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The effect of agricultural landscape type on field margin flora in south eastern Poland

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Abstract – Plant species diversity is threatened in many agricultural landscapes due to the changes it has to undergo. Although the modification of the agricultural landscape pattern is observed across Europe, both extensive and intensive agricultural landscapes still co-exist in Poland. The objective of the study was to examine the flora in field margins in intensively and extensively managed agricultural landscapes, located across three regions in SE Poland. The flora was compared with respect to species richness, diversity, and evenness indices. Detrended correspondence analysis was employed to characterise variation in species composition. Agricultural landscape type made a higher contribution than the topography or geology to species richness and composition in field margins. Field margins function as important habitats for general vascular plant species diversity and are useful for the conservation of rare, threatened, endangered or bee plants. A significant decline in species diversity was observed over a distance of 1000 m from the habitat elements. Plants growing on field margins are mainly perennials; however participation of annuals clearly increases in intensive landscapes. The participation of wind-dispersed species decreased in an open-spaced intensive landscape. Animal-dispersed plants predominated in an extensive landscape with forest islands. Irrespective of landscape type, native species predominated. However, these habitats create the biota and corridors for alien-invasive species as well.

Keywords: extensive landscape, intensive landscape, invasive species, vascular plant biodiversity

Introduction

Agricultural landscape constitutes ca 47% of the area of the European Union (Eurostat 2015) and ca 60% of land in Poland (Central Statistical Office 2014). Since 1970s, the vegetation of the agricultural landscape has been under increased anthropogenic pressure in Europe (Stoate et al., 2009, Andreasen and Andresen 2011). Agricultural landscape structure i.e. 'a heterogeneous land area composed of a cluster of interacting ecosystems' is affected by large-scale changes, i.e. the fragmentation of habitats is rising significantly and the decline of heterogeneity of semi-natural habitats is observed (Baudry et al., 2000, Forman and Baudry 1984, Liira et al. 2008). As a result, a variety of small biotopes – woodlots, hedgerows, ditches or field boundaries – have largely disappeared from agricultural landscape (Robinson and Sutherland 2002, Reif et al. 2008).

The occurrence of non-crop habitats within cultivated field systems is particularly important. These structures are a buffer against run-off of chemicals from the field into water, serve to reduce soil erosion, floods and pesticide drift, provide breeding and shelter sites, extend food niches for a variety of animals (Marshall and Moonen 2002, Delattrea et al. 2010), and also provide seed banks of many taxa (Duelli and Obrist 2003, Dajdok and Wuczyński 2008). On a landscape level, non-crop habitats ensure linkages between habitats, maintain landscape diversity (Vickery et al. 2009), and have positive aesthetic effects (Marshall and Moonen 2002). Among non-crop habitats, field margins are of economic interest for farmers, because these structures harbour organisms such as pollinators and predators of pests, (Herzon and O'Hara 2007, Denisow and Wrzesień 2007, 2015a, Wrzesień and Denisow 2007, Morelli 2013).

In western European countries, field margins have been reduced drastically (Robinson and Sutherland 2002). By contrast, in Central and Eastern Europe with more extensive farming the network of field margins is richer (Reif et al. 2008). Since 1990s, radical economic reforms and changes in agriculture sector have occurred in Poland. Currently, both intensive (market oriented) and extensive (self-suffi-

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cient, family-run) farms can be distinguished. The economic changeovers led to environmental changes that are refleced in the modification of the agricultural landscape pattern (Wuczyński et al. 2014). One of the specific features of the Polish agricultural landscape structure is the co-existence of both extensive (related to more traditional) and intensive (related to modern) landscapes.

The aim of the study was to analyse field margin flora on the large-scale landscape level in both intensively and extensively managed agricultural landscapes across three regions of Poland. The more specific goal was to investigate how habitat elements (forests and meadows) have an impact on the species composition, richness and diversity. We established field margins at increasing distances from habitat elements to measure effects of isolation on species diversity. To make the survey more complex we analysed lifespan, dispersal mechanism, geographical status, and synecological groups of species in field margins.

Material and methods

Study area

The survey was conducted in the Lublin province (SE Poland) with about 68.4% of the area (1657.3 ha) covered by farmlands (Central Statistical Office 2014). The study area included the three regions selected due to variability in agricultural landscape types (Kondracki 2002). In each region both extensively and intensively managed landscapes as well as various habitat elements (grasslands, forests) are present. The regions are similar in climatic conditions, yet slightly differ in topography (Fig.1).

The Hrubieszów Basin (HB) (50°48’N, 23°53’E) has an almost flat to gently undulating topography, with elevations of generally less than 220 m above sea level, average annual temperature is 7.3 °C, annual precipitation is 600 mm. The soils are brown and chernozem. The natural vegetation of the area is composed of grasslands (*Festuco-Brometea, Molinio-Arrhenatheretea*) and mesophilous forests (*Tilio-Carpinetum*). The agricultural landscape is a mosaic of small-acreage fields and modern large-acreage fields and mean field acreage is 9.2 ha. The main crops are wheat, sugar beets and legume crops.

