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The occurrence and variation of *Centaurea oxylepis* (Wimm. & Grab.) Hayek in the Silesian Beskid

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Abstract: Results of preliminary studies on habitat requirements and morphological variation of *Centaurea oxylepis* are presented. The studies were carried out in the Silesian Beskid (West Carpathians). Fifteen populations were chosen for studies on morphological variation of the species. 28 traits of each specimen were analyzed using 1-Way ANOVA and G-test. The cluster analysis separated populations into two groups: one associated with southern slopes, other associated with northern and eastern slopes. 11 traits differentiated populations in statistically significant way. However, ranges of traits variation overlapped in majority of populations. The highest differentiation is evidenced in relation to: plant height, 1st-order ramifications number and the longest ramification length. Populations characterized by similar ranges of trait values were located on slopes similarly exposed. Probably, the morphological variation is caused only by habitat and climatic conditions.

Key words: *Centaurea oxylepis*, variation, taxonomy, montane species

1. Introduction

Centaurea oxylepis plays a special role in taxonomic studies on representatives of the *Centaurea* L. genus, the *Jacea* (Miller) Hayek (Dostal 1976) subgenus which occurs in Poland. Diagnostic features of the species described for the first time in *Flora of Silesia* (Wimmer & Grabowski 1829) are as follows: lack of or residual pappus on fruits, mid-appendages of involucral bracts lanceolate or triangle-lanceolate, regularly fimbriate, with arcuate or recurved top. Its primary distribution is limited to the Sudeten and the Carpathians only (Hayek 1918; Dostal 1976), where it occurs in the lower montane zone, rarely in the dwarf-pine zone (in the Tatra Mts. up to 1800 m a.s.l.) (Mądalski & Ciaciura 1972). In Polish flora, it was included into the group of montane species which has numerous localities in lowlands (Zając 1996). Due to its uncertain origin it is treated as a critical species.

Morphological variation of the species, observed during the field studies, caused the author to take up more detailed research. The main aim of the studies was the determination of *Centaurea oxylepis* range variation; then an attempt in order to establish its causes was made. An additional objective was to determine spectrum of habitats and plant communities, in which populations of the described species occurred. Investigation had an initial character and was conducted within one mountain massif – the Silesian Beskid – a part of the West Beskids which ends the Carpathians arch. The highest points are: Skrzyczne (1257 m a.s.l), Barania Góra (1214 m a.s.l) and Małe Skrzyczne (1211 m a.s.l.). This is strongly exploited area due to its dense network of tourist routes and increasing urbanization.

2. Material and methods

15 populations of *Centaurea oxylepis* were chosen for biometrical studies. They were localized in various parts of the Silesian Beskid (Table 1). Then, 3-9 specimens (blooming shoots) were collected from each population. These represented possible complete traits variation within the population.

Each specimen was analyzed in relation to the following traits: 1 – shoot height; 2 – ramification type; 3 – 1st order ramifications number; 4 – shoot and the lowest ramification height ratio; 5 – the longest ramification length; 6 – shoot colour; 7 – the way of inflorescences blooming (simultaneous or sequential); 8 – upper leaves shape; 9 – upper leaves margins shape; 10 – underside

leaves hair; 11 – middle leaves shape; 12 – middle leaves margins shape; 13 – lobes number from one side of leave; 14 – middle leave base; 15 – middle leaves structure (petiolate, sessile); 16 – length and width ratio in leave blade of middle leave; 17 – presence and hair type of middle leaves underside; 18 – upper part shoots hair; 19 – blooming head diameter; 20 – the ratio of involucral bracts height to width; 21 – margin type in top parts of middle appendages; 22 – the way of the bracts appendages bending; 23 – rows number of internal involucral bracts; 24 – involucral bracts colour; 25 – involucral bracts appendages tops colour; 26 – the visibility of bracts from behind the appandages; 27 – heads type of distribution on shoots; 28 – pappus presence.

Table 1. Characteristics of analyzed populations

No.	Location	Exposition	Altitude (a.s.l.)	Number of specimens
1	Ustroń Zawodzie	W	480 m	6
2	N od Lalików	S	620 m	5
3	Koniaków Ochodzita	N	846 m	5
4	Stara Godziszka	SE	580 m	3
5	Szczyrk Skalite	N	640 m	9
6	Słotwina	E	520 m	6
7	Orłowa	SW	780 m	3
8	Kamesznica Złatna	SW	600 m	6
9	Szczyrk Gronik	N	800 m	5
10	Ustroń Polana	N	500 m	5
11	Szczyrk Malinów	NE	700 m	4
12	Równica	SW	800 m	4
13	Przełęcz Kubalonka	W	761 m	6
14	Istebna	N	644 m	5
15	W od Buczkowic	E	500 m	7

The similarity of analyzed populations was determined using cluster analysis (minimal variance method, Euclidean distance) by means of MVSP 3.0 software package. In order to test significance of differences between populations in particular traits 1-Way ANOVA for variables expressed in interval scale and G-test for categoric data (presence/absence) were applied (Sokal & Rohlf 1995). All statistics were calculated using STATISTICA 5.1 (StatSoft 1997) and SAS (SAS. 2002, 2003).

