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Letter to the Editor

Changes of the Sozofloristic Value of Opole Province in Southwestern Poland

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Abstract

The presented work shows a method of evaluating the changes of territorial sozofloristic value which illustrates the effects of anthropogenic pressure on threatened and rare flora of a given area. As a result, a distribution map of the changes of the flora is shown, aiming to support conservation activities within Opole voivodship, e.g. the flora conservation strategy.

The territorial sozofloristic value has been determined in two stages. In the first stage, the species sozofloristic value for a selected group of 302 plant species has been evaluated on the basis of 14 criteria. These were plants considered rare, threatened or protected within the province borders, so-called sozophytes. Then, species sozofloristic values have adequately been summed up on the readily prepared cartogram consisting of 2298 basic squares, thus receiving the territorial distribution of floristic richness of the region. Next, the comparison of the sozofloristic value between two periods, 1806-1944 and 1945-2001 were done. The analysis of characteristic features and reasons of the received distribution has been undertaken, with the particular taking into consideration the territories of the highest changes of the sozofloristic value. The possibilities to use these analyses in regional flora conservation have been presented.

Keywords: environmental changes**,** sozoflora, sozofloristic value, threatened plants, Opole Province, flora conservation

Introduction

In the territory of Opole Province, as in the whole country, the process of changing flora that resulted from human activity began in the neolith. The anthropopression grew in amount together with the increasing number of people, the introduction of new means of cultivation and, finally, beginning at the end of the 18th century, with the ongoing industrial revolution. Natural adapting processes connected with the evolution of organisms could not keep up with swiftly changing external conditions shaped by humans, which gave way to the processes of extinction [7].

The unfavourable changes of flora and withdrawing of its components also occurred in Opole Province. The region of Opole, as part of Silesia, had already undergone intensive development in the 17th and 18th centuries and in the 19th century the ongoing industrialisation and the development of transportation systems completed the range of negative influences. So-called "rational" forest economy and "highly developed" agriculture and especially the change of water regimes connected with them led to considerable impoverishment of the Opole Silesia flora in recent years. The retreating processes of native species of Opole Province can be traced by the analysis of the abundant geobotanic bibliography from the 19th and the beginning of the 20th centuries [e.g. 19, 17, 3].

The main aim of this article is to show the changes of the value of Opole Province sozoflora as an indicator of the biocenotic and environmental long-term alterations. As a sozoflora we consider the group of so-called "red" species, listed on the regional list of threatened vascular

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plants [13]. The name comes from Greek "*sodzein*" which means "rescue", "protect".

Before analyzing the changes, it was needed to work out the original model of valorization of species based on an evaluation system of 14 criteria. The number of locations, the average size of a location, the change in the number of locations, the risk of direct threat, the risk of indirect threat, complicated or handicapped process of reproduction, the phyto-sociological value of species, the registration into the list of protected species of the Washington Convention [18], Bern Convention [1] and Habitat Directive [6], species conservation in Poland [16], the category of endangerment in *The List of Endangered Plants in Poland* [20], relictness and the presence at the range border or in isolated populations were taken into account [12].

One of the basic purposes of work was to situate the historic and presently existing locations of 302 chosen species discovered between 1806-2001 on a cartogram with 2298 basic fields and calculating the changes of sozofloristic value for each of the fields. As an effect, there was a map of the territorial changes of sozofloristic value of the examined area. It became possible to carry out the internal comparative analyses and claiming the regularity and characteristic features typical for the distribution of this value.

Methods

In order to compare qualitatively and quantitatively the floristic data from various research periods, especially pre- and post-war ones, it was necessary to complete the phyto-geographical picture of Opole Province. The field works were carried out in five successive vegetation seasons: the years 1997, 1998, 1999, 2000 and 2001, during which about 1200 new locations of chosen plants were discovered and many literature stands were confirmed.

To show the spatial and qualitative distribution of the sozofloristic value at the research area in the first phase, 302 species were chosen from the group of vanishing plants, for which there is sufficient data necessary to conduct the analysis [13].

Due to the considerable area of analyzed territory (over 8500 km^2), for the outdoor work a selective-systematic method was used [2]. A thorough analyses of historical materials was conducted and then given localities were checked systematically. During fieldwork, habitat and spatial differentiation were considered. The floristic data noted in over 200 publications of phyto-sociology, phyto-geography, biosozology, conservation biology and other fields as well as other available floristic materials, e.g. herbaria, were taken into consideration in this work.