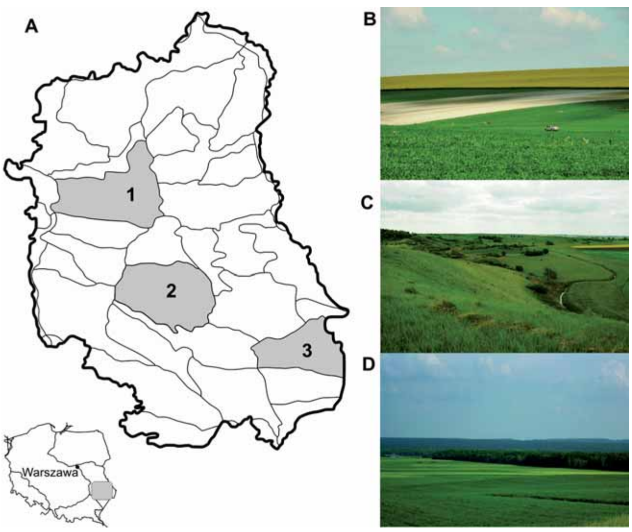

Fig. 1. Map of province in SE Poland, showing the study area; A – the location of regions: 1 – Lubartów High Plain (LHP), 2 – Giełczew Elevation (GE), 3 – Hrubieszów Basin (HB). Type of agriculture landscape: B – intensively managed, C – extensively managed with grasslands, D – extensively managed with forests.

Giełczew Elevation (GE) (51°5’N, 22°58’E) is a plain with gently undulating topography, often with hills > 300 m above sea level, the average annual temperature is 7.5 °C and the annual precipitation is 630 mm. The main soil types are brown and grey-brown or rendzina. The area has an intensive agricultural landscape dominated by ≥ 6 ha fields (~83% of region area) and only small areas of grassland (*Molinietalia, Arrhenatheretalia*) and forests (*Tilio -Carpinetum*). The common crops are wheat, potatoes, herbs.

Lubartów High Plain (LHP) (51°28’N, 22°38’E) is an undulating area, 170–180 m above sea level, average annual temperature is 7.4 °C, annual precipitation is 590 mm. Soils are mainly podzolic composed of sands and clays. Landscape structure is dominated by small-scale farming, mean field acreage is 6.3 ha. Forests (*Peucedano-Pinetum* and *Querco-Pinetum*), and grasslands (*Molinio-Arrhenatheretea*) occur in the landscape matrix. Rye and other cereals predominate among crops.

Data collection

The field survey was conducted in 2010 and 2011 from late June to mid August. Field margins were defined as homogeneous linear structures with vegetation occurring on the outer border of fields. For each landscape type, we randomly selected 15 transect plots (300 m long and 1.3 to 2.8 meters width), i.e. in each region 45 transect plots have been investigated. In total 135 transect plots were explored. Transect plots were designed according to Dajdok and Wuczyński (2008).

The geographic position of each *transect plot* was recorded with a differential GPS. The transect plots were categorized based on the type of agricultural landscape. According to the habitat types in the surrounding of field margins in each region three agricultural landscapes were selected (1) intensively managed with absence of habitat elements at > 1000 m distance from field margins (I); (2) extensively managed with grasslands in the surrounding of field margins (E_G); and (3) extensively managed with forests in the surrounding of field margins (E_F). The grassland and forest habitats were located at < 1000 m distance from transect plots.

Vascular plant species were identified in each transect plot. The abundance of plant species was estimated on the basis of the Braun-Blanquet scale (van der Maarel 1979). The syntaxonomic units were described according to Matuszkiewicz (2001), and the nomenclature of vascular plants was based on Mirek et al. (2002).

To make the description of field margin flora more complex we analyzed how landscape type interacts with species characteristics. We compared the distribution patterns of: lifespan (annuals, biennials, perennials) and dispersal mechanism (animal, wind, auto). In addition, geographical status (natives, archaeophytes, i.e. those alien species that arrived prior to 1500, neophytes, i.e. those alien species that arrived after 1500), synecological groups (grassland species, forest species, synanthropic species) have been considered. All of these categories are hereafter called ‘traits’ in this paper. The relevant data concerning the species characteristics were obtained from the LEDA traitbase (Kleyer et al. 2008) and BIOFLOR database (Klotz et al. 2002). Some species were assigned to more than one trait of a set of multistate categorical traits.