Furthermore, habitat types were noted and either phytosociological relevés were taken or lists of species accompanying *Centaurea oxylepsis* were compiled.

3. Results

3.1. Morphological variation

As a result of cluster analysis two groups of specimens were distinguished (Fig. 1). Almost all individuals from populations: 2, 4, 7, 8 and 12 were gathered in group 1,

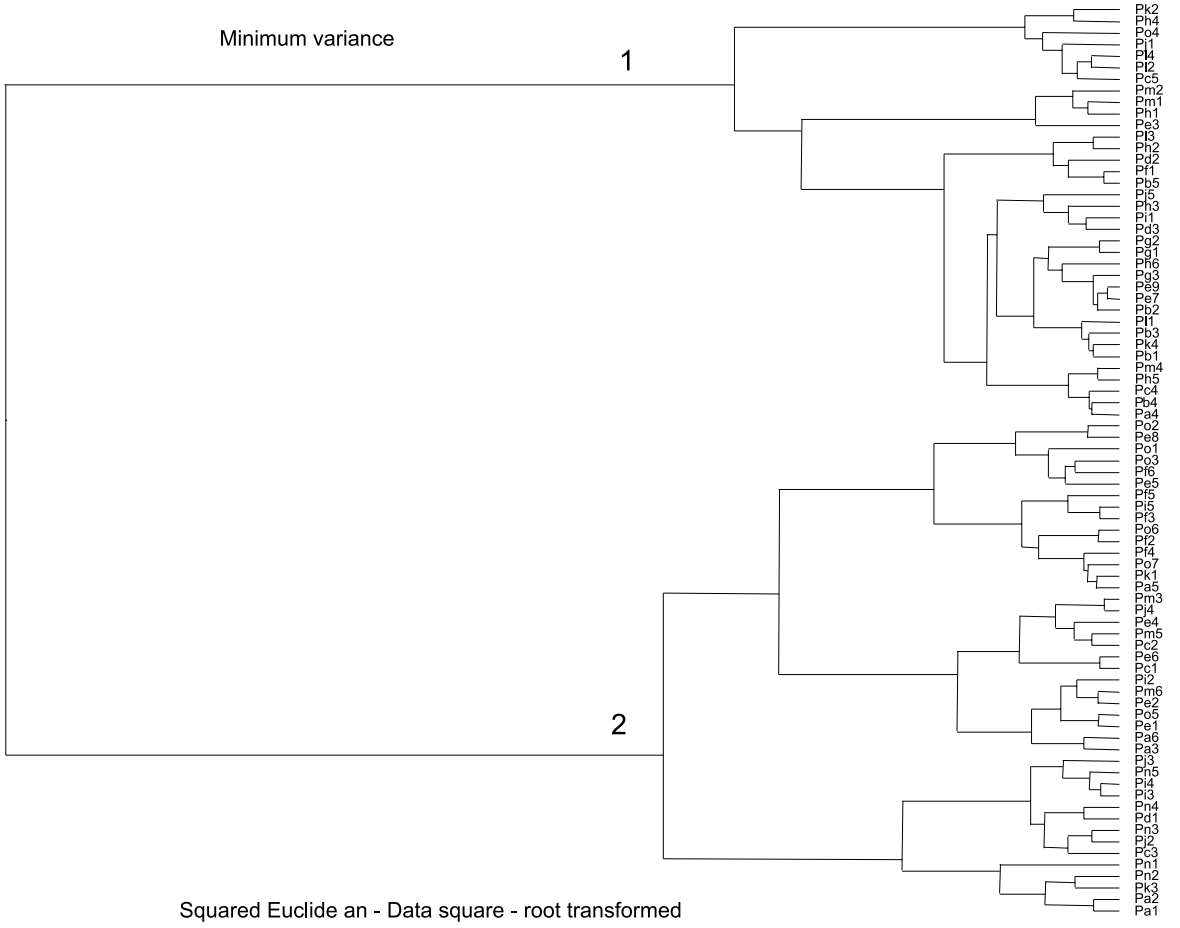

Fig. 1. The similarity of populations on the base of analyzed traits
Explanations: 1, 2 – two groups of indyviduals of analyzed populations; the number of population and number of specimens from each population (in brackets) is given; 1: 1(1), 2(5), 4(2), 5(3), 7(3), 8(6), 10(3), 11(2), 12(4), 13(3), 15(2); 2: 1(5), 3(5), 4(1), 5(6), 6(6), 7(3), 9(5), 10(2), 11(2), 13(3), 14(5), 15(5)

while specimens from 1, 3, 5, 6, 14 and 15 populations aggregated in group 2. Furthermore, specimens from populations 10, 11 and 13 were equally clustered in these two branches. The first group of populations was located mainly on S and SW slopes, but second group on N and NE slopes.