For carting of floristic dates and for the presentation of the results, a map of field quantitative cartogram with proportional class range was used [2]. The ranges were established, taking into consideration the frequency of occurrences so that the frequency would be comparable quantitatively.

For the need of graphical presentation, a map of Opole Province, adequately reformatted to A4 size, scaled 1: 50,000 was used from The National Geodesy-Cartography Authority, according to the "1996 model". It was divided into 2298 squares – basic fields, with a side of 4 cm, which represents 2 km in reality.

The Choice of the Species

The species were chosen on the basis of the analysis of the degree of endangerment and the degree and uniformity of population examining. Also, legal protection was taken into account. While choosing, proportionality of particular groups of endangerment, habitat taxonomy and syntaxonomy were taken into consideration. The basis for estimating the degree of endangerment was the Red List of Vascular Plants of Opole Voivodship [13].

The syntaxonomical classification, biological and species features, range characteristics as well as habitat requirements were established on the basis of works by Oberdorfer [14], Matuszkiewicz [10], Meusel et al. [11].

In total, 302 species (out of about 1700 naturally occurring in Opole Province), representing 74 families, were analyzed, 113 of which fall under legal protection under the decree of Environment Minister from September 11th 2001 [16], 9 protected by Bern Convention and 7 by the Habitat Directive.

In this work such native plants were considered that grow or grew on the territory of today's Opole Province in the 19th and 20th centuries, as well as the archeophytes. Some mistakenly or doubtfully given species, e.g. *Potentilla sterilis*, were left out of account as well as taxons from *Alchemilla, Hieracium, Rosa* and *Rubus* genera because of taxonomical and determination difficulties and lack of comparative data (with the exception of *Rosa gallica*).

The method of species point bonitation was used by Fijałkowski [4] as an element of suggested valorization of swamps and landscape types connected with humid habitats. There was established the floristic richness evaluation model of swamps on the basis of valorization grading scale of 220 endangered species of vascular plants, including 40 of those dying out. The plants, according to the endangerment classification, partly based on the methodology of the Polish red list of vascular plants [20], were divided into 5 groups, depending on endangerment status, with prescribing the appropriate number of points, e.g. *Orchis tridentata* (EX-extinct) – 5 p., *Lindernia procumbens* (E-endangered) – 4p., *Gymnadenia conopsea* (V-vulnerable) – 3p., *Drosera rotundifolia* (R-rare) – 3p., *Achillea ptarmica* (I-indeterminate) – 1p.

After careful analysis of the criteria of evaluation, an attempt to show the values of chosen species of vascular plants occurring on the territory of Opole Province was undertaken. This attempt was based on the point of view of the process of their extinction and their protection in such a way as to make this attempt possibly precise, comparable and accumulative. The agreed name for this value is "sozofloristic value" [12].

It was assumed that, from the point of view of the process of extinction of a given species and the need for its conservation, it is necessary to consider the following criteria while evaluating its sozofloristic value:

1. The present state of the species: the number of locations, average size of a location.
2. The situation of a species in the past: the change in the number of locations.
3. The prognosis of the situation of the species in the future: the risk of direct and indirect threats.
4. The biological risk factors: a complicated or ineffective process of reproduction, the syntaxonomical value of a species.
5. Over regional importance of a species preservation: the registration into the list of protected species of Washington Convention, Bern Convention, Habitat Directive, species protection in Poland, the category of endangerment on *The List of Endangered Vascular Plants in Poland*.
6. The phyto-geographical value: relictness, the occurrence on the border of the range, isolated populations.

Precise methods of species evaluation and estimation of the territorial sozofloristic value are described in literature [e.g. 12]. The resulting range of point scale for the chosen group of species was from 6p for *Corydalis cava* to 79p for *Corallorhiza trifida*.

It only seems to be mentioned that in the first stage of evaluations the species sozofloristic value was established for a group of chosen 302 vascular plants. Then the territorial sozofloristic value were stated separately for the first (1806-1944) and second (1945-2001) periods. Finally, a numerical comparison