Data analyses

The vegetation on the transect plots was compared with respect to three types of indices, focusing on (i) species richness $S = n_i$, where n_i = species i; (ii) species diversity with the Shannon-Wiener index – $H' = -\sum p_i \log_2 p_i$, where p_i = frequency of the species i; (iii) species evenness with the Pielou index– $J' = H'/\ln S$, defined as the ratio of the observed diversity to the maximum diversity, where: S = the number of species and $H_{max} = \ln S$. J’ is constrained between 0 and 1; the less variation in communities between the species, the higher J’ is. The MVSP package was used to calculate the indices (Kovach 2005). The mean and SD (standard deviation) were computed and the values obtained were compared by the Kruskal-Wallis non-parametric test to reveal the significance of differences in the above-mentioned indices (Stanisz 2007). To characterize the general pattern of variation in species composition within the entire data set of vegetation we used an indirect ordination method, detrended correspondence analysis (DCA), from CANOCO ver. 5 (ter Braak and Šmilauer 2012). The strength of the relation between species diversity and the distance from habitat elements was measured with the Pearson’s correlation coefficient (r). The Statistica software package version 10 developed by StatSoft Krakow was used for these analyses.

Results

A total of 376 vascular plant species, belonging to 36 families was recorded on field margins within the three regions and agricultural landscape types (Fig. 2). The most abundant were *Asteraceae* (63 species – 16.7%), *Fabaceae* (35 species – 9.3%), *Poaceae* (31 species – 8.2%), *Rosaceae* (25 species – 6.6%), *Lamiaceae* (22 species – 5.8%), *Caryophyllaceae* (17 species – 4.5%), accounting for 51.3% of species.

The most frequent were 32 species (noted on > 80% of transects), e.g. *Dactylis glomerata, Elymus repens, Hypericum perforatum, Knautia arvensis, Veronica chamaedrys, Alopecurus pratensis, Berteroa incana, Euphorbia cyparissias, Achillea millefolium.* The next most frequent 57 species were noted in 50–80% transects, 251 species were present in 10–50% transects, and 36 species were recorded with a frequency lower than 10% in agricultural landscape. A few rare weeds – e.g. *Anchusa arvensis, Cerinthe minor, Consolida regalis, Fumaria vaillantii, Lathyrus tuberosus, Salvia verticillata, Stachys annua, Herniaria hirsuta, Agrosthemma githago, Neslia paniculata, Euphorbia falcata,* and *Bromus secalinus* were found (noted on < 5% of transects), including seven species from the Red List of the vascular plants in Poland (Zarzycki and Szeląg 2006)

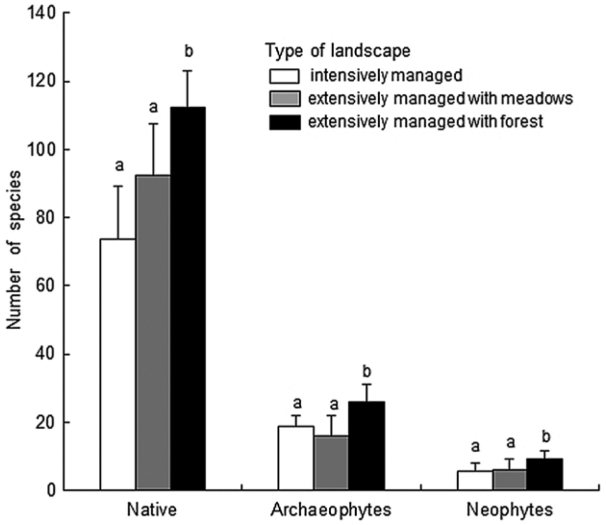

Fig. 2. The number of native and alien (archaeophyte and neophyte) species recorded in various type of agricultural landscape, located in SE Poland (mean from three regions). Vertical bars indicate standard deviation (+ SD); the values indicated with different small letters are significantly different between types of landscapes according to the Kruskal-Wallis test.

(*Adonis aestivalis, Bromus secalinus, Cerasus fruticosa, Elymus hispidus, Muscari comosum, Myosurus minimus, Potentilla rupestris*).

Native species (274 species – 72.83%) predominated on field margins under consideration (Fig. 2). Out of total vascular flora recorded, 102 species – 27.17% were alien species. The number of alien species was similar among regions (Kruskal-Wallis test: H = 5.83, P = 0.122), but differed by the type of agricultural landscape (Kruskal-Wallis test: H = 15.33, P = 0.0005). The highest number of alien species was recorded within traditional landscape with forests in the surrounding of field margins. Most of the alien species were identified as archaeophytes (68 species –18.05%), only 34 neophytes (species – 9.08%) were noted. Most of the archaeophytes were identified as segetal weeds (e.g. *Thlaspi arvense, Consolida regalis, Geranium dissectum, Viola arvensis, Fumaria officinalis*) and they were almost exclusively found in the peripheral zones of margins (= adjacent to fields).

