	3	3	4	3.5	3	.	.	.
Silene vulgaris	3	0	0	0	0	0	2	2	0	0	0	3	3	4.5	3	2	2	4	3	3	.	I	.
Sium latifolium	0	0	0	0	0	0	0	2	0	0	0	5.5	4	4.5	0	0	8	4	3.5	3	I	.	.
Solanum dulcamara	0	0	0	0	0	0	0	2	0	0	0	4.5	3.5	4	0	3.5	8	4	3.5	3	I	.	.
Stachys palustris	0	0	0	0	0	0	0	2	0	0	0	4.5	4	4.5	4.5	3	7	4	3.5	3	I	.	.
Tanacetum vulgare	2	0	0	0	0	0	0	0	0	0	0	3	4	0	3.5	3	5	5	3.5	3	.	.	.
Taraxacum officinale	0	3	3	0	0	0	0	0	0	0	0	3	4	4.5	4.5	3	7	4	2.5	3	I	.	.
Thlaspi arvense	2	0	0	0	0	0	0	0	0	0	0	3	4	4.5	4	3	7	4	3.5	3	.	.	.
Trifolium arvense	2	2	7	0	0	5	2	2	0	0	0	2	1.5	4	2	2	1	5	4	3	.	.	.
Trifolium hybridum	0	2	0	0	0	0	0	0	0	0	0	4	4	4	4.5	3.5	5	4	3.5	3	.	.	.
Trifolium pratense	2	2	0	0	0	0	0	0	0	0	0	3	4	4	4	3	0	4	3	3	I	.	.
Trifolium repens	0	0	0	0	3	0	0	0	0	0	0	3.5	4	4	4	3	0	4	2.5	3	I	.	II
Tripleurospernum inodorum	0	0	5	0	0	0	0	0	0	0	0	3	4	4.5	4	3	6	4	3.5	3	.	.	.
Urtica dioica	0	0	0	0	0	0	0	7	0	0	3	3.5	4.5	4.5	4	3.5	8	3	3	3	I	I	.
Valeriana officinalis	0	2	0	2	0	0	0	0	0	0	0	3.5	4	0	4	3.5	5	3.5	3.5	3	.	.	.
Verbascum thapsus	5	0	0	0	0	2	3	2	0	5	0	3	3.5	4.5	2	2	7	4	3.5	3	.	.	.
Veronica chamaedrys	0	0	0	0	0	0	0	0	0	3	0	3	4	4	4	3	0	4	3	3	.	.	.
Vicia hirsuta	2	3	0	0	3	0	0	2	0	3	2	3	3	3.5	3.5	3	0	4	3.5	3	.	.	.
Vicia sativa	2	0	0	0	0	0	0	2	0	0	0	3	3.5	4.5	4	3	0	4	3.5	3	.	.	.
Viola arvensis	2	2	0	0	0	0	0	0	0	0	0	3	3.5	3.5	3.5	2.5	0	4	3.5	3	.	.	.
Viola tricolor	1	2	0	2	0	0	0	0	0	0	0	2.5	2.5	3	4	2	0	4	3.5	3	.	.	.

SSM - superficial square measures;
Indicators:
edaphic: W - humidity, Tr - trophicity, R - acid, D - mechanical content, H - organic matter content, N - nitrogen content;
climate: L - luminous, T - thermal, K - continental
other: S - salinity, M - heavy metal, P - treading and corroding

Table 2. Average values of trophic and edaphic indicators of the flora from the surrounding of the pesticide tomb in theWarmia Region.

Examination surface number			1	2	3	4	5	6	7	8	9	10	11	Average
Indicators	edaphic	humidity (W)	2.8	3.3	3	3	3.4	2	2	3.5	3.4	2.8	3.1	3.0
		trophicity (Tr)	3.2	3.4	3	3	3.5	3	3	3.4	3.9	3.3	3.8	3.3
		acid (R)	3.8	4	4	4	4.1	4	4	4.1	4.2	4.1	3.9	4.0
		mechanical content (D)	3.4	3.7	3	4	3.8	3	3	3.5	4.2	3.7	3.9	3.6
		organic matter content (H)	2.5	2.9	3	3	2.8	2	2	2.8	2.8	2.7	3.0	2.6
		nitrogen content (N)	3.2	2.4	3	6	2.5	3	3	4.2	5.9	3	6.1	3.8
	climate	luminous (L)	4	4.1	4	4	4.2	4	4	4.1	4.4	4.1	3.4	4.1
		thermal (T)	3.4	3.4	4	4	3.5	4	4	3.6	3.6	3.5	3.2	3.6
		continental (K)	2.9	3	3	3	3	3	3	3	3	2.9	3	2.9

is normal for neutral habitats in relation to the continentality of climate, and typical for the species growing in both more Atlantic (western) and continental (eastern) regions of the country. Among the examined surfaces only *Corynephorus canescens* is Atlantic specie. Only *Cirsium decussatum* and *Salix myrtilloides* can be enumerated among species typical of continental climate. The remaining species are typically sub continental.

