MEASURES OF ASSOCIATION AND CORRELATION BETWEEN TWO COEXISTENT FORMS OF *CAREX SEROTINA* MÉRAT; PATTERN AND DISTRIBUTION OF DOMINANCE

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Abstract. Two *Carex serotina* forms ('A' similar to forma serotina, 'B' similar to forma thalassica) occur together on the mud of a meander lake in the Tiszaalpár Basin.
The distribution of the forms in space seems to be independent of the location of the cenological sample in the lake bed. The frequencies of dominances show a close paralelism in the 2 - 10 % domain of dominances. The measures of association and correlation between the two forms refer to a close positive relation of the forms.

According to our current information, it is the first paper in which such a degree of phenotypical variability increase is reported, which had led to the discontinous segregation between two cooccurrent plant forms in a natural population.

*Key words: **Carex serotina**, mud vegetation, plant architecture, vegetation structure*

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Introduction

Two different forms ('A' and 'B') of *Carex serotina* can be found on the mud of a meander lake in the valley of the River Tisza. The appearance of the 'A' form is similar to 'forma serotina', the 'B' form has an appearance which is similar to 'forma thalassica' of *Carex serotina* (Soó, 1973), (Fig. 1). There is no transition between the two forms, so they can be well distinguished in the field. The lack of transitional forms excludes the possibility of supposition according to which the forms would be regarded as representatives of *Carex serotina* at different ages, therefore, in different stages of their life history (Havlíčková, 1982; Şoó, 1955). The phenotypical variability in this case is manifested in architectural characteristics, e.g. height of the plants, length and curvature of the leaves.

There are several, sometimes contradictory data on the intra- and interpopulation variability of the species of *Carex flava* agg. (*C. flava* L. var. *flava*, *C. flava* var. *alpina* Kneucker, *C. lepidocarpa* Tausch, *C. tumidicarpa* Anderss. and *C. serotina* Mérat) (Cretin and Bidault, 1974; Davies, 1953, 1955; Havlíčková, 1982; Schmid, 1982, 1984 a, b;

1986 a, b; Senay, 1950-51; Stoeva and Štěpánková, 1990, Wiinstedt, 1947). Most of these publications agree on the fact that the variability within a population of the *Carex flava* complex is very high. In some cases it is higher than the variability between the studied populations in relation to several studied morphological characteristics. There is a debate on the ratio of the ecological cr/and genetical dependence of the variability of the characteristics: Schmid (1984 a,b) regards *Carex serotina* to have the lowest genetical variability within its populations and finds its characteristics to have the widest plasticity. Stoeva and Štěpánková (1990) found a higher variability of characteristics of *Carex serotina* which can be regarded as being less sensitive to environmental factors compared to other species of the complex. (It is undoubted that the plant architecture, on which this paper is based, is under strong environmental influence (Havlíčková, 1982).) Nevertheless, it should be noted that the comparison of populations has often occured between populations of localities which are far from each other, and the cenological-environmental conditions are seldom documented sufficiently, while the authors agree on the
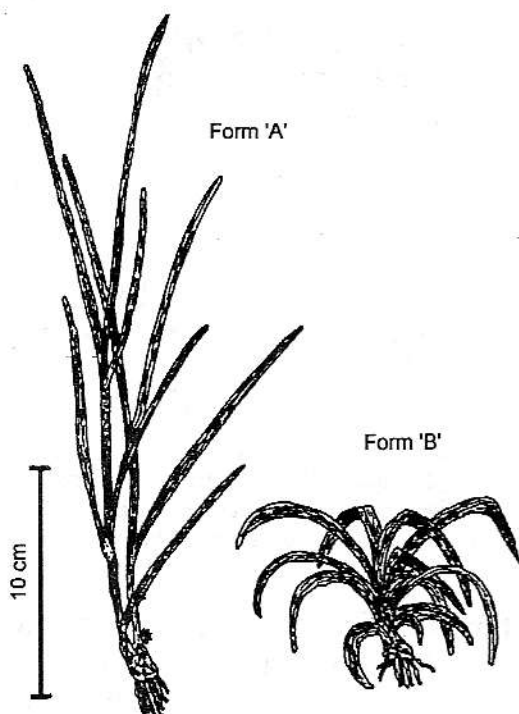
Fig. 1. Typical representatives of the two coexistent *Carex serotina* forms.

Materials and methods

Thirty-seven cenological relevés were recorded in the territory (cf. Bagi, 1988). The relevés almost entirely cover the lake bed. The size and shape of the plots where the cenologial relevés were taken conform to the patches with homogeneous vegetation (Fig. 2). As the cover values of the other species have no role in this paper (available in Bagi, 1988), the cover values (%) of the two *Carex serotina* forms are presented in Table 1.

The standard reference work is Goodall (1978) in relation to applied mathematical-statistical methods.