We recorded 19 invasive plant species among neophytes (Tab. 1). The most frequent were *Galinsoga ciliata*, *Erigeron annuus, Conyza canadensis*, *Galinsoga parviflora*, *Setaria pumila*, *Solidago gigantea, Echinochoa crus-galli, Amaranthus retroflexus*. The most abundant neophytes, with > 30% of cover were *Solidago gigantea* and *Amaranthus retroflexus*.

The species composition was similar among the regions, out of 80% of field margin flora was recorded in all regions, however the species composition differed considerably among landscape types (Fig. 3).

The number of species in the particular transect plots was variable (mean = 97 ± 29.7 SD; ranging from 36 to 160). Species richness noted in field margins differed among the types of agricultural landscape (Kruskal-Wallis test: H = 9.83, P = 0.032), however was similar across regions (Krus-

Tab. 1. List of invasive plant species occurring in field margins in SE Poland. The frequency of invasive species in transects depending on landscape type (I – intensively managed landscape, E_G – extensively managed landscape with grasslands, E_F – extensively managed landscape with forests) and the habitats under threat. n – total number of transects, A – habitats created by humans, S – habitats partly transformed, N – communities of a natural character, Ar – archaeophyte, Ne – neophyte. Asterisk (*) denotes potentially invasive species.

Species	n	%			Type of habitats colonized	Geographical-historical group
		I	E_G	E_F		
Amaranthus retroflexus	48	43.75	20	43.75	A	Ne
Aster x *salignus*	13	6.25	17.5	5.55	A,S	Ne
Bunias orientalis	31	12.25	20	37.53	A,S	Ne
Conyza canadensis	98	56.25	86.66	75	A	Ne
Echinochloa crus-galli	57	37.55	40	50	A,S	Ar
Echinocystis lobata	14	6.25	13.3	12.54	A,S,N	Ne
Erigeron annuus	100	75	53.33	93.8	A,S	Ne
Galinsoga ciliata	121	81.25	86.66	100	A	Ne
Galinsoga parviflora	97	62.55	53.33	100	A	Ne
*Geranium sibiricum**	6	–	–	12.55	A	Ne
Helianthus tuberosus	6	–	6.67	6.25	A,S,N	Ne
Heracleum sosnovsky	3	–	5.66	–	A,S,N	Ne
Lupinus polyphyllus	28	6.25	6.67	50	A,S,N	Ne
Rosa rugosa	17	12.5	13.33	12.5	A,S,N	Ne
Rumex confertus	14	12.5	13.33	6.25	A,S	Ne
Setaria pumila	68	75	33.33	43.75	A	Ar
Setaria viridis	27	16.25	13.33	31.25	A	Ar
Solidago gigantea	66	31.25	40	75	A,S,N	Ne
Vicia grandiflora	11	12.6	6.67	5.8	A,S	Ne

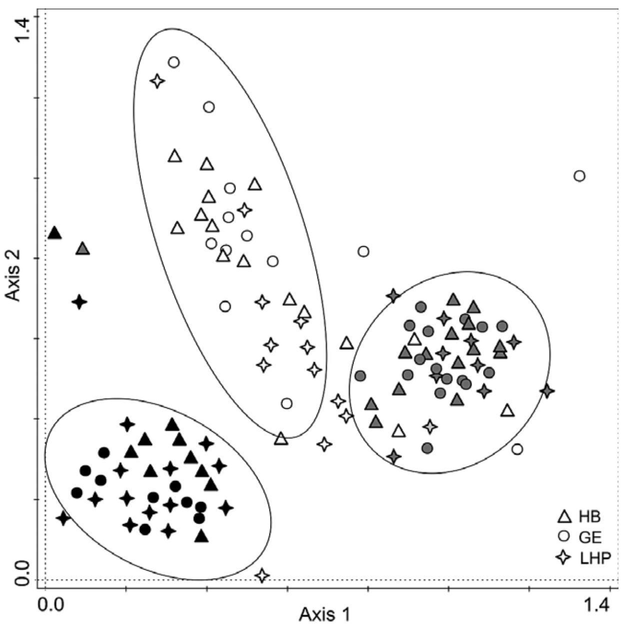

Fig. 3. Ordination diagram of the detrended correspondence analysis (DCA) based on species matrix comprising the flora occurring in field margins within three regions in SE Poland. Each point refers to the field margins location within agriculture landscape. White points correspond to intensively managed landscape (I), grey points – extensively managed landscape with grasslands (EG) and black points – extensively managed landscape with forests (EF). Regions: HB – Hrubieszów Basin, GE – Giełczew Elevation, LHP – Lubartów High Plain. Eigenvalues: Axis 1 – 0.102, Axis 2 – 0.066. The diagram explains 18.2% of total variance.

kal-Wallis test: H = 5.83, P = 0.176). The number of species on field margins located in extensively managed landscapes with forest (E_F) was approx. 30% higher than in margins located in extensively managed landscapes with grasslands (E_G), and approx. 50% higher than in field margins located in intensive landscapes (I) (Fig. 4).

