Variability of ventral scales in polish populations of *Conocephalum conicum* (L.) Dum. (Hepaticae, Marchantiales)

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(Received: August 14, 1978)

Abstract

Samples taken from 6 natural populations of the liverwort species *Conocephalum conicum* were cultivated in a glasshouse and the variability of 9 ventral scale characters was studied in them.

Genetic differences were discovered between population samples but all the attempts to correlate them with the geographic distribution and/or habitat ecology have failed so far.

INTRODUCTION

Conocephalum conicum belongs to widespread Polish liverwort species. Its geographical area covers the whole country from North Polish Lowlands till the mountains in the South where it grows copiously in forest belts (mainly in the lower forest belt, but it can be found even at higher elevations, max. in the Tatry Mts. 1900 m a.s.l.).

At the same time its ecological amplitude is rather narrow throughout the area: it grows in humid and wet shady places frequently along streams where the soil is neutral or only slightly basic (the plant is a neutrophyte in Poland). Along with the ecological uniformity, the plants seem, at least at the first glance, very similar throughout the country (and the same is true for its whole geographical area).

As it has been shown recently (Krzakowa, Szweykowski, in press) there exists a substantial amount of genetical variability even in morphologically uniform hepatic species, and because hepatics are notorious for their enormous morphological plasticity it becomes evident that to know the genetical part of the variability special methods should

This study was supported by the Polish Academy of Sciences, grant MR II/6.

be used. The comparative cultures in possibly homogenous environment give usually good results (Jones and Wilkins, 1971; Szweykowski, Krzakowa, 1969; Krzakowa, 1972). To reduce the differential influence of variable environmental factors we decided to measure the variability of various characters of ventral scales. These are hyaline, delicate, one-layered structures located on the ventral side of the thallus — in growing plants they are, then, situated between the substrate (soil, rock) and the thallus. As *Conocephalum* grows usually tightly adpressed to the substrate the ventral scales live in a very stable environment: there is always very high humidity and practically no light. Then, the two most potent modificatory factors in liverworts i.e. air humidity and light intensity can be neglected here.

MATERIAL AND METHODS

Random samples from six natural population were taken and at least 40 thalli were put on wet turf in the glasshouse. The samples came from following stations:

1. Sample no. 0276: Diabli Skok Reserve, district Piła, leg. J. Szweykowski 5.VI.1976.
2. Sample no. 0376: Tatry Mts., Kotlinowy Wierch in a road ditch, 1200 m, leg. J. Szweykowski 15.VI.1976.

Fig. 1. Geographical distribution of populations sampled. The most similar ones are connected by heavy lines. The joining occurred according to generalised (Mahalanobis') distance matrix. The percent of colour-less or coloured ventral scales are also given

0276/g

Fig. 2. Diagram showing the technique of ventral scale measuring

3. Sample no. 0476: Wolin Island (Baltic Sea) by Lubin village, leg. M. A. Bobowicz and W. Prus-Głowacki 22.VI.1976.
4. Sample no. 0776: Banks of Wąwóz Homole ravine, Pieniny Mts., leg. M. A. Bobowicz 8.VII.1976.
5. Sample no. 0876: Banks of a small stream by Ochotnica Górna village, Gorce Mts., leg. M. A. Bobowicz 10.VII.1976.
6. Sample no. 0976: wet places along a stream by Zawoja-Policzne village Beskid Wysoki Mts., leg. M. A. Bobowicz 9.VII.1976.

Samples nos. 1 and 3 come from North Polish Lowlands, the rest of them from the mountains (Fig. 1).

Thalli were grown on separate (but adjacent) blocks measuring 50×100 cm for about three months. Then 30 thalli were taken randomly from each block. Ventral scales were prepared under a dissecting microscope, made semipermanent and then drawn on a sheet of paper. Every scale was characterised according to following traits (see Fig. 2).

1. Width of the scale base
2. Length of the scale
3. Maximal width of the upper part of the scale
4. Length of the upper part of the scale

5. Width of the scale between upper and lower parts
6. Number of elongated cell layers at the scale margin
7. Maximal cell length in the upper part of the scale
8. Number of oil body cells in the upper part of the scale
9. Colour of the scale (violet-brown or hyaline).

The data (except those of the trait no. 9) were sent to Computer Center of the Agricultural Academy in Poznań for processing. Correlations between traits, multivariate analysis of variance (Manova), principal components and generalised distance (Mahalanobis' distances) were computed.