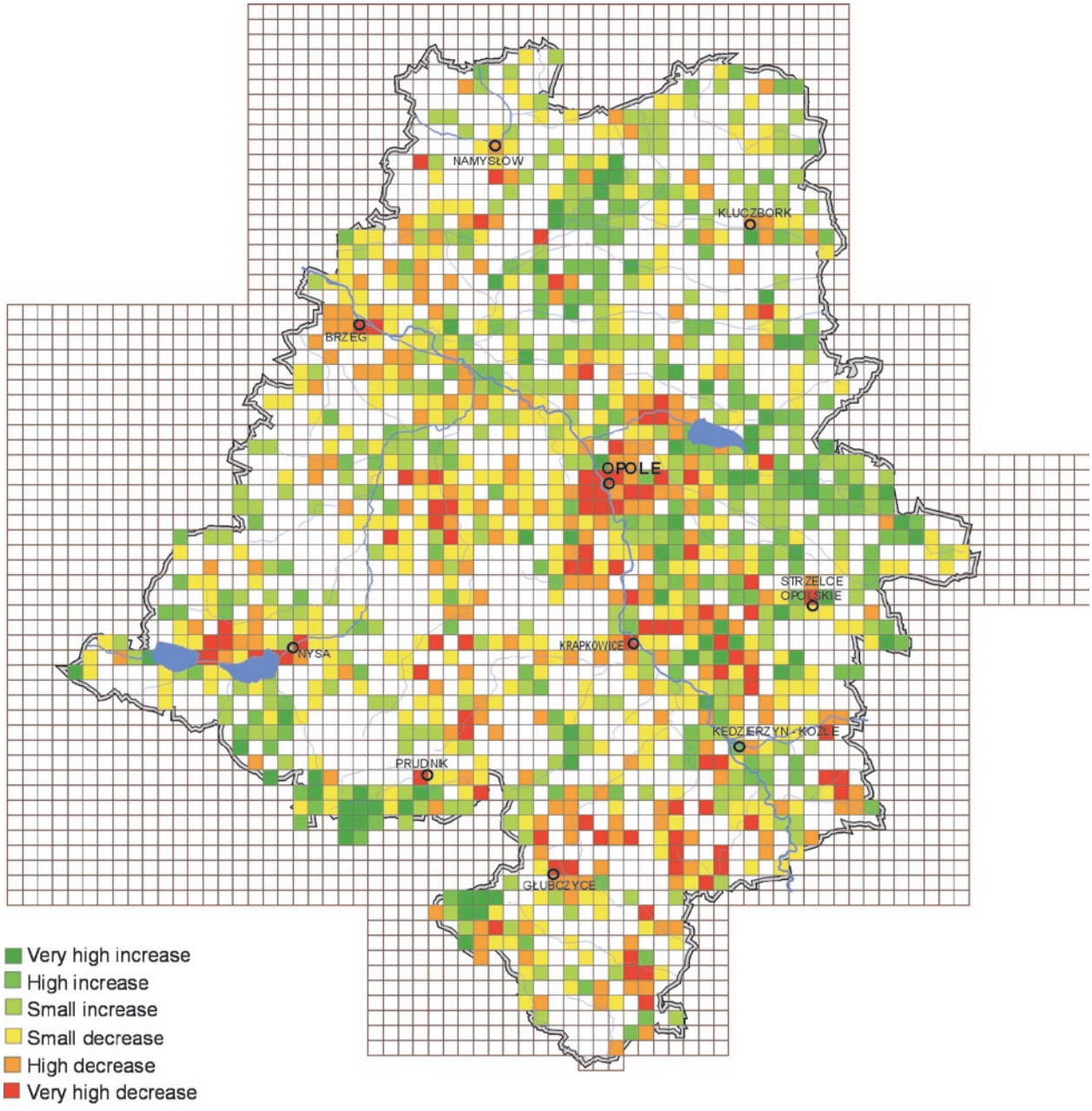

Fig.1. Changes of the sozofloristic value of Opole province.

between those periods aiming to show the distribution of decreases and increases of the analyzed parameters was conducted.

The map has been worked out on the basis of six-range colourful scale of values. The increases were painted green and decreases red. Squares without any values were left white. The intervals were distinguished in accordance with the rule of proportionality of frequency of occurrence. Only the extreme range of the highest values both for increases and decreases was distinguished due to its rank, as a result of cutting out of about 30% of occurrences from the preceding interval.

Thus, the most important area of the highest increases or decreases of the floristic values have been demonstrated.

It should be emphasized, that in the above-mentioned analyses only decreases have scientific and rational value. Increases prove basically only higher intensity of geobotanical investigation within the researched area.

Results

Being based on methodological assumptions, a map of the spatial-qualitative distribution of the changes of the territorial sozofloristic value (Wo) for the whole province was created (Fig. 1). Increases were noted in 512 basic squares and decreases in 643 basic squares. For the whole provincial territory a total sozofloristic value decline of 39040p., or 31.44%, were noticed. In average the sozofloristic value for the basic square diminished 33.8p.