No significant relation was observed between species diversity and the habitat elements (forests, meadows) under a distance of 700 m (Fig. 5). At larger distances, over 1000 m from habitat elements, species diversity decreased significantly with increasing distance from the habitat islands.

The ratio of perennials to biennials to annuals was approximately 5:1:2 (averaged 74 ± 7.3 and 34 ± 5.59 and 30 ± 18.15 species in the total flora, respectively). The share of perennials, biennials and annuals was related to landscape type but not the region (Kruskal−Wallis test for landscape effect: H = 9.32, P = 0.035; for region: H = 1.65, P = 0.43). The highest participation of annuals was recorded in intensively managed landscape (Fig. 6). There was no difference in the share of perennial plant species between extensively managed landscapes (E_F vs. E_G).

The dispersal type of species noted within field margins was related to the types of agricultural landscape (Kruskal-Wallis test: H = 0.32, P = 0.035). The number of wind-dispersed species was the lowest in the modern landscape. Animal-dispersed plants predominated in the traditional landscape with forest islands (Fig. 6).

Taking into consideration the synecological groups, the participation of grassland species (*Molinio-Arrhenathere-*

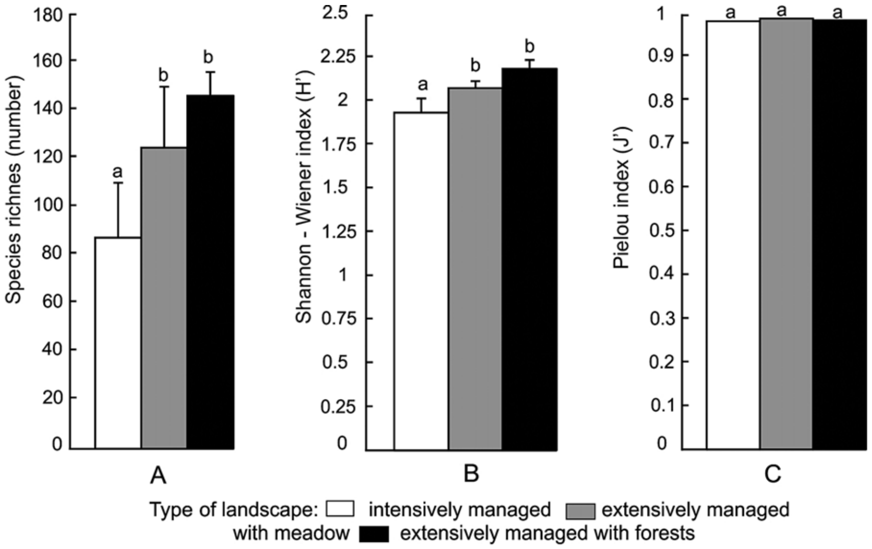

Fig. 4. Species richness, Shannon-Wiener diversity index (H'), and Pielou evenness index (J') calculated for flora in field margins located in intensively and extensively managed agricultural landscapes. Vertical bars indicate standard deviation (+ SD); the values indicated with different small letters are significantly different between type of landscapes according to the Kruskal-Wallis test.

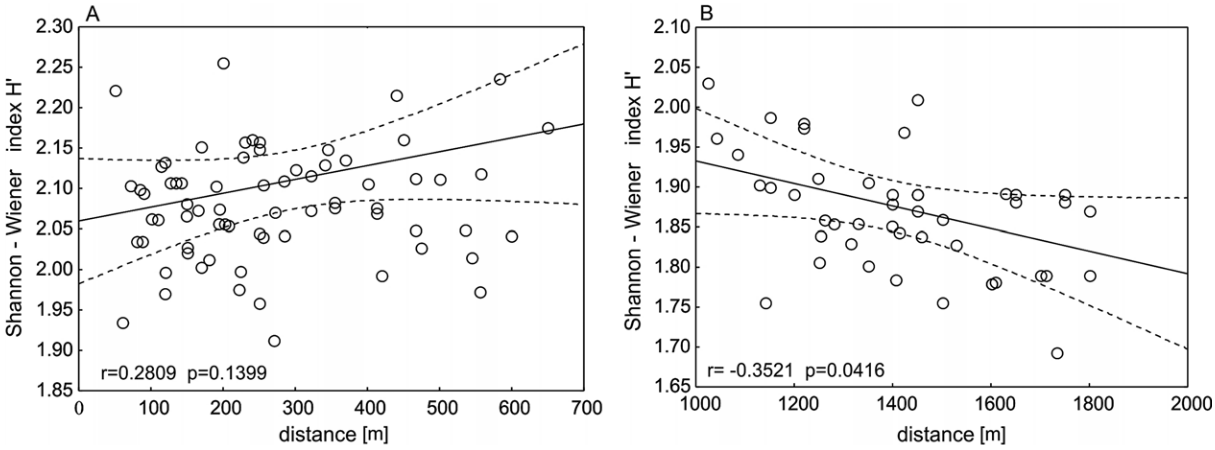

Fig. 5. Pearrson's correlation between the diversity of species within field margins located in extensively managed (A) and intensively managed (B) agricultural landscapes.

