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EVALUATION OF ENVIRONMENTAL PREFERENCES OF PLANTS ACCORDING TO FLORISTIC AND PHYTOSOCIOLOGICAL DATA

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ABSTRACT. Two methods useful in floristic and phytosociological data handling are presented, aimed at lending credence to results of studies on attachments of plants to selected environmental conditions.

Key words: biotope preferences, ecological requirements, autecology

Within the framework of floristic and phytosociological research devoted to selected areas large quantities of data are gathered concerning the occurrence of species. Such information may be successfully applied to determine correlations between plants (or plant communities) and selected environmental factors (or factor-complexes) such as altitude, relief form, exposition, inclination, insolation, soil moisture and reaction, hemeroby degree (the measure of human impact on ecosystem) and many others, thereby leading to a better understanding of a species autecology or the community's synecology.

However, a simple percentage participation of the species recordings does not usually reflect its actual attachment to the specific ranges or types of the analysed biotopic variable, because it is to a large extent affected by the non-uniform distribution of locations resulting e.g. from the route of the state border, mountain ranges, valleys or – last but not least – unconscious preferences of the scientist. During my studies on the dendroflora of the Eastern Sudetes I was searching the literature for the efficient method that would make it possible to eliminate the influence of these factors. I did not come across a publication that would solve this problem, although a number of authors were aware of its existence and they applied various descriptive methods to authenticate the achieved results (e.g. **Boratyński** 1991, **Szeląg** 1998). And hence, for example within

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the framework of determining the vertical range of species (which was one of the goals of my study), the results are interpreted in the light of the course of hypsometric curves of a given area or the distribution of the studied localities in specific altitude ranges. These endeavours, however complicated, bring us sometimes closer to the truth about the actual environmental preferences of plants, but they are still hardly effective in comparative research or in calculating the more complex ecological coefficients. In order to account for the non-uniform distribution of sampling locations in relation to the biotopic diversity aspects selected for research I have introduced an "relativized" percentage of locations, which can be useful in any analysis. It depicts distribution of a given species in distinguished types (or ranges) of the analysed environmental factor (biotope variable) in the proportions in which it would occur with the equal number of recordings in each of them.

To illustrate this problem let us assume a hypothetical situation that 90 out of 100 sampling locations were in slopes and 10 in places with concave topographic profile. Let us also assume that the species of our interest had 10 recordings in each of these relief forms. A simple calculation of the percentage share of these biotopes will indicate in this case that the species occurs as frequently in the slopes as it does at concave areas. However, taking into consideration the distribution of all sampling locations, we find out that the species occurred at all locations with concave relief and at only a bit over 11% of slopes. On these basis we may suspect (with the respectively high quantity of data) that the species is actually more attached to the areas with concave relief than to the slopes and its identical share in both relief forms results merely from the significant prevalence of recordings in slopes and not from its actual biotope preferences (similar example in Table 1).

Table 1

Hypothetical comparison of "relativized" and "normal" percentage with the use of an example of four relief forms
Hipotetyczne porównanie „zrelatywizowanego" i „normalnego" udziału procentowego na przykładzie czterech form reliefu

	Relief form Forma rzeźby			
	concave wklęsła	convex wypukła	flat płaska	sloping zbocze
Number of records of particular species Liczba notowań gatunku	10	10	10	10
Number of all examined stands Liczba wszystkich stanowisk	10	100	20	200
"Normal" percentage „Zwykły" odsetek	(10/40) 25%	(10/40) 25%	(10/40) 25%	(10/40) 25%
Finding a common denominator Sprowadzenie do wspólnego mianownika	200/200	20/200	100/200	10/200
"Relativized" percentage „Zrelatywizowany" udział procentowy	(200/330) 61%	(20/330) 6%	(100/330) 30%	(10/330) 3%

