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Influence of the human activity on forest plant diversity

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Abstract: The vascular flora of Bolimow Landscape Park forests (Central Poland) has been surveyed. The research was carried by the carthogram method on the grid of square 1x1 km and 100x100 m. The meaningful participation of synanthropic plants in the flora was ascertained. The geographical-historical classification of the synanthropic species was carried out. The vascular flora of research area forests is composed of 603 species of which 516 are native taxa and 87 species are anthropophytes. The most anthropophytes occur on the forest roads verges, on the forest borders, near towns and settlements. The most common are kenophytes. The research by transect method in the three forest associations (*Tilio-Carpinetum, Querco-Pinetum, Leucobryo-Pinetum*) proved that bigger species richness and bigger syntaxonomic and ecologic diversity characterize the plots which are adjacent the roads as compared to those situated far from the roads. The presence of forest roads has meaningful influence on the diversity of vascular flora of forest complexes.

Keywords: synanthropization, vascular flora, distribution, forest roads, species richness, diversity.

Introduction

Anthropopressure is a very complex factor including all direct and indirect, conscious and involuntary human impacts on plant cover (OLACZEK 1982). Anthropogenic changes of flora and vegetation have been stated in different

ecosystems and climatic regions (GUTTE 1988, JÄGER 1988, MÜLLER 1988, WOJTERSKI & BENESETTITI 1988). One of the main results of anthropopressure is synanthropization of flora and vegetation (FALIŃSKI 1972).

As a consequence of human activity most of natural forests have been transformed. Since the early neolith middle Europe forests have been subjected to intensive changes (POTT 1988, 1992). The activity of man has an impact not only on the area but also on the structure of forest ecosystems. Recently forest phytocoenoses are an example of accelerated synanthropization (OLACZEK 1982).

Especially roads contribute highly to that process. Road verges are sites for grassland and meadow vegetation of a great ecological and geographical variety (BRANDES 1988, LAUSI & NIMIS 1985, SZWED & SYKORA 1996, ULMANN et al. 1990). However roads are not only migration routes for many species (KOPECKÝ 1978) but also the cause of fragmentation of natural landscapes. Not only public roads but also forest administration divisions can have an impact on composition of flora and nonforest plant communities creation (FALIŃSKI 1961, HERBICH & HERBICHOWA 1987).

The Bolimów Landscape Park (BLP) is located in Central Poland (Fig. 1). The present state of forest phytocoenoses of this area reflects not only the properties of the natural environment but also anthropopressure that has been going on for a few thousand years (OLACZEK 1999).

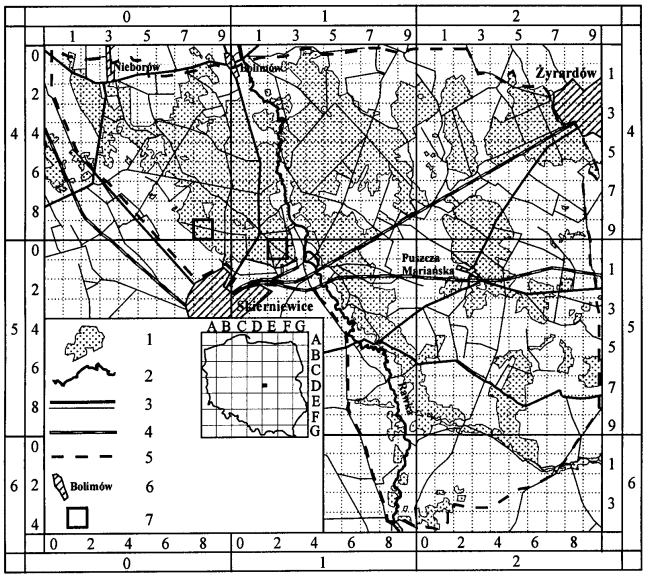

Fig.1. Location of the Bolimow Landscape Park in the grid of squares 1x1 km, according to the grid of Atlas of Polish Vascular Plants (Zając 1978). 1- forests, 2- rivers, 3- roads, 4- railway roads, 5- border of Bolimow Landscape Park with protection zone, 6-bigger villages and towns, 7- squares investigated in the grid 100x100 m.