tea, Festuco-Brometea), coniferous and mesophilous broad-leaved forest species (*Vaccinio-Piceetea, Querco-Fagetea*) and synanthropic communities species (*Artemisietea, Stellarietea mediae*) were recorded. Irrespective of the agricultural landscape type, grassland species predominated and accounted for 40 – 43%.

Discussion

The field margins in the agricultural landscape of SE Poland function as important habitats for general vascular plant species diversity, which is typified by our research in which 376 vascular plant species were identified, i.e. approximately 1/3 of the regional flora (Fijałkowski 2003). This is consistent with a study conducted in Mediterranean region (Bassa et al. 2011) or Finland (Tarmi et al. 2009) and indicates the essentiality of field margins as hotspots of plant species richness in agricultural landscape, irrespective of geographic regions, climatic types or flora history. It is well documented that the species richness in field margins is particularly important for wildlife conservation in a cropland surrounding. It is crucial for agronomic reasons, e.g. many plants that grow in field margins are hosts for insects and spiders that are beneficial to agriculture by controlling the number of crop pests, i.e. aphids (Marshall 2004).

The diversity of species in field margins reflected the occurrence of grassland and forest islands in their vicinity. The species diversity declined significantly over the 1000 m distance from habitat elements indicating that mid-field islets are valuable sources of diversity in the landscape. Landscape heterogeneity is one of the landscape factors most adequate to explain plant diversity in non-crop habitats of agricultural landscapes (Andreasen and Andresen 2011). In several studies the species diversity declined significantly with increasing distance from the nature reserves; however different distances for such a decline have been reported. For example, Kohler et al. (2008) documented a drastic decline in forb species in field margins in the first 75 m from habitat elements. Marshal and Arnold (1995) demonstrated that field margin flora is strongly influenced by