RESULTS

a. Correlation analysis. As it can be seen from the correlation diagrams (Fig. 3) there are two types of them differing in the behaviour of the trait no. 7 (i.e. maximal cell length in the upper part of the scale). This trait is usually not correlated with any other (populations nos. 0276, 0376, 0976) or shows very little correlation (population no. 0776). But, in two populations no. 0476 from the Wolin Island and no. 0876 from Gorce Mts. the maximal cell length is highly correlated with nearly all other traits. Similarly there are two types of populations differing in their hierarchy of correlation coefficients as shown on graphs (Fig. 4).

Fig. 3. Diagrams showing the correlations between particular traits in all six populations investigated. Lines connecting particular trait (numbers on the margin) denote highly significant (thick ones) and significant (thin ones) correlations between them

Fig. 4. Dendrograms showing the results of clustering the particular traits according to their mutual correlations

b. Multivariate analysis of variance (MANOVA). As the general hypothesis stating that there are no significant differences between population means was rejected, three groups of particular hypotheses were tested.

b1. The hypotheses stating that there are no significant differences between means of particular traits for all comparisons taken together. All 8 hypotheses of this kind were rejected; it means that all traits used in the present work are important in that they all give non redundant information for the description of variability.

b2. The hypotheses stating that there are no significant differences between means of particular traits in each of 15 possible comparisons. Only one hypothesis of this group was confirmed (there are no significant differences between populations 0476 — Wolin — and 0776 — Tatry Mts. — in all 8 traits investigated). The rest (i.e. 14) of hypotheses of this group were rejected. It means that all populations sampled (excepting those from Wolin — 0476 and Tatry — 0776) are statistically significantly different.

Table 1
Conocephalum conicum MANOVA
 Critical value JF=13,017

Comparison \ Trait	1	2	3	4	5	6	7	8
0276-0376	—	—	—	+	+	+	+	—
0276-0476	+	+	+	+	+	+	+	+
0276-0776	+	+	+	+	+	+	+	+
0276-0876	—	—	—	+	+	—	+	—
0276-0976	—	—	—	+	+	+	+	—
0376-0476	+	+	+	+	—	—	—	—
0376-0776	+	+	—	—	—	—	—	—
0376-0876	—	—	—	+	—	—	+	—
0376-0976	—	—	—	—	—	+	—	—
0476-0776	—	—	—	—	—	—	—	—
0476-0876	+	+	+	+	—	+	+	—
0476-0976	+	+	+	+	—	+	+	—
0776-0876	+	+	+	+	—	+	—	—
0776-0976	+	+	+	+	—	+	—	—
0876-0976	—	—	—	—	—	+	+	—

"+"—denotes significant difference

"—"—denotes lack of significant difference

b3. The third group of 120 hypotheses stating that there are no significant differences for a particular comparison in respect of particular traits. The results of testing are given in the Table 1.

c. Principal components and generalized (Mahalanobis') distances. The distribution of populations on the plane of first and second PC axes is given on the Fig. 5. Also the Mahalanobis' distances are drawn in.

d. Colour of the ventral scales. Four populations are monomorphic in this respect: in both lowland populations (0276 — Diabli Skok Re-

Tab
 Arithmetical means ($\bar{m}$) and standard deviations (st.d) for

Popu- lation	No. of thalli	Trait		1		2		3		4
				$\bar{m}$	st.d.	$\bar{m}$	st.d.	$\bar{m}$	st.d.	$\bar{m}$
0276	30			.5597	.1254	.8113	.1474	.6813	.1094	.5487
0376	30			.5260	.1443	.6933	.1143	.5903	.1213	.3787
0476	20			.3920	.1423	.4980	.1449	.4230	.1327	.2900
0776	20			.3880	.0908	.5345	.0964	.4985	.1021	.3235
0876	30			.5233	.1652	.7003	.1866	.6720	.1533	.4700
0976	30			.6163	.1595	.7460	.1172	.6253	.0767	.4280