Contemporary woods of the BLP are mainly composed of half-natural and anthropogenic communities that have been changed or completely formed by the forest management (JAKUBOWSKA-GABARA 1999). Penetration of foreign species into forest phytocoenoses is usually preceded by their previous degeneration (FALIŃSKI 1969), connected with changes of the species composition and structure of stand. An important form of the forest management is enrichment of the species composition of stand and undergrowth by introduction of foreign species.

The location of the research area as well as rich and long history of the BLP woods exploitation determines the degree of their synanthropization. The direct neighbourhood of big towns Skierniewice and Żyrardow and presence of numerous villages and settlements is what leads to intensive anthropopression on the forest. Numerous roads intersect forest complexes of the Park in different directions (Fig. 1). Not only does their presence facilitate penetration of synanthropic plants into the forest and settlement in it, but ditches and waysides make additional habitats for synanthropic species.

The work contains part of the results of the authors' own research having been carried out from 1996 in the forests of Bolimow Landscape Park and in the adjacent areas. The aim of the work is evaluation of synanthropic plant participation in the vascular flora of the Bolimów Landscape Park forests and presentation of some synanthropic species distribution and it dependence on anthropogenic elements of the forest landscape, especially forest roads.

Material and methods

Floristic research was conducted in three spatial scales. The whole area was studied with the cartogram method adopting the grid of 1km^2 according to the Atlas of Polish Vascular Plants (ZAJĄC 1978, ZAJĄC & ZAJĄC 2001). 274 squares were taken into consideration. Two of the squares were divided into smaller ones, of 100 x 100 m. The list of vascular plants has been made for each square.

For the analysis of forest roads influence on floristic diversity the method of transect was used (TRACZYK 1960, KERSHAW 1978, FALIŃSKI 2001). In the area of the most important communities of BLP (*Querco-Pinetum*, *Tilio-Carpinetum* and *Leucobryo-Pinetum*) 39 transects were set perpendicularly to the roads. Each transect consisted of three adjoining plots (each of 10 x 40 m) marked: a, b, c. The plot "a" adhered directly to the road, "c" was situated in the typical community, "b" lay between them. Communication routes established by forest administration were chosen to the research.

All species were divided into ecological groups (ELLENBERG et al. 1992), syntaxonomical groups (MATUSZKIEWICZ 2001) and geographical – historical groups (KORNAŚ 1968; JACKOWIAK 1990).

The nomenclature of species was adopted after Flora Europaea (TUTIN et al. 1980).

Results

The vascular flora of the Bolimów Landscape Park forests is composed of 603 species out of which 516 (85.6%) are native taxa and 87 (14.4%) are anthropophytes (Fig. 2). Native species group is composed of 316 species of spontaneophytes and 200 species of apophytes (JAKUBOWSKA-GABARA & ZIELIŃSKA 2003).

Particularly numerous apophytes appear in transformed forest communities. Species such as *Chelidonium maius* L., *Alliaria petiolata* (M. BIEB.) CAVARA & GRANDE, *Geranium robertianum* L., *Chaerophyllum temulentum* L., *Galeopsis bifida* BOENN., *Rumex obtusifolius* L. are often the dominant components of the herb layer in degenerated oak-hornbeam forests and wet woods.

The anthropophytes of the researched area are both species spontaneously penetrating forest complexes and purposely planted trees and shrubs. The most common species among those introduced by forest management are *Quercus rubra* L., *Prunus serotina* EHRH. and *Picea abies* (L.) H. KARST. Species planted along roads, on the edges of forests and in the neighbourhood of settlements and spontaneously penetrating forest phytocoenoses are also frequent. Here belongs: *Robinia pseudacacia* L., *Acer negundo* L., *Amelanchier canadensis* (L.) MED., *Amelanchier spicata* (LAM.) C. KOCH and *Aesculus hippocastanum* L.