ANOVA and G-test showed that 11 traits differentiate the populations (Table 2). The ranges of traits variation revealed as statistically significant were considerably wide and overlapping within the most of the studied populations. The populations are the most varied in respect to: the plant height (trait 1), the ramifications number (3) and the longest ramification length (5). In most cases, populations which specimens were characterized by: lower height, smaller number of ramifications of 1st order as well as shorter ramifications (i.e. populations 2, 4, 7, 8, 12) were located on southern slopes. The other statistically significant traits do not considerably differentiate populations studied. Only in the case of trait 2 (ramifications type), its value was significantly higher in the population no. 14 in comparison with the others. Similar situation can be observed during analysis of 19 trait (blooming head diameter). The higher value of this variable was observed in populations 1 and 12. Diagnostic traits (21, 22, 28) revealed similar range of variability within the populations studied and they were not statistically significant.

Table 2. Results of ANOVA and G-test

Variable (trait)	Statistics*	Probability
1	F= 4.044306	<0.001
2	F= 2.421778	<0.01
3	F= 2.440979	<0.01
5	F= 3.348979	<0.001
16	F= 1.995624	<0.05
17	F= 3.193698	<0.001
19	F= 2.249325	<0.05
20	F= 2.249325	<0.05
7	G= 31.834	<0.01
24	G= 34.237	<0.01
26	G= 48.536	<0.001

*only the values below 0.05 level of probability are given in the table

3.2. Habitats and plant communities

Centaurea oxylepis is phytosociologically classified as a characteristic species for the *Gladiolo-Agrostietum* association which includes eutrophic mowed meadow communities in the montane zone of West Carpathians (Matuszkiewicz 2001). *Centaurea oxylepis* the most frequently occurred in meadows of various wetness and different type of management. In most cases these were neglected meadows. In these plant communities the following species were dominants: *Agrostis capillaris*, *Phleum pratense*, *Alchemilla gracilis, Lotus corniculatus.* Some patches had similar composition to *Gladiolo-Agrostietum,* but they were always scarce in species (Table 3). Moreover, meadows located in the vicinity of transportation routes were penetrated by common anthropophytes as e.g. *Solidago canadensis.* Populations of the species analyzed were encountered in man-made habitats characterized by water deficiency such as: railway ground, roadsides, wastelands. *C. oxylepis* was quite rarely and not abundantly found in thickets along streams.

4. Conclusions

Cluster analysis revealed two groups of populations. The first one is associated with southern slopes and the second one – with northern and eastern slopes.

11 traits (out of 28 analyzed) significantly varied among populations studied. This was confirmed by the results of statistical data processing. However, ranges of variation overlapped. The highest differentiation was observed in the case of 3 traits only: shoot height, 1st order ramifications number and the longest ramification length.

Taking into account similar values of specific trait among populations occurring in similar conditions, one can suppose that morphological variation of *Centaurea oxylepis* is caused probably by habitat and climatic conditions. However, this problem needs further studies involving larger sample and comparative research with populations from the other mountain regions and from Polish lowlands.

Centaurea oxylepis the most frequently occurs in meadows with *Agrostis capillaris* and the most rarely – in thickets along streams or paths.

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Table 3. Selected meadow patches with *Centaurea oxylepis*