To calculate "relativized" percentage of locations, I have applied a simple mathematical operation analogous to that applied in respect of the numerators of fractions brought to a common denominator (within the framework of calculations it is the easiest to operate on the product of the number of all locations in distinguished ranges or on the types of the selected biotopic factor). In this way we obtain the new numerators corresponding to the number of localities in the proportions in which they would occur in case of the equal number of recordings in each of them (Table 1). A mathematical formula for this issue is as follows:

$$St_r(k) = \frac{g_k * \frac{s_1 \cdot s_2 \cdot s_3 \ldots s_n}{s_k}}{\sum_{i=1}^{n}\left(g_i \cdot \frac{s_1 \cdot s_2 \cdot s_3 \ldots s_n}{s_i}\right)} \cdot 100\% = \frac{g_k}{s_k \cdot \sum_{i=1}^{n}\frac{g_i}{s_i}} \cdot 100\%$$

$$St(k) = \frac{g_k}{\sum_{i=1}^{n} g_i} \cdot 100\%$$

where:

- $St_r(k)$ – "relativized" percentage of locations of a given species in k range or type of the biotopic variable;
- $St(k)$ – "normal" percentage of locations of a given species in k range or type of the biotopic variable;
- $g_1, g_2, g_3, \ldots, g_n$ – number of occurrences of the species in the distinguished n ranges or types of the biotopic variable;
- $s_1, s_2, s_3, \ldots, s_n$ – number of all positions in distinguished n ranges or types of the biotopic variable;
- g_k – number of recordings of a given species in k range or type of the biotopic variable;
- s_k – number of all locations in k range or type of the biotopic variable.

In the majority of cases I include both the "relativized" and the "normal" share of locations. The former characterises the preferences of the species better, however, the latter – assuming that the distribution of locations is close to random – is more precise in reflecting the conditions of occurrence of a species in a given area in which specific biotope types may prevail.

As an example how this method works in practice can serve the occurrence conditions of Norway spruce in the Polish part of the Eastern Sudety Mts. (Fig. 1). Percentage shares in analysed biotopic factors reflect a rather natural differentiation of this area than result from environmental preferences of *Picea abies*. The "relativized" percentage distribution is much more even, which can be easy explained by anthropogenic influence – Norway spruce is the most common tree in this area, widely planted and cultivated in various types of habitats.

An additional procedure that may be useful during "extraction" biotope preferences for selected species is to disregard the locations in which it occurs individually or in small numbers (Fig. 2) – they are often accidental and/or short-lived. The abundance of species in a sampling location constitutes mainly the result of their biological properties