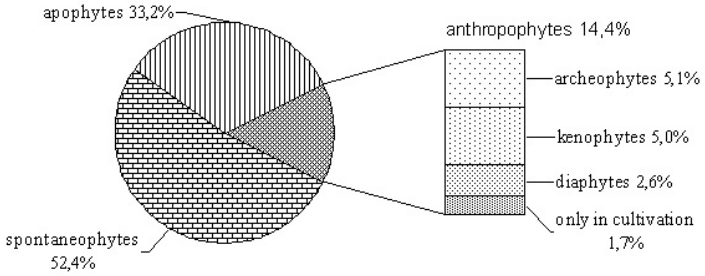

Fig. 2. Participation of geographical-historical groups of species in the flora of Bolimow Landscape Park forests.

The group of anthropophytes is formed by 31 archeophytes (5.1% of total number of species), 30 kenophytes (5%), 16 diaphytes (2.6%) and 10 species growing only in cultivation (1.7%) (Fig. 2). Almost all the archeophytes appear in disturbed places, exept *Viola odorata* L. and *Bilderdykia dumetorum* (L.) DUMORT., which are present in the herb layer of forest phytocoenoses. The majority of archeophytes grows in neighbourhood of settlements. In the group of archeophytes the most abundant are: *Capsella bursa-pastoris* (L.) MEDIK., *Myosotis arvensis* (L.) HILL, *Vicia hirsuta* (L.) S. F. GRAY, *Scleranthus annus* L., *Cichorium intybus* L., *Artemisia absinthium* L., *Viola arvensis* MURRAY.

Among anthropophytes the most common are kenophytes. *Conyza canadensis* (L.) CRONQUIST, *Juncus tenuis* WILLD., *Oxalis stricta* L. growing on roads, waysides, wood routes and trachways are the ones, which are expansive and frequently found. The neophyte *Impatiens parviflora* DC. grows particularly often and in abundance in the herb layer of forests situated in the vicinity of towns and settlements.

The net of roads plays an important role in spreading of synanthropic species in the forest (Fig. 3). Human impact upon flora results in changes of its composition due to the expansion of some groups of taxa and the retreat of others. According to the balance of these two processes, the floristic diversity may either increase or decrease (KORNAŚ 1982). Due to appearance of synanthropic plants we can observe biggest floristical richness near almost every road in BLP. It was also observed that the species richness is bigger near commonly used main roads (Fig. 3).

Each ecological system responds in a different way to anthropogenic pressure (OLACZEK 1982). The research conducted by transect method realized in the three forest associations (*Tilio-Carpinetum*, *Querco-Pinetum* and *Leucobryo-Pinetum*) has proved the differences in the participation of synanthropic species in the flora of examined plots. The smallest number of anthropophytes was noted in *Leucobryo-Pinetum* (Fig. 4) which occur on the poor dry soils. However independently of forest community the species richness is considerably bigger on the plots situated in the direct neighborhood of roads. Also the biggest syntaxonomical diversity was ascertained there. On the plots adjacent to roads numerous grassland and meadow species (classes: *Sedo-Scleranthetea*, *Nardo-Callunetea*, *Molinio-Arrhenatheretea*) were noted (Fig. 5). These heliophilous species occur on narrow forest roadside and migrate to forest phytocoenoses. Nevertheless, they don't form typical grassland and meadow communities such as on road verges in deforested areas (NAGLER et al. 1989, BERG & MAHN 1990, ULMANN et al. 1990).

Taxonomical composition of the flora of plots lying near the roads is strictly connected with the type of community but there is a group of cosmopolitan species migrating due to appearance of roads. These are for example *Poa annua* L., *Plantago major* L., *Juncus tenuis* WILLD., *Trifolium repens* L., *Taraxacum officinale* WEBER, *Dactylis glomerata* L. These plants were not found in the plots lying away from the roads. Forest roads facilitate presence of heliophilous plants, indicators of high moisture and soils rich in available nitrogen (Fig. 6).