Table 1. Cover values (%) of the *Carex serotina* forms

relevé	1	2	3	4	5	6	7	8	9	10
Form 'A'	2	3	8	5	10	4	2	8	5	4
Form 'B'	4	10	5	0	1	5	2	+	1	4
relevé	11	12	13	14	15	16	17	18	19	20
Form 'A'	3	15	10	3	5	15	6	11	3	3
Form 'B'	3	4	0	3	5	2	+	0	+	0
relevé	21	22	23	24	25	26	27	28	29	30
Form 'A'	4	14	3	4	8	10	8	4	35	12
Form 'B'	+	+	2	2	10	5	4	10	3	3
relevé	31	32	33	34	35	36	37			
Form 'A'	14	17	1	5	4	4	10			
Form 'B'	4	1	4	7	8	10	3			

Results

Spatial relations

Investigations on the spatial distribution of *Carex serotina* forms (Fig. 2) refer to the following conclusions: Neither form 'A' nor form 'B' is bound unambiguously to a particular part of the lake; both forms may occur in high coverage both in the inner as well as in the outer parts. The distribution of the two forms seems to be random in scale of the cenological relevés involved by the perceptible patchiness of the vegetation. The water in the lake, however, is shallow; there are no important differences of reliefs between the lowest and the highest sampled plots (max. 20 cm).

Distribution of dominance

In spite of the fact that the summarized dominance value of the form 'A' is significantly higher (285) than the value of 'B' (127.5), the distribution of dominance values seems to be very similar in the most important 2-10 % domain (Fig. 3). The differences outside of this domain are resulted by the fact that dominance values of form 'A' are higher then 10 more frequently than 'B', and 'B' shows low dominance values more frequently than 'A'.

dominant significance of environmental conditions in the formation of the spectra of the phenotypical variables. The territory studied by us is exceptional because the forms, which are significantly different in their architecture, can be found in the same stand or cenological relevé.

The cenological relations and the outlined edaphic conditions of the habitat have already been published (Bagi, 1988): It is characteristic of the cenological relations that the *Carex serotina* forms occur in a highly modified *Eleocharito-Caricetum bohemicae* community (Müller-Stoll and Pietsch, 1985; Pietsch and Müller-Stoll, 1968), which is influenced by *Bidentetea* elements due to the strong nutrient loading. The soil parameters refer to a high concentration of plant nutrients that originate from the hypertrophic water of the lake by an organogenic sedimentation process. The taxonomical consequences of the morphological dimorphism have also been mentioned (Bagi, 1989).

The subjects of this contribution are: first the documentation of the fact of the coexistence, moreover, the investigations of the parameters of coexistence of *Carex serotina* forms, the distribution of their dominance in cenological relevés, and their spatial allocation in the territory.
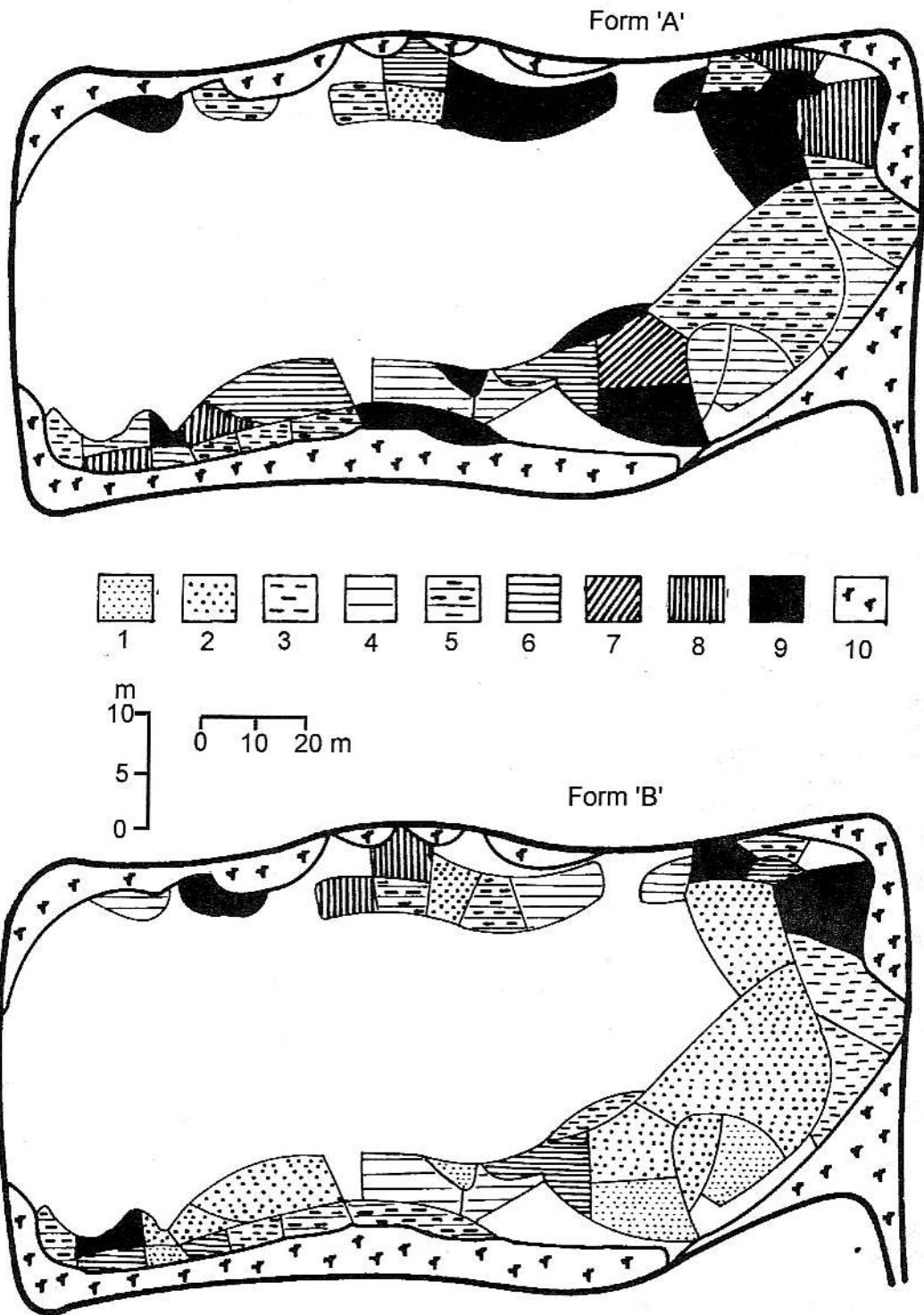
Fig. 2. Allocation of dominance values of the two *Carex serotina* forms. 1-9: cover values of the forms 'A' and 'B' in the relevés; 1: 0 %, 2: + - 1 %, 3: 2 %, 4: 3 %, 5: 4 %, 6: 5 %, 7: 6 %, 8: 7-8 %, 9: >=10 %, 10: *Phragmites - Typha* community. Note that the vertical and the horizontal scale are not identical.
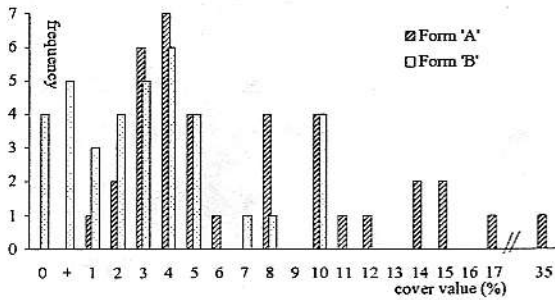
Fig. 3. Distribution of dominance values of the two *Carex serotina* forms.