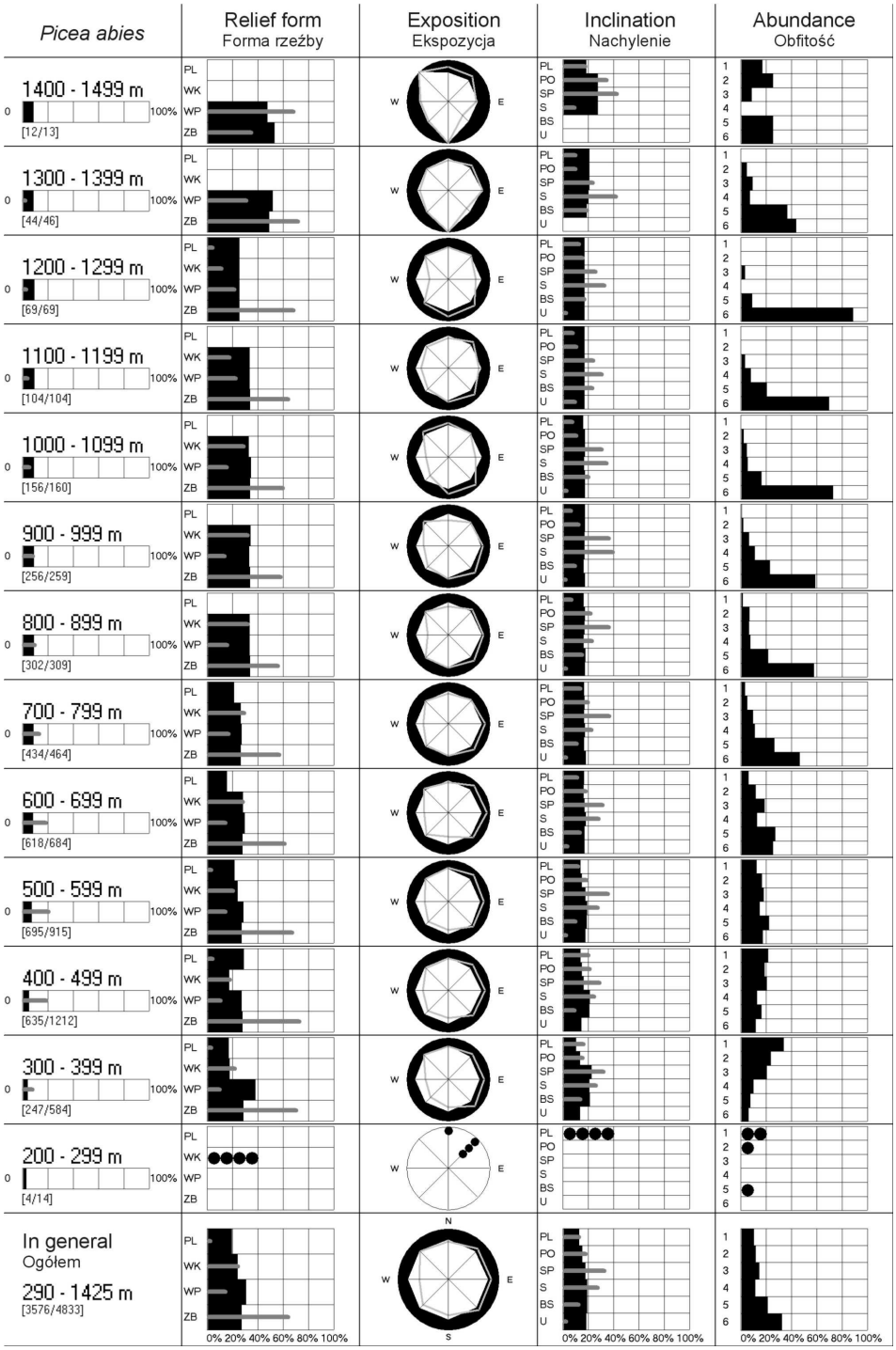
Picea abies
Relief form
Forma rzeźby
Exposition
Ekspozycja
Inclination
Nachylenie
Abundance
Obfitość
1400 - 1499 m
[12/13]
1300 - 1399 m
[44/46]
1200 - 1299 m
[69/69]
1100 - 1199 m
[104/104]
1000 - 1099 m
[156/160]
900 - 999 m
[256/259]
800 - 899 m
[302/309]
700 - 799 m
[434/464]
600 - 699 m
[618/684]
500 - 599 m
[695/915]
400 - 499 m
[635/1212]
300 - 399 m
[247/584]
200 - 299 m
[4/14]
In general
Ogółem
290 - 1425 m
[3576/4833]
PL
WK
WP
ZB
PO
SP
S
BS
U
N
W
E
S
0
100%
0% 20% 40% 60% 80% 100%

Fig. 1. Occurrence conditions of *Picea abies* (L.) H. Karst. in the Polish part of the Eastern Sudety Mts. (**Kosiński** 2001). First column – proportional frequency of observations in 100-meters altitude layers. Relief form – percentage share of observations in relief forms: PL – flat, WK – concave, WP – convex and ZB – sloping. Exposition – percentage share of observations in geographical directions (r = 50%). Inclination – percentage share of observations in classes of inclination: PL – 0-5º, PO – 6-10º, SP – 11-20º, S – 21-30º, BS – 31-45º, U – 46º and more. Abundance – percentage share of observations in classes of abundance: 1 – 1-3 specimens, 2 – 4-9 specimens, 3 – 10-20 specimens, 4 – 21-50 specimens, 5 – 51-100 specimens, 6 – more then 100 specimens. If the number of observations is below 11, then they are marked as black circlet. Black bars and black part of circles signify "relativized" percentage, while grey lines – "normal" percentage