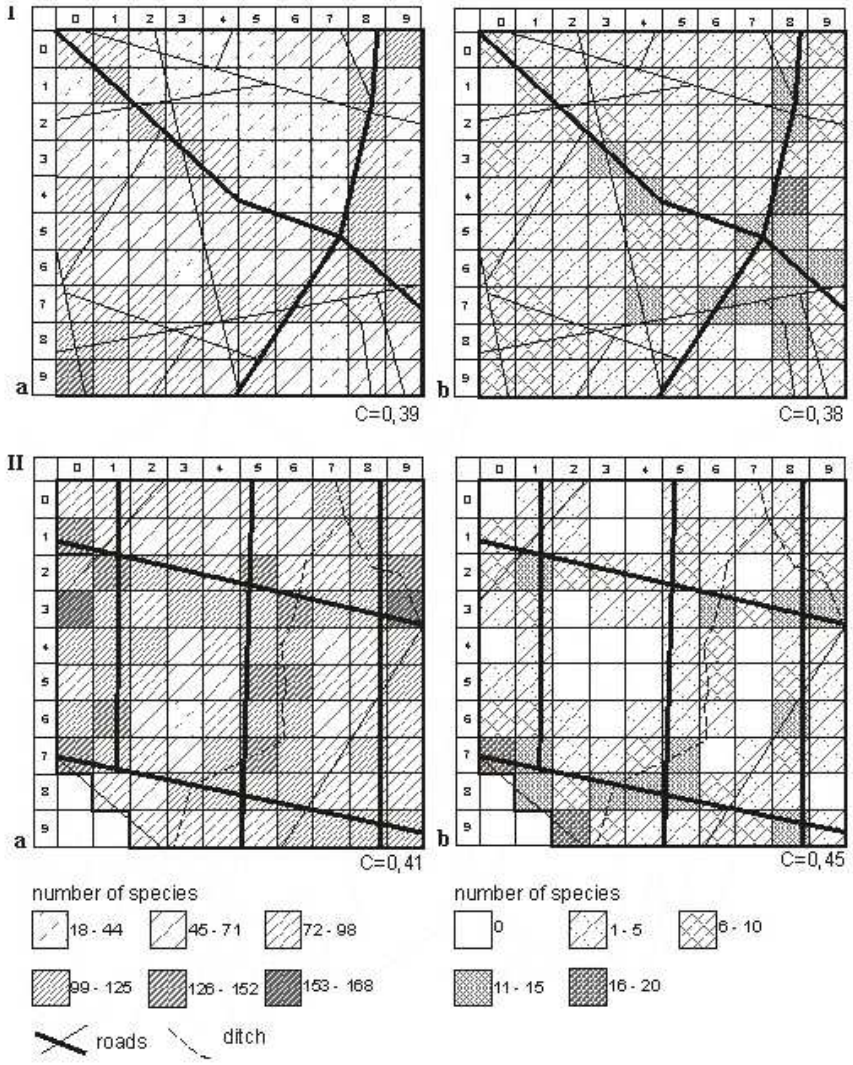

Fig. 3. Influence of the presence of forest roads and nearness of settlements on the species richness (a) and anthropophytes distribution (b) in the areas : I- pine forest *Leucobryo-Pinetum* -ED 5102 square, II- oak-hornbeam forest *Tilio-Carpinetum*-ED 4098 square (grid of 100x100 m).
C – Pearson's coefficient of correlation between the presence of roads or ditches and total number of species > 72 (a**) or number of anthropophytes > 6 (**b**). The permissible range of the coefficient C is: 0≤C<0,71.**

