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Carex flava-complex in the Czech lands I
Analysis of the variability of morphological characters

Komplex *Carex flava* na území ČSR I
Rozbor proměnlivosti morfologických znaků

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The paper presents an analysis of 37 morphological characters of the following species: *Carex flava* L., *C. lepidocarpa* Tausch, *C. tumidicarpa* Anderss., *C. oederi* Retz. of *Carex flava*-complex. The results of measuring 17 quantitative characters are statistically evaluated. Material was studied from Bohemia and Moravia only. In the summary of this paper a comparative table of characters of four studied species is compiled.

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The taxonomically difficult group *Carex flava*-complex has not been studied in detail in Bohemia or Moravia. The problems of this group are mentioned in papers by Holub (1960, 1965). As far as Europe is concerned, this complex is most intensively being investigated in north and north-west Europe at the present time. In Scandinavia it was elaborated in detail by Palmgren (1959), in Great Britain by Davies (1953, 1955). In Denmark the problem of this complex has been studied by Wiinstedt (1943—51, 1946—1951). The latest results of research of *Carex flava* agg. in the Netherlands are given in a paper by Vonk (1979). Senay (1950—51) was engaged in this complex in France. Patzke et Podlech (1960) investigated this group in Germany. In the remaining parts of Europe this complex has been examined within the framework of sundry Floras only.

This paper presents only the first, biometrical part of the whole study of *Carex flava*-complex in the Czech lands. The identification of the members of this group is based on many quantitative characters, but some overlappings variation ranges of quantitative characters bring about some difficulty. That is why in this paper such great attention is devoted to the analysis of variability of quantitative characters.

METHODS AND MATERIALS

In total, 37 morphological characters were evaluated, 17 of wich were statistically processed. The symbols used in the tables are as follows: $\bar{x}$ — arithmetical mean, s — standard deviation. $s_{\bar{x}}$ — standard error of the mean, n — number of objects, max — empirically ascertained maximum, min — empirically ascertained minimum, v — variation coefficient, F — statistic for one, way analysis of variance. Additionally, correlations were found in the set of 14 selected characters. These are leaf breadth, bract breadth, length of bract sheath, length and breadth of female spike, number of female spike, male spike length, length and breadth of perigynium, length of perigyn-

ium beak, glume length of female spike, length and breadth of nut, lengthof nut beak. To compute correlation coefficients the program BMDP5M was used, developed in The Department of Biomathematics, University of California, Los Angeles (cf. DIXON [red.] 1975). It prints fundamental statistics for all evaluated characters of each studied taxon.

To obtain further mathematical evaluation of the 14 selected characters, the method of Stepwise Discriminant Analysis (SDA) was used by means of the program BMDP7M (cf. HAVRÁNEK et ŠTĚPÁN 1977). The methods SDA finds the subset of variables that maximize possible group differences (cf. RAO 1978, WEBER 1961). SDA was also used as a multivariate test for group differences. The output of this program includes arithmetical means, standard deviations, coefficients of variation, and F — statistics with degrees of freedom (for one-way analysis of variance) for each character in individual species. It prints also F — statistics for distances between pairs of groups, Wilks' lambda (= U — statistic) for multivariate test of analysis of variance, Mahalanobis D^2 of each case from each group mean, classification functions, classification matrices, and percent correct classification, coefficients for canonical discriminant functions, canonical correlation, canonical variables and plot of the first two canonical variables (Fig. 3). Both problems (BMDP5M and BMDP7M) were worked out in cooperation with the Mathematical Centre of Biological Institute of the Czechoslovak Academy of Sciences.

For the studies only the herbarium specimens from the following herbaria were used: BRNM, BRNU, PR, PRC, MJ. The specimens were chosen at random, if possible 1 specimen from 1 locality respectively. Only in the case of less common species (*C. lepidocarpa* and *C. oederi*) was it necessary to take for measurement more specimens from one locality, in order to obtain a sufficient number of measurements for statistical evaluation (in such cases at least the plants collected by various collectors were measured, and in this way the possibility of repeatedly collected materials from the same bunch was eliminated). The samples for measurement were in all cases taken from one specimen separately. The necessary numbers of measurements for individual features were ascertained by means of the provisory control graphs (cf. HRUBÝ 1950).

In evaluation of the statistically ascertained parameters of individual features, in all cases the differences between two neighbouring links of the series *C. flava* — *C. lepidocarpa* — *C. tumidicarpa* — *C. oederi* were analysed, i.e. between the most similar members of the complex respectively.