Numerical approach to coexistence

The significance tests for "interspecific" association based on 2 x 2 contingency table of presence-absence data (one or two fictive "cenological" data pair(s) should be added to the data set depending on the kind of the test or index) refer to an association between the two forms. The χ^2-values are higher than what would be issued from the hypothesis which supposed total independence between *Carex serotina* forms. The χ^2-values are 1.6946 (n=38) and 3.8338 (n=39) by calculation according to Yates and Gilbert-Wells formulae, respectively (cf. Goodall, 1978), but these values are more or less lower than the critical $\chi^2_{0.05} =3.841$.

In case of the more effective Gilbert-Wells formula, the difference is only 0.0072. As the number of the cenological relevés is low, it is difficult to demonstrate the significant statistical association. (The chance of positive results is decreased by the introduction of fictive data.)

Every measure calculated from presence-absence contingency table data refer to a positive correlation and association of the two forms of *Carex serotina*: Association coefficient or percentage co-occurrence (Agrell, Whittaker-Fairbanks) is 0.8919, the coincidence index (Dice) is 0.9429, Fager's association-index is 0.8574, the ratio of the observed and the expected number of joint occurrences by Forbes is 1.00, the inverse measure of association (Margalef) is 0.00, the Hacker-index and the Sokal-Michener-index both are 0.8919, the relative point correlation coefficient (Cole) is 0.8702 and the Pielou-index is 1.00.

Measures for correlation of qualitative (i.e. dominance in percentage) data between the forms refer to close positive relationship, too: Ellenberg's "specifische Massen-Gemeinschaftskoeffizient" is 0.8677, the index of interspecific overlapping (Morosita) is 0.6151, the information measure of association by Estabrook is 0.7194, and the most widely used Pearson correlation coefficient is 0.8858, (P<0.001), however, the normal distribution have not been tested.

Discussion and conclusions

The similar distribution of the two *Carex serotina* forms refers to their similar role in community structure. The close positive correlation between the forms can be explained by their similar environmental demands. As a consequence of the high level of sources of nutrients, it may be supposed that the interspecific effects are more relaxed and - in accordance with the niche variation hypothesis (van Valen, 1968) - development of higher phenotypical variability have occured within the population of *Carex serotina*. The higher variability aims at the reduction of intraspecific effects (see Bagi, 1992). Nevertheless, I have no information about a publication yet in which such a degree of phenotypical variability increase - which clearly manifested in plant architecture - is reported, which would lead to the discontinous segregation between cooccurrent plant forms in a natural population.

Acknowledgements

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