Successive no of relevé	1	2	3	4	5	6	7	8	9	10	
Population no in table 1	1	3	4	5	6	8	9	10	13	15	
Date	9.07. 2005	5.07. 2005	5.07. 2005	5.07. 2005	12.08 2004	9.07. 2005	29.07. 2004	12.08. 2004	29.07 2004	9.07. 2005	Constancy
Exposition	W	N	SE	N	E	SW	N	N	W	E	
pH (5-12 cm)	5.0	5.5	5.5	5.0	5.0	5.0	5.0	5.0	5.0	5.5	
Cover of layer c [%]	100	100	90	95	100	90	90	95	90	100	
Relevé area [m^2]	20	20	20	15	15	25	12	15	10	20	
Number of species in relevé	25	27	28	11	22	21	14	27	18	23	
Centaurea oxylepis	3.2	3.2	2.2	3.2	3.3	3.3	2.2	2.2	2.2	3.2	V
Ch. O. *Arrhenatheretalia elatioris* + Ch. All. *Arrhenatherion elatioris**											
Lotus corniculatus	1.2	1.2	+	.	1.2	+	+	+	1.2	1.2	V
Achillea millefolium	+	+	+	+	1.1	+	r	+	.	+	V
Dactylis glomerata	1.2	.	.	1.2	2.2	.	1.2	.	.	1.2	III
Leucanthemum vulgare	.	+	+	.	+	1.2	.	+	.	.	III
Heracleum sphondylium	.	1.2	.	.	+	.	.	+	1.2	.	II
Daucus carota	+	.	.	.	+	+	r	.	.	.	II
*Galium mollugo**	.	1.2	+	.	.	+	.	+	.	.	II
*Arrhenatherum elatius**	.	.	+	.	1.2	.	.	.	.	1.2	II
*Campanula patula**	.	.	+	.	1.2	.	.	.	.	+	II
Ch. Cl. *Molinio-Arrhenatheretea*											
Agrostis capillaris	2.2	.	2.2	3.2	2.2	2.2	3.3	2.2	2.2	2.2	V
Phleum pratense	1.2	+	+	1.2	1.2	1.2	1.2	1.2	.	+	V
Ranunculus acris	r	+	r	r	.	.	r	+	+	.	IV
Cerastium holosteoides	.	+	+	r	+	+	.	+	.	+	IV
Poa pratensis	.	.	.	+	1.2	.	1.1	1.1	.	1.2	III
Vicia cracca	1.2	.	+	.	+	.	+	1.2	.	+	III
Stellaria graminea	+	+	+	.	.	+	.	1.1	.	+	III
Alchemilla gracilis	1.2	.	1.1	.	.	1.2	.	2.2	.	1.2	III
Trifolium pratense	.	.	+	.	+	+	.	+	+	.	III
Potentilla erecta	+	.	+	.	.	.	+	+	+	.	III
Leontodon autumnalis	.	+	+	.	.	+	+	.	.	+	III
Lysimachia vulgaris	.	.	1.1	+	1.2	.	.	.	.	1.2	II
Lathyrus pratensis	+	.	+	.	.	1.2	.	+	.	.	II
Rumex acetosa	.	+	+	.	+	.	.	.	.	+	II
Plantago lanceolata	1.2	.	.	.	.	.	.	+	+	.	II
Prunella vulgaris	+	.	+	.	.	.	.	.	+	.	II
Veronica chamaedrys	.	+	r	.	.	.	.	+	.	.	II
Leontodon hispidus subsp. *hastilis*	.	+	.	.	.	+	.	+	1.2	.	II
Cynosurus cristatus	.	1.2	+	.	.	.	.	.	+	.	II
Linum catharticum	+	.	.	.	.	+	.	.	+	.	II
Other species:											
Hypericum perforatum	1.2	.	1.1	.	.	1.2	.	+	1.2	.	III
Holcus mollis	1.2	1.2	.	.	.	.	.	.	.	1.2	II
Thymus pulegioides	.	1.2	.	.	.	1.2	1.2	.	.	.	II

Sporadic species: Ch. O. *Arrhenatheretalia elatioris* + Ch. All. *Arrhenatherion elatioris*:* *Crepis biennis* 5 (+), 8 (r); *Carum carvi* 3 (+); *Knautia arvensis** 3 (r); *Rhinanthus serotinus* subsp. *serotinus* 8 (+); *Taraxacum officinale* 1 (+); **Ch. Cl. *Molinio-Arrhenatheretea*:** *Angelica sylvestris* 3 (1.2), 13 (1.2); *Carex hirta* 1 (r), 3 (+); *Cirsium palustre* 4 (1.1), 13 (1.2); *Centaurea jacea* 13 (+), 15 (+); *Deschampsia caespitosa* 4 (2.2), 13 (2.2); *Euphrasia rostkoviana* 3 (+); *Festuca pratensis* 1 (+), 10 (+); *Festuca rubra* 10 (+); *Holcus lanatus* 4 (1.2); *Juncus tenuis* 3 (+); *Pimpinella saxifraga* 3 (+), 8 (+); *Potentilla anserina* 1 (+); *Potentilla reptans* 1 (r); *Rumex crispus* 1 (+), 4 (r); **Other sporadic species:** *Acer pseudoplatanus* (seedling) 10 (r); *Anthoxanthum odoratum* 15 (+); *Carex pallescens* 10 (1.1), 13 (+); *Chaerophyllum aromaticum* 6 (r), 9 (r); *Cirsium arvense* 6 (r); *Equisetum arvense* 1 (r); *Galeopsis tetrahit* 15 (r); *Hypericum maculatum* 5 (+); *Libanotis pyrenaica* 3 (+); *Rosa canina* 4 (r), 8 (r); *Rubus idaeus* 5 (r); *Rumex obtusifolius* 15 (r); *Senecio ovatus* 3 (+); *Solidago canadensis* 15 (1.2); *Tanacetum vulgare* 6 (+), 15 (+); *Urtica dioica* 10 (+); *Vicia sepium* 6 (+)