ANALYSIS OF MORPHOLOGICAL CHARACTERS

The stem length

This is a very variable character which is largely dependent on the environmental conditions. Great differences exist among plants growing in the same locality. We mention at least relative data. *Carex flava* and *C. lepidocarpa* have usually longer stems than *C. tumidicarpa* and *C. oederi*. These data are, however, only approximate. For example, the stem length was found in *C. oederi* from the locality Řeporyje near Prague up to 30 cm, whereas, on the other hand, in *C. flava* from the locality Malý Bílichov near Kladno at most 15 cm. The stem length depends also largely on the time of vegetation period. Generally it can be said that riper plants have a longer stem than unripe ones.

From the remaining characters of the stem the shape of the transverse section is important. In *C. flava* this shape is sharply triangular, sometimes with a slight suggestion of wings. *C. lepidocarpa* has a conspicuously triangular stem, *C. tumidicarpa* obtusely triangular and *C. oederi* indistinctly triangular to obtuse. The upper part of the stem in *C. tumidicarpa* is usually bent downwards. A stem of this type has not been observed in other species.

The leaves

The variability of length, breadth, ratio of leaf length by stem length, and colour has been examined.

The ratio of leaf length to stem length is more important than the absolute leaf length. *C. flava* has leaves as long as, or a little shorter than, its stem.

Tab. 1. — Breadth of leaf (mm)

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	3.12	2.25	2.41	1.66
s	0.69	0.47	0.52	0.42
$s_{\bar{x}}$	0.07	0.05	0.05	0.04
v	22.12	20.91	21.64	31.42
n	100.00	100.00	100.00	100.00
max	5.2	3.5	4.0	2.6
min	1.5	1.1	1.4	0.9

F = 126.39; degrees of freedom 3, 402; P < 0.999

This character depends, however, on the ecological conditions of the habitat. In *C. lepidocarpa* the leaves are almost always shorter than the stem; they often reach a length of one half of the stem. The leaves in *C. tumidicarpa* are often longer, or infrequently shorter, than the stem, reaching up to three quarters of the stem. In *C. oederi* they are in most cases longer than the stem. For this character, different data are mentioned in literature. WIINSTEDT (1946—1951) and JERMY et TUTIN (1968) consider that the leaves of *C. tumidicarpa* are always longer than the stem. MORAVEC (1950) mentions that the leaves of *C. lepidocarpa* are longer than the stem, but in his work *C. lepidocarpa* includes also the taxon *C. tumidicarpa*, which explains the difference between the values of this character stated in the present and Moravec's work.

The leaf colour is very variable, but certain differences among studied species can be distinguished. *C. flava* and *C. lepidocarpa* have yellow-green to grass-green, *C. tumidicarpa* and *C. oederi* grass-green leaves.

The variability of the leaf breadth was statistically evaluated (see Tab. 1). Through relatively large differences exist in values of arithmetical means and though the F-values corroborate the significance of this character, the limits of variability coincide in single species, which makes the determination of taxa difficult. The correlation coefficients (Tab. 24) show the dependence of this character on the remaining characters. The leaf breadth has a highest correlation with the perigynium length. In the sequence of significance of characters for distinguishing individual taxa of the studied group, the leaf breadth is given the place 6 by the method SDA (Tab. 26).

The ligule

Between a blade and leaf sheath there is a membrane formation — ligule. Its length was measured and statistically processed (Tab. 2). It follows from

Tab. 2. — Length of leaf ligule (mm)

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	0.58	0.14	0.18	0.11
s	0.21	0.08	0.06	0.04
$s_{\bar{x}}$	0.02	0.01	0.01	0.00
v	36.21	57.14	35.56	33.64
n	175.00	110.0	169.0	115.0
max	1.2	0.3	0.4	0.2
min	0.2	0.1	0.1	0.1

F = 382.00; degrees of freedom 3, 568; P < 0.9995

Tab. 3. — Breadth of bract (mm)

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	2.32	1.07	1.97	1.43
s	0.56	0.61	0.45	0.39
$s_{\bar{x}}$	0.06	0.06	0.05	0.04
v	24.3	61.0	22.5	27.9
n	100.0	100.0	100.0	103.0
max	3.6	2.6	3.1	2.4
min	0.7	0.1	0.8	0.6

F = 118.93; degrees of freedom 3, 402; P < 0.0075

the corresponding means that *C. flava* has a longest ligule with regard to the whole complex. Also *C. tumidicarpa* has a longer ligule than *C. lepidocarpa* and *C. oederi*, but this difference is not so striking, and therefore is not suitable for separating *C. tumidicarpa* from *C. lepidocarpa* and *C. oederi*.

The bract

Only the bract below the lower female spike was examined. The following features were observed: length, breadth, length of the bract sheath and the shape of the ending of the upper margin of bract sheath — antiligule. In the case of *C. tumidicarpa* these characters were studied on the bract situated below the female spike in the upper half of the stem.