The highest decreases of Wo in a square of the cartogram were noted in:

- Urbanized areas and their close surroundings of Opole, Głubczyce, Niemodlin, Otmuchów, Brzeg, Nysa, Strzelce Opolskie, Krapkowice, Koźle and Biała,
- Intensively cultivated farmlands within Głubczyce Plateau (in this neighbourhood of Gipsowa Hill), Niemodlin Plain, around Brzeg, Osowiec Śląski, Trzęsin, Winów, Korfantów and also in Chełm Upland between Krapkowice, Góra św. Anny and Leśnica,
- Woody areas around Stara Kuźnia, Ligota Fyrlądzka, NW part of the Niemodlińske Forests, around Kup and Głubczyce Forest.

The most significant decreases of Wo in a basic square were noticed in the nature reserve "Nowokuźnicki Pond" (-1216 p.), in Winów (-992 p.), Osowiec (-865 p.), Niemodlin (-791 p.), Gipsowa Hill (-760 p.), Pawłowiczki (-757 p.), Głubczycki Forest (-753 p.), Wronin (-728 p.), Otmuchów (-726 p.), Krapkowice (-680 p.), Pokój (-655 p.), Większyce (-623 p.), Kup (-535 p.) and Trzęsin (-531 p.).

The highest increases were stated in:

- Woody areas of eastern, northern and central parts of Stobrawa-Turawa Forests and in a small territory to the south from Ligota Górna within Chełm Upland,
- Opawskie Mountains, in SE part of Paczków Foothills and in Głogówek neighbourhood,
- Odra River valley on the stretch near Stobrawa and Zdzieszowice, in Nysa Kłodzka River valley near Głębocko and Osiek Grodkowski and in Budkowiczanka River valley between Kamieniec and Szumirad,
- Forest-meadow areas to the SE from Opole.

The highest increases of Wo in a basic square were noticed in Kopa Biskupia Mt (+1111 p.), Długota Mt (+634 p.), Kamieniec (+556 p.), Srebrna Kopa Mt (+524 p.), Nature Reserve "Smolnik" (+517 p.), Czarnocin (+453 p.), Duczów Mały (+399 p.) and Pielgrzymów (+368 p.).

Discussion

The method used in this paper differs considerably from others applied in nature valorization. In the case of flora evaluation from the point of view of nature conservation, the floristic lists, eventually with threat category stated on the basis of IUCN methodology, were used most often [e.g. 9]. While assessing the conservation worth of a given area floristic richness or occurrence of indicating (in this rare, threatened) species is taken into account [e.g. 5, 15]. In the last few years, valorization model based on occurrence of important species is commonly implemented. It was used in delimitation of ecological network system Natura 2000. Not only fact of occurrence of previously indicated species is important in this approach, but also population size and state, geographical isolation, endemism, threat category and overall regional conservation importance. The outcomings of such analyses are sophisticated descriptions, which are unclear and hardly understandable for non professionals. In consequence, it is very hard to answer such easy questions as: which area, which reserve or which Natura 2000 site is more important and has higher value and in which area the anthropopressure has the most severe consequences on nature values. So the comparison of extensive floristic lists or naturalistic description is not an easy approach and gives equivocal answers. But it is important and obligatory in implementation of flora conservation strategy. So the transfer of environmental information to decision bodies in the abovementioned methods could often exceed the capacity of the system and then "information chaos" phenomenon occurs [8]. An attempt to grant the species with adequate point values gives possibilities to compare different areas and different periods and to assign conservation priorities, also for non professionals, e.g. administration staff. The summarized value of the group of species could be also easily presented in spatial distribution inside the border of a given area and the internal comparisons could be conducted (e.g. commune areas or reserves).

Among the territories with the highest values of Wo are uplands and mountain areas of the region that are characterized by diverse geological structure and the presence of limestone rocks at the basis (Chełm Upland and its west foothills, Opole surroundings, Opawskie

Mountains and the southeastern parts of the Paczków Foothills), valleys of middle and small rivers (Mała Panew, Ścinawa Niemodlińska, Prószkowski Potok, and sections of Nysa Kłodzka, Budkowiczanka, Stobrawa and Odra), and the area abundant in fishing ponds of the territory of the towns Niemodlin and Pokój, and the southeastern fragment of Głubczyce Plateau at the mouth of Morawska Gate – the migration trail of southern species. The lowest value of Wo is found on the areas of arable lands (Głubczyce Plateau, Grodków and Oleśnica Plains) forest territories of compact horizontal structure (eastern part of Niemodlińskie Forests) .