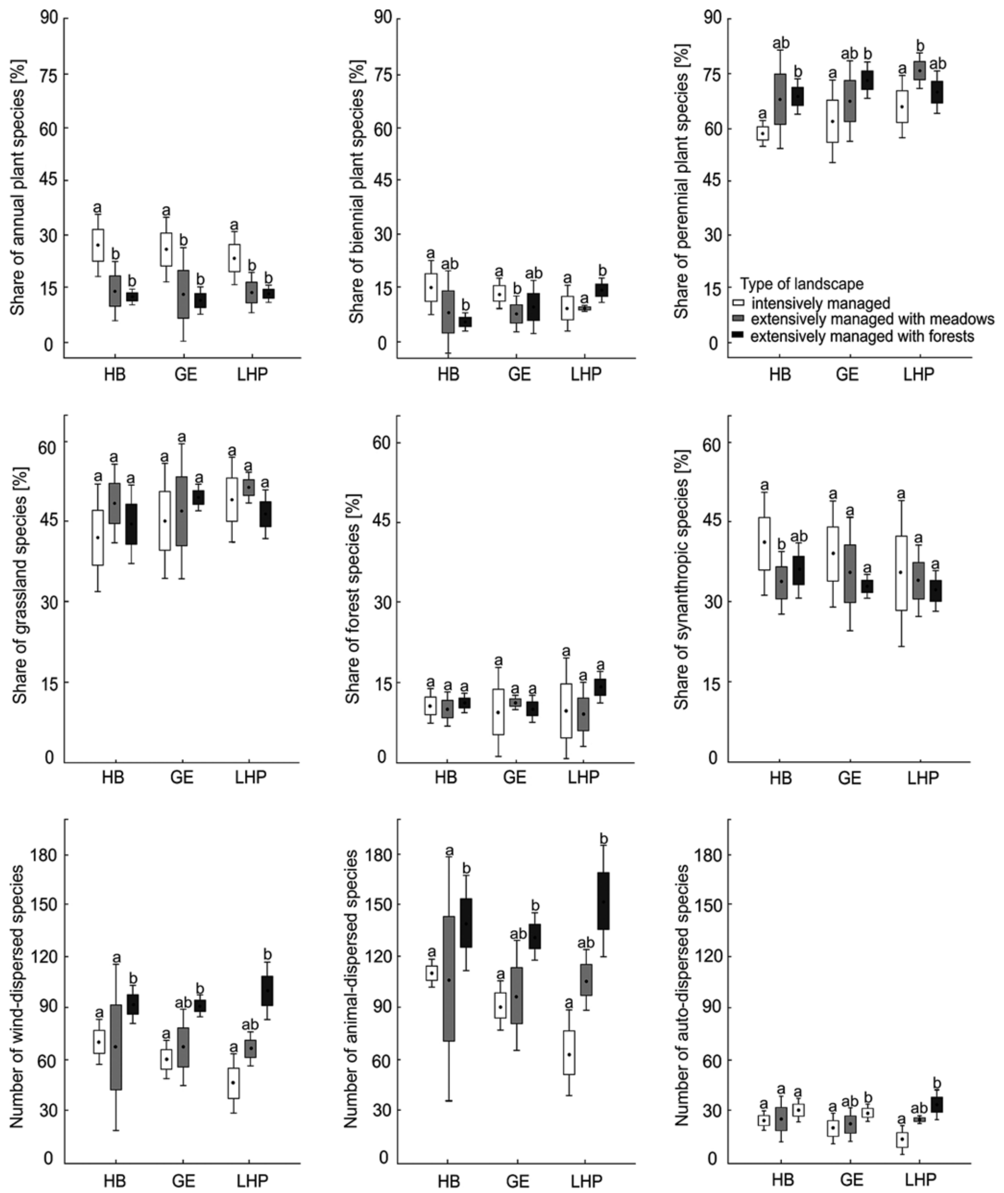

Fig. 6. Boxplots displaying various traits of field margin flora depending on the type of agriculture landscape located in three regions in SE Poland (HB – Hrubieszów Basin, GE – Giełczew Elevation, LHP – Lubartów High Plain). Vertical bars indicate standard deviation (± SD); the values indicated with different small letters are significantly different between type of landscapes according to the Kruskal − Wallis test.

location and documented a variety of species from adjacent woodlands. The plant communities of field margins are determined by colonization along these linear structures (Marshall and Moonen 2002). Maintenance of diversity requires continuous colonization and our results suggest that beyond 1000 m colonization of species from the habitat islands can no longer compensate disappearance. Here, only species well adapted to the intensive management practices in the agricultural landscape are able to survive.

The species composition across regions was similar, indicating that local topography, geology and environmental conditions had far less significance for field margin flora than the type of agricultural landscape. According to Aavik et al. (2008) the effects of agricultural landscape structure on field margin flora is particularly important. It is accepted that field margin flora reflects the specificity of habitat, e.g. the soil eutrophication, the increase in nitrogen and other nutrient levels (Kleijn and Verbeek 2000) or the physical disturbance of the soil environment related to agricultural practices (Bassa et al. 2011). We noted a great number of nitrophilous weeds (*Urtica dioica, Amaranthus retroflexus, Artemisia vulgaris, Cirsium arvense, Glechoma hederacea*) and frequent occurrences of disturbance-tolerant generalists were also recorded (e.g. *Poa pratensis, Rumex acetosa, Achillea millefolium, Elymus repens, Equisetum arvense, Artemisia vulgaris*).

Interestingly, regardless of the region and the landscape type we found a relatively high share of grassland specialists in field margins. Lindborg et al. (2014) reported that high grasslands species richness found in linear structures (field margins, road verges) across agricultural landscapes is partly related to transformation of grasslands to cropfields. Indeed, the process has been continuing since the 1960s in the study area (Fijałkowski 2003). Studies from other parts of Europe (Estonia, Switzerland) have also revealed the role of field margins as alternative habitats for grassland species (Aavik and Lira 2010).

We documented a high participation of perennials in field margins; however their number declined in intensively managed landscape. In Poland the margins are allowed to regenerate naturally, therefore the occurrence of long-lived plants reflects the intermediate stages of ecological succession. Many data have demonstrated the beneficial effects of perennials on the diversity of many organisms, i.e. insects (Szymkowiak et al. 2014), including pollinators (Faring et al. 2015), butterflies (Delattrea et al. 2010), birds (Vickery et al. 2009), small mammals (Żurawska-Seta and Barczak 2012). The effects are due to repeatable food niches, i.e. vegetative organs feed insects, seeds and fruits are suitable for birds (Vickery et al. 2009), nectar and pollen enhance pollinators (Denisow and Wrzesień 2015b). Among perennials we noted, i.e. *Ranunculus acris*, *Hypericum perforatum, Berteroa incana, Euphorbia cyparissias, Pastinaca sativa, Potentilla argentea, Geranium pratense*, species regarded as particularly important for pollinators (Denisow 2011). Indirectly, the nectar and pollen producing perennials observed near entomophilous crops may have positive effects on their yields, as wild flower abundance increases the sizes of wild pollinator populations (Meek et al. 2002, Denisow and Wrzesień 2015a). In some EU countries, field margins are exploited in the agri-environmental programs for sowing flower-rich seed mixes to counteract the unprecedented decline in pollinators (Potts et al. 2010). Therefore, we assume that the occurrence of wild bee-flora in the surrounding of crops should be regarded as important in consideration of these habitats as playing a role in the conservation of pollinators.