The bract breadth

The F-values (Tab. 3) refer to a considerable significance for this character. The bract breadth separates most markedly *C. lepidocarpa* from *C. flava* and *C. tumidicarpa*. It is evident from the comparison of correlation coefficients (Tab. 24) that the character studied is in the closest correlation with the leaf breadth. The bract breadth is the only character from the evaluated set that is directly linearly correlated, more precisely highly correlated with, the number of female spikes.

The bract breadth was evaluated by SDA as the second most important character for the determination of single species of the *Carex flava*-complex. From the F — matrix (Tab. 25) it follows that this feature, together with the perigynium length, can discriminate between single complex species at a high level of significance. A geometrical interpretation of this fact is given in a scatter plot (Fig. 3).

Tab. 4. — Length of sheath of bract (mm)

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	2.58	3.98	3.42	2.52
s	1.52	3.00	2.20	1.73
$s_{\bar{x}}$	0.15	0.30	0.22	0.17
v	58.46	75.0	64.70	69.2
n	100.0	100.0	100.0	103.0
max	7.0	25.0	10.2	8.0
min	0.5	0.3	0.8	0.1

F = 10.39; degrees of freedom 3, 402; P < 0.95

Tab. 5. — Frequency (%) of types of antiligule in *Carex flava* — complex

Species	Types 1	2	3	4	5	6	7
C. flava	24.8	17.9	22.1	16.6		18.6	
C. lepidocarpa	44.3	21.2	11.5	3.5		19.5	
C. tumidicarpa	26.5	32.8		7.9		29.6	3.2
C. oederi	2.5	35.8			37.3	24.5	

The sheath of the lower bract

Only the length of this character was statistically examined. Table 4 shows that *C. lepidocarpa* has the longest sheath, then come *C. tumidicarpa*, *C. flava* and *C. oederi*, but the variation ranges largely coincide in the whole group. The corresponding correlation coefficients showed that the sheath is in relatively slight dependence on the other valuated character. It is indirectly correlated with six from the 14 selected characters.

The results of SDA indicated that this feature should not be omitted when determining this group, because the sheath takes a significant part in the discrimination of individual taxa, but it must of necessity be evaluated carefully because of its great variability.

Tab. 6. — Length of male (mm)

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	13.50	15.32	14.27	9.47
s	3.08	3.37	3.79	3.76
$s_{\bar{x}}$	0.31	0.34	0.38	0.37
v	22.81	22.03	26.50	39.56
n	100.0	100.0	100.0	103.0
max	20.3	26.8	30.0	20.5
min	6.0	8.0	5.0	4.0

$F = 53.99$; degrees of freedom 3, 402; $P < 0.995$

The shape of the antiligule is sometimes mentioned in literature as of significance for differentiation of the *Carex flava*-complex. The plant material examined shows, however, a great variability of this feature. There were obtained 7 shape variants of antiligule in the whole complex (Fig. 1). Tab. 5 presents percentage spreading of these shape types in single species. It thus follows that this character has a very low taxonomic value.

Tab. 7. — Length of female spike (mm)

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	12.14	10.68	9.65	8.03
s	2.46	1.71	1.63	1.65
$s_{\bar{x}}$	0.25	0.17	0.16	0.16
v	20.33	15.98	16.80	20 62
n	100.0	100.0	100.0	103.0
max	19.9	15.0	15.0	11.5
min	6.9	6.9	7.0	5.0

$F = 84{,}81$; degrees of freedom 3, 402; $P < 0.9975$

Tab. 8. — Breadth of female spike (mm)

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	8.73	7.14	6.33	5.33
s	1.89	0.97	0.88	1.07
$s_{\bar{x}}$	0.19	0.10	0.09	0.11
v	21.72	13.66	13.97	20.19
n	100.0	100.0	100.0	103.0
max	18.0	9.9	8.5	11.0
min	5.2	5.1	4.0	3.0

F = 130.14; degrees of freedom 3, 402; P < 0.999

The inflorescence

C. flava and *C. oederi* show a certain similarity in arrangement of their spikes. Both species usually have sessile male spikes, which in *C. oederi* are occasionally partly female. The female spikes are usually contiguous and crowded around the male spike. In both species, but more frequently in *C. flava*, lower female spikes are sometimes somewhat distant. In contrast to both species, male spikes of *C. lepidocarpa* and *C. tumidicarpa* are often peduncled. This character distinguishes mainly *C. lepidocarpa* from *C. flava*; the peduncle of male spike of *C. lepidocarpa* is often oblique spreading. Its mean length is 14.5 mm, maximum measured length is 31 mm. In contrast to *C. lepidocarpa*, the peduncle in *C. tumidicarpa* is usually shorter and erect. Mean length is 8.5 mm, maximum is 15 mm. Female spikes of these two species are often separated from the male spike and sometimes from one another. In *C. lepidocarpa*, lower female spikes are not shifted to the basal half of the stem. On the contrary, the basal female spikes of *C. tumidicarpa* are often found in the basal quarter of the stem. In this species there is frequently one remote basal spike with a long peduncle.