Edaphic Indicators of the Plants of the Pesticide Tombs in the Warmia Region

Water economy of the soil, next to its abundance in nutrients, is a significant factor, deciding on the productivity of an ecosystem. In order to evaluate the water condition properly attention was paid to the plants of spring aspect, which were not present in phytosociological relevés taken in summer. From the observations that were made in the first decade of May it appears that in the examined surfaces (except for 9) the following species were present (amounting to 2 - 3): *Erophila verna, Myosotis micrantha, Veronica Hederifolia*. It suggests great horizontal water motion in the soil [18]. Indicator W denotes that the following types of soil were dominant on the given examined surfaces: fresh soils (1, 3, 4, 10, 11), dry soils (6, 7) – steep sliding slopes on the southern side of the tomb, to humid soils (5, 8, 9) (Table 2). Changeable topographic features might account for such distribution of indicator W. The level of humidity may indicate the direction of leakage from the tomb to the East towards reed area (surface 8) and to the South towards the pit remaining after an exploited gravel heap (surfaces 5, 9).

The dispersion indicator denotes that the soils are sandy-clayey, quite coherent and heavy with low levels of permeability.

Trophic indicator ranged from 3.0 to 3.9 (Table 2): in terms of mesotrophy these are moderately poor soils (3, 4, 6, 7) in the lowering and quite steep places in the direct exposure to the leakage from the tomb, to 3.8 to 2.9 (11, 9): places of the highest location, potentially the most independent of the tomb.

The received value of the indicator of organic matter content and of humus content in the soil (H) is interesting and ranges from 2.0 to 3.0 (Table 2). In this case the species composition of plants clearly shows that we deal with soils that are very poor in humus (1, 6, 7). The presented values were noticed on the surfaces of the lowest location, where organic matter should cumulate, be carried with rainfall from the surfaces that are in an upper position. Especially that it is also a disposal site of organic remains from slaughterhouses that form a large waste-tip where the tomb is placed. Whereas on the uplifted areas the interpretation of the indicator denotes that these are soils of mineral-humus type. Similar values were noted for natural lowering (8), through which rainwater flows from the tomb.

The distribution of the nitrophylity indicator is also very interesting. On a small area this indicator assumes extremely different values: from 2.4 to 6.1 (Table 2).

Whereas the level of acidity coefficient is stable (3.8-4.1) (Table 2) and indicates that the soils of the examined surfaces belong to the types: moderately acid to slightly acid (pH 5.5-6.5).

Recapitulation and Conclusions

The characteristics of a habitat based on biotopic/habitat requirements of plants by use of index numbers has its advantages and drawbacks. Short, coherent, standardized records, compiled with the same method for many taxa, are easily comparable; they can be keyed in the computer, used for various calculations, comparisons and groupings. The main drawback is that they suggest precision where it is sometimes not present, and take only certain biotopic/habitat factors into consideration. Nevertheless, based on the received results we may draw the following conclusions:

1. Indicators of tropism, organic matter content and nitrophylity denote high poverty of soils. It is incon-

sistent with the history of exploiting the area. This area used to be a waste disposal site of residues generated in the process of managing post-slaughter waste and carcass and this fact should to a large extent influence the fertility of the habitat. Lower than expected trophic indicator, low organic matter content indicator and the dispersion of the values of the nitrophylity indicator suggest the existence of a new factor which modifies the species composition of the analyzed communities. Particularly in the light of acquired information may we put forward a hypothesis that some other factor determines such low values of the listed coefficients.

2. Humidity indicator and soil mechanical composition indicator confirm the direction of the flow of rainwater from the pesticide tomb. The flow is consistent with topographic features and the feature of the soils occurring on the examined area.
3. Soil acidity ranges from 5.5 to 6.5 pH.
4. Climatic indicators are quite stable, the continental indicator in particular, and they are typical of North-Eastern Poland. The diversity of the thermal indicator is caused by surface features. Whereas the diversity of the luminous indicator is influenced by large participation of weeds from the upper plant layer and topographic diversity.
5. Further research is recommended in order to exclude or confirm the emerging hypothesis of the modifying influence of pesticides deposited in the tomb on the characteristics of the flora and the fauna of the nearby ecosystems. Further studies are necessary in order to state whether the hypothesis of the migration of the xenobiotics to the environment evokes the asserted state of affairs.

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