Ryc. 1. Warunki występowania świerka pospolitego w polskiej części Sudetów Wschodnich (**Kosiński** 2001). Pierwsza kolumna (pod nazwą gatunkową) – zasięg pionowy i procentowy udział w stumetrowych pasach wysokości; Forma rzeźby – liczba stanowisk w podstawowych typach reliefu, w podsumowaniu (ostatni wiersz) procentowy udział: PL – równinny, WK – wklęsły, WP – wypukły i ZB – zboczowy; Ekspozycja – liczba stanowisk o określonych wystawach w podstawowych i pośrednich kierunkach geograficznych, w podsumowaniu procentowy udział (zacieniona część koła, r = 50%); Pochylenie – liczba stanowisk w wyróżnionych klasach nachylenia zboczy, w podsumowaniu procentowy udział: PL – płasko (0-5º), PO – pochyło (6-10º), SP – spadziście (11-20º), S – stromo (21-30º), BS – bardzo stromo (31-45º), U – urwiście (46º i więcej); Obfitość: 1 – pojedynczo (1-3 okazy), 2 – nielicznie (4-9 okazów), 3 – dość licznie (10--20 okazów), 4 – licznie (21-50 okazów), 5 – bardzo licznie (51-100 okazów), 6 – pospolicie (powyżej 100 okazów). Czarne kółka zastosowano, gdy obserwacji było 10 lub mniej. Na wykresach słupkowych i kołowych zaczernione części oznaczają „zrelatywizowany" udział procentowy, natomiast szare linie – „normalny"

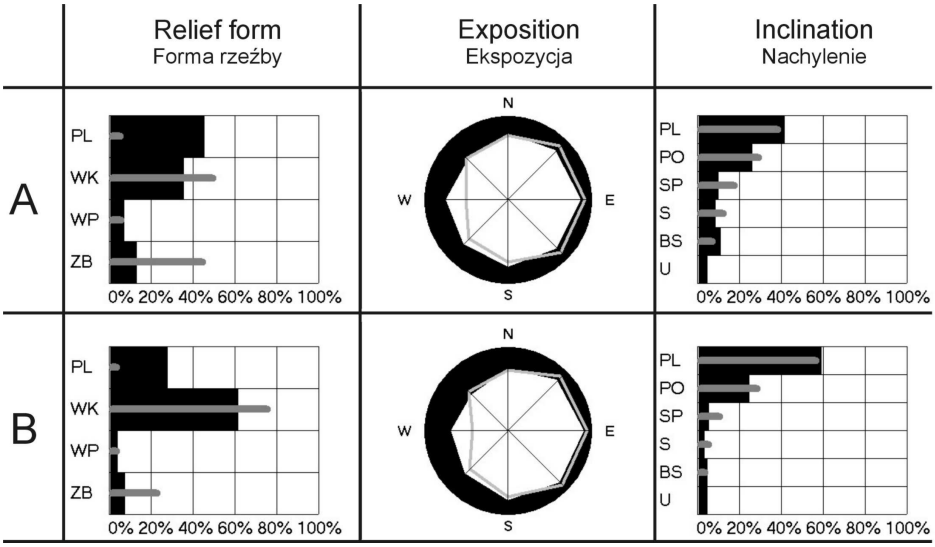

Fig. 2. Occurrence conditions of *Prunus padus* L. in the Polish part of the Eastern Sudety Mts.: A – all locations with this species, B – only most abundant stands with more than 20 specimens (other explanations see Figure 1)

Ryc. 2. Warunki występowania czeremchy pospolitej w polskiej części Sudetów Wschodnich: A – wszystkie notowania tego gatunku, B – notowania, w których występowało co najmniej 20 okazów (inne objaśnienia jak na rycinie 1)

and the conditions of the environment in which they live (we do not take into consideration random incidents or human interference which significantly disturb the picture). Assuming that biological properties are fixed for a given species, its abundance of occurrence in various biotopes may be applied as one of the components for evaluation of their ecological requirements.

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WYZNACZANIE EKOLOGICZNYCH PREFERENCJI GATUNKÓW NA PODSTAWIE DANYCH FLORYSTYCZNYCH I FITOSOCJOLOGICZNYCH

S t r e s z c z e n i e

Przedstawiono dwie metody pomocne w ustalaniu i uwiarygodnianiu stopnia przywiązania gatunków do wybranych warunków siedliskowych na podstawie zgromadzonych danych florystycznych lub fitosocjologicznych.

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