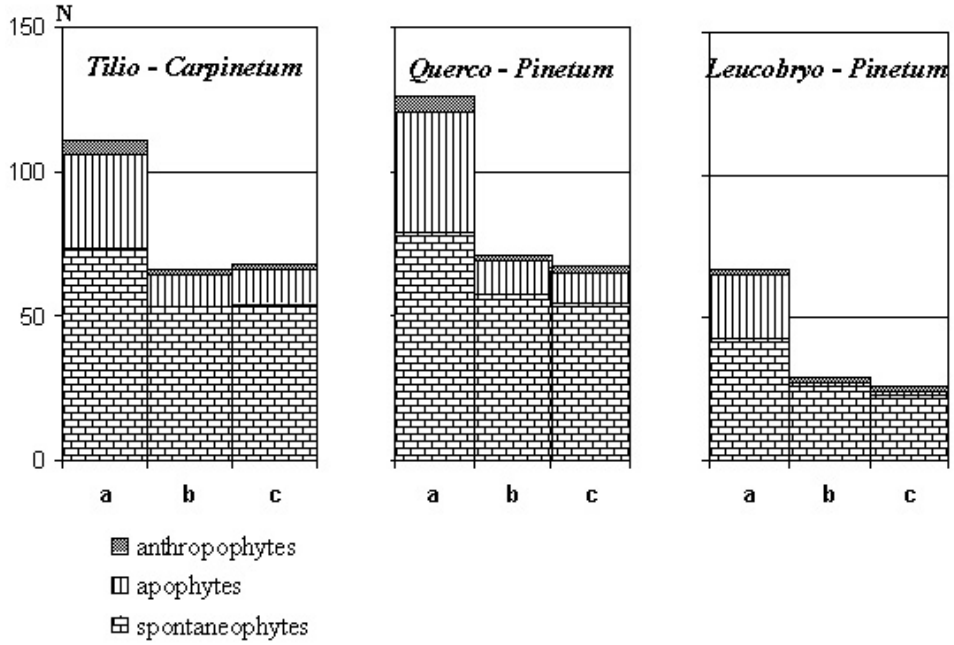

Fig. 4. The participation of geographical-historical groups of species; a, b, c –plots of each transect, N – total number of species.

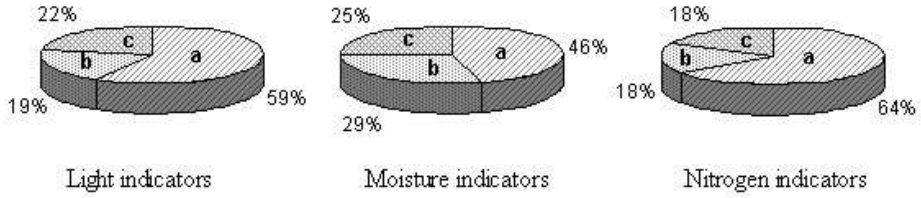

Fig. 5. The participation of syntaxonomical groups of species; a, b, c – as in Fig. 4; N – as in Fig. 4.

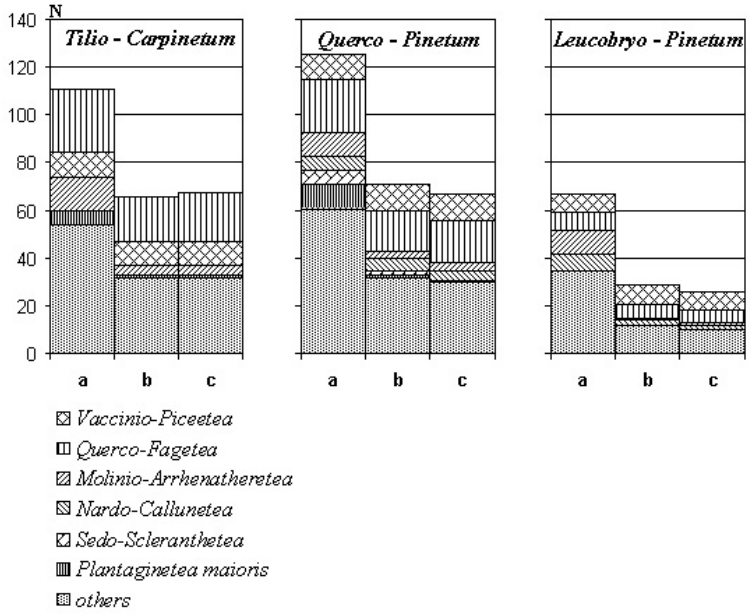

Fig. 6. The percentage participation of ecological groups of species; a, b, c – as in Fig. 4.

Conclusions

There is a relation between the distribution of synanthropic species and the presence of communication routes of different sizes. The number and spread of synanthropic species prove long duration and large intensity of anthropopression in forests. The presence of roads increases species richness and diversity. Forest roads contribute also to the cosmopolitization of plant cover.

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