The proportion of annual weeds in field margins correlated with the type of agricultural landscape. An analogous result was reported by Petersen et al. (2006), Liira et al., (2008) and Lindborg et al. (2014), who found that more annuals are present in field margins located in intensely managed modern agricultural landscape than in those that are extensively managed. The relationship may reflect the differences in farm management, agricultural operations, or differences in herbicide applications followed by large-scale and small-scale farmers. For example, disturbance of field margins, reported from many European countries is more common in modern, intensive farming (Marshall and Moonen 2002). The habitat perturbance can create background, i.e. gaps for colonization of annuals, the r- strategist (*sensu* GRIME, 1974). These species possess the ability to use resources rapidly for successful establishment in changing environmental conditions.

The absence of differences in the participation of annual species between field margins located in extensive landscape indicates that the number of annual weeds was effectively reduced by competition from perennials. The significance of perennial species for the limitation of annual weeds was highlighted by Aavik (2008).

We documented that the type of dispersion was significantly related to landscape type. In accordance with Lindborg et al. (2014), we found that the share of animal- and auto-dispersed-species increased significantly in extensively managed landscapes with mid-field vegetation islets. Presumably, directional dispersal by biotic agents (animal- or self-dispersal), which delivers seeds less randomly is more effective to enhance colonization in an extensive landscape with different vegetation patches. However, in contrast to our expectations, we noted the lowest share of wind-dispersed species in an open-spaced intensively managed landscape. The phenomenon needs more empirical study to be explained.

We recorded 3–4 fold more native than alien species. Predominance of native species in field margins was also recorded in agricultural landscapes in other parts of Poland (Dajdok and Wuczyński 2008). Among aliens, the prevalence of archaeophytes (i.e., those aliens that arrived prior to 1500), over neophytes (i.e., those aliens that arrived after 1500) has been found in our study. The majority of archaeophytes were identified as segetal weeds. According to Dajdok and Wuczyński (2008), weed archaeophytes are noted most frequently in the peripheral areas of field margins, i.e. in zones that adjoin fields, and therefore field margins play a minor role in the re-dispersion of weeds into crops.

Notwithstanding their positive impact on general species richness, field margin habitats also create corridors for migration of alien-invasive species. We observed that some of neophytes formed dense patches. Invasive alien species have a particularly devastating *impact* on native biota and are responsible for the decline of species richness or even extinctions (Vilà et al. 2010). In the regions studied, the calcareous species (e.g. *Adonis aestivalis, Fumaria vaillantii, Stachys annua, Thlaspi perfoliatum, Valerianella dentata*) are considered at high risk from invasive plants (Haliniarz and Kapeluszny 2014). *I*n Poland, neophytes from Asia and North America are particularly disadvantageous for native biodiversity (Tokarska-Guzik et al. 2012). Among them, we noted *Bunias orientalis* and *Solidago gigantea.* Due to the attractive floral reward (nectar and pollen), these species lure a variety of pollinators (Denisow 2011). Therefore, in addition to negative *effects on* local plant species *biodiversity* such species may induce the collapse of pollination webs and disrupt pollination services of entomophilous crops. We observed strong competition for *Apis mellifera* between *Bunias orientalis* and oilseed rape (*Brassica napus*).

We frequently noted *Amaranthus retroflexus, Setaria pumila* and *Galinsoga parviflora*. These species are known to invade various habitats (ditch banks, grasslands, wood edges) as well as fields, vineyards, pastures, orchards in many parts of the world, not only in Europe (Tokarska-Guzik et al. 2012, Daisie 2015). Among the species the geographical distribution of which has expanded and the number of stations substantially increased (approx. 40% since 1970; Latowski et al. 2010, Wrzesień 2010) we recorded *Vicia grandiflora* and *Geranium sibiricum*.

Our results confirm the findings that field margins are useful for the conservation of biodiversity in the agricultural landscape, as well as for plant species currently considered rare, threatened or endangered. In the 1970s, most of these species were common weeds associated with crops. Radical changes in cropping methods and chemical applications are responsible for the disappearance of segetal weed species or even a risk of their extinction (Haliniarz and Kapeluszny 2014, Wuczyński et al. 2014). Therefore disappearance of weed species, mainly archaeophytes, is nowadays a common trend in many regions of Poland (Zając et al. 2009) and in Europe (Pinke et al. 2011), where field margins are also recognized as refugial habitats (Hamre et al. 2010, Fahrig et. al. 2015). The presence of rare or red list species has been suggested as an alternative indicator for the evaluation of diversity in agricultural landscapes (Weibull and Östman 2003). However, our observations indicate that only few rare, endangered or protected species occurred in field margins and consequently, the idea that rare species might indicate the biodiversity in agroecosystems seems to be untenable.

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