Fig. 5. Distribution of populations investigated on a plane of the first (V_1) and second (V_2) principal component axes. The population points are connected according to generalised (Mahalanobis') distance matrix. G = populations from the mountains, N = lowland populations. See also Fig. 1

le 2

individual traits in six populations of *Conocephalum conicum*

4	5		6		7		8	
st.d.	$\bar{m}$	st.d.	$\bar{m}$	st.d.	$\bar{m}$	st.d.	$\bar{m}$	st.d.
.0860	.2877	0.952	2.7333	.9803	.0943	.0165	4.7667	2.2079
.0682	.1820	.0580	1.9333	.6397	.0527	.0128	3.8000	1.4948
.0870	.1790	.0590	1.4500	.5104	.0395	.0143	3.6000	2.0876
.0769	.2140	.0382	1.7000	.5712	.0525	.0162	2.6500	1.5313
.0987	.2093	.0633	2.4667	.8193	.0777	.0194	3.5000	1.7370
.0603	.2113	.0751	3.7000	1.6220	.0633	.0177	3.5000	1.6135

Table 3
Coefficient of variation (c. var.) values for individual traits in the six populations of *Conocephalum conicum*

Population	Trait		2	3	4	5	6	7	8
	No. of thalli	1							
0276	30	22.4078	18.1686	16.0582	15.6693	33.1007	35.8634	17.5370	46.3191
0376	30	27.4259	16.4899	20.5525	18.0146	31.8884	33.0871	24.3939	39.3373
0476	20	36.2908	29.0889	31.3638	29.9989	32.9711	35.2012	36.2476	57.9877
0776	20	23.4074	18.0319	20.4810	23.7814	17.8358	33.6024	30.8220	57.7831
0876	30	31.5594	26.6514	22.8117	20.8167	30.2371	33.2152	25.0040	49.6292
0976	30	25.8846	15.7101	12.2706	14.0910	35.5348	43.8391	27.9185	46.1006

Fig. 6. Five different ventral scales drawn to the same scale

serve — and 0476 — Wolin Island) and in the Pieniny Mountains (0776) the scales are hyaline (colourless), whereas in the population from the Gorce Mts. all the scales are violett-brown. Two remaining mountain populations are polymorphic in respect to scale colour; for details see Table 4.

Table 4
Colour of the ventral scales

Population	ventral scales		
	coloured	hyaline	% hyaline
0276	0	30	100
0376	23	7	30
0476	0	20	100
0776	0	20	100
0876	30	0	0
0976	24	6	25

The numerical data for particular traits and populations can be found in Tables 2 (arithmetical means and their standard errors) and 3 (coefficients of variation). Five different ventral scales are drawn in the Fig. 6.

DISCUSSION

The results of our investigations described above show that the six populations in question show significant differences both in their traits and in correlations between them. As the data come from plants grown simultaneously in similar conditions at least a major part of these differences reflect different genetical structures of our populations. At the same time we could not find any correlation whatsoever between the variation pattern found and geographical situation of the populations or their ecology. Two most similar samples come from the sea coast and Tatry Mts., then, from places of very different ecology (the very sea coast and high mountains). The geographical distance between them exceeds 600 km. Similarly, both populations from the Polish Lowland (no. 0276 — Diabli Skok Reserve and no. 0476 — Wolin Island) belong to the most different ones (they differ — acc. to Table 1, — in all their traits significantly), although the distance between them is only a little over 100 km. In addition there is no simple relation between the morphological variability and the correlations between particular traits: populations of most similar correlation patterns (i.e. 0476 — Wolin Island — and 0876 — Gorce Mts. — see Fig. 3) are quite different morphologically (see Table 1).

The same is true for the ventral scale colour: both lowland populations have hyaline scales; on the contrary, all mountain populations but one have rather high percent of violet-brown scales. The population from the Pieniny mountains is exceptional in this respect having all its scales hyaline.

All that indicates that there is a substantial amount of genetical variability in populations of the liverwort *Conocephalum conicum*. At the same time the variation pattern is rather complicated here and no simple explanation for it could be found. The problem should be investigated on a higher number of populations and with more precise methods.

Acknowledgments

Thanks are due to miss Bożena J. Kwiatkowska for her skillful technical assistance.

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*Zmienność łusek brzusznych w polskich populacjach wątrobowca
Conocephalum conicum L. Dum.*

Streszczenie

Zbadano w kulturze porównawczej (układ bloków zrandomizowanych) zmienność dziewięciu cech łusek brzusznych wątrobowca *Conocephalum conicum* w sześciu naturalnych populacjach z terenu Polski (dwie populacje z niżu, reszta z gór). Stwierdzono, że istnieją dość wyraźne różnice między tymi populacjami i że różnice te mają przynajmniej częściowo charakter genetyczny. Nie udało się jednak dotychczas powiązać tej zmienności ani z rozmieszczeniem geograficznym, ani z rodzajem siedliska.