The distribution map of the changes of territorial sozofloristic value shows the placement and the abundance of sozophytes taken together and also depicts the response of the most vulnerable flora species to the anthropopressure.

The analyses of the changes of sozofloristic value, especially within the areas of its decrease, seems to be very important and helpful in conservation strategy implementation. The declines seem to be caused most often by intensive agriculture and urbanization processes. The first factor plays a crucial role in the central part of Głubczyce Plateau, where in the last 50-60 years significant structural and ownership transformations in agriculture have taken place. The domination of two State Farms from Kietrz and Głubczyce, known as the most economically effective in Poland, use the newest and technically most advanced cultivation methods, which have deep negative effects upon the environment of these valuable areas. It is clear to see the difference of the sozofloristic value between the areas of intensive agricultural activity in so-called highly developed farming areas (surroundings of Baborów, Głubczyce, Grodków, Korfantów), where the areas owned by big managing units such as National Agricultural Farms and Agricultural Companies have noticed a remarkable decrease of the sozofloristic value, in comparison with areas of parcelled out, small fields, most often owned privately by small family farms, where the sozofloristic value hasn't changed. This kind of less intensive agricultural development is characteristic of northern, central and eastern parts of the Opole region. Among lands of extensive agricultural development one can also rate fishing pond complexes. They are the mainstay for many rare plants and show a high biodiversity ratio with no signs of any negative changes.

Urbanisation processes play a key role in the vanishing flora of the major cities of the region and its close neighbourhood, e.g. Opole, Głubczyce, Niemodlin, Otmuchów. It was not always connected with the expansion of the built-up areas. Common causes of the negative transformations of semi-natural biocenoses were development of the recreational areas, like in Nysa and Otmuchów, changes in function and style of manorial parks and other wooded areas within the cities (e.g. Niemodlin), drainage of the wet areas around the housing departments because of microclimatic nuisances and also anti-flooding undertakings resulting in total destruction of riverside ecosystems (e.g. Opole). However, one can notice, the still remaining relatively high value of urban areas, which is connected with the accompanying urban-developing and industrial processes of creating many wastelands (e.g. quarries, sand lands), or specific habitats of roadsides, parks, ponds and recreational meadows. Specific, mild microclimate conditions of bigger towns are also significant here.

Particularly alarming is the decrease of sozofloristic value within the legally protected areas like landscape parks or even nature reserves. It is apparently perceptible in a strict nature reserve like "Gipsowa Hill" and "Ligota Dolna," and also in partially protected areas like "Nowokuźnicki Pond". Conservation initiatives dated before the 1950s concentrated on strict closing of valuable areas and protection against any human interference brings unexpected and completely reverse effects. This phenomenon has sources also in the weakness of the State Conservation Service and the whole administration supervising the protection system. The scarcity of state financial support gives no possibilities to implement effective conservation management.

In general it could be stated that the territorial sozofloristic value has not decreased within woodlands and mountains. So, one can assume that the decisive role in the distribution of changes of territorial sozofloristic value is played by economic calculation and safety of economic activities of different kinds, especially agricultural, industrial and forest ones. The areas hardly accessible, with no good transportation systems like mountain, upland areas and large forest complexes, are the mainstay for the rarest elements of flora.

Conclusions

Presenting the distribution of changes of floristic richness and natural value on the map seems essential to work out regional strategies of flora conservation. It allows for undertaking strategic actions against the most hazardous processes of human origin. It enables one to establish the priority areas of the greatest interest for nature conservation services and to determine areas of limited use.

Finally, relying on analysis of the reasons for the changes of the territorial sozofloristic value enables one to integrate flora conservation with actions of the range of spatial economy and economic development in order to work out little-harmful methods of managing the natural environment.

Thanks to a simple method of illustrating a summarised value of the changes of rare and endangered flora, floristic worth is readable not only for specialists of botany or conservationists but also for the workers of administration, forest service, spatial plan makers, the executives of environmental impact assessment, and for individuals undertaking economic actions. Nature preservation services of Opole Province have been using the results of the above analyses for some years as the floristic database, but most of all, as a means for active, large-scale and comprehensive conservation of regional floristic resources.

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