The length of male spike

The important statistical data for this character are presented in Tab. 6. There exist considerable distances between values of arithmetical means. The F-values also show a high significance of this feature. From the correlation coefficients (Tab. 24) if follows that the highest linear correlation exists between the length of male spike and the length of female spike; this character is indirectly correlated with the number of female spikes. SDA puts this character on place 3 in a sequence of significance (Tab. 26). From the F — matrix (Tab. 25) it is evident that this character, together with the

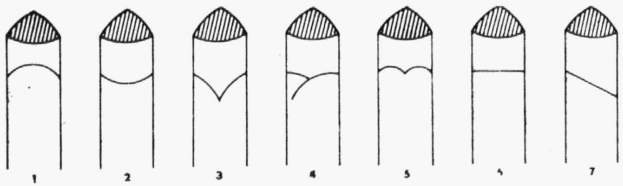

Fig. 1. — Types of antiligule in *Carex flava*-complex

Tab. 9. — Number of female spikes

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	2.64	1.98	2.84	3.19
s	0.63	0.45	0.62	0.87
$s_{\bar{x}}$	0.06	0.05	0.06	0.09
v	24.23	22.50	22.14	27.19
n	100.0	100.0	100.0	103.0
max	4.0	3.0	4.0	6.0
min	2.0	1.0	2.0	1.0

F = 59.43; degrees of freedom 3, 402; P < 0.995

perigynium length and bract breadth, is able to discriminate the *Carex flava*-complex on a high level of significance. However, it is necessary to point out a considerable difference between measured maximum and minimum; this fact reduces its applicability for differentation of members of studied group.

The length of female spike

Though certain differences exist between ascertained means (Tab. 7), regarding to considerable overlapping of variability limits in the whole complex, this character does not separate individual taxa in the best manner. The values of correlation coefficients (Tab. 24) exhibit a high linear correlation with perigynium length. The indirect linear dependence on the number of female spikes is likewise logical. With regard to the high correlation of all characters on the perigynium, the female spike length entered the classification functions of SDA as variable 11, that is, it is on place in the corresponding sequence of significance (Tab. 26).

The breadth of female spike

This is a feature that depends even more than the female spike length on the variability of perigynium dimensions. The results obtained from SDA indicate that this character, when using the whole set of variables, does not significantly influence the distinguishing of single species in a statistical sense. After excluding the perigynium length from the studied set, the F-value of the female spike breadth markedly falls, so that it was not taken into SDA classification functions.

The results of the comparison of data obtained for length and breadth of female spikes are that *C. flava* has the longest and broadest spike, followed

Tab. 10. — Length of glume of male spike (mm)

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	3.75	3.56	3.80	3.40
s	0.39	0.35	0.37	0.45
$s_{\bar{x}}$	0.03	0.03	0.03	0.04
v	10.54	9.72	9.74	13.24
n	156.0	115.0	134.0	125.0
max	4.5	4.3	5.1	4.5
min	3.0	3.0	3.0	2.5

F = 22.06; degrees of freedom 3, 529; P < 0.99

Tab. 11. — Length of glume of female spike (mm)

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	3.01	2.38	2.48	2.02
s	0.35	0.32	0.40	0.46
$s_{\bar{x}}$	0.04	0.03	0.04	0.05
v	11.67	13.33	16.00	23.00
n	100.0	100.0	100.0	13.0
max	4.0	3.5	3.5	3.4
min	2.2	1.8	1.5	1.5

F = 113.27; degrees of freedom 3, 402; P < 0.9975

by *C. lepidocarpa*, *C. tumidicarpa* and *C. oederi* which has the shortest and narrowest spikes.

C. flava and *C. lepidocarpa* have ovate to oval, *C. tumidicarpa* and *C. oederi* globular or terete female spikes. The shape of female spike is a reliable character for separating the group *C. flava-C. lepidocarpa* from that of *C. tumidicarpa-C. oederi*.

Number of female spikes

Tab. 9 summarizes all necessary data for the statistical evaluating of this character. The number of female spikes is negatively correlated with most of the observed features; it is directly correlated with the length of bract sheath.

The SDA results show that this character contributes in a statistically significant sense to the discrimination of single species. SDA puts it on place 5 in the sequence of significance (see Tab. 26).

The evaluation of all these inflorescence characters leads to the conclusion that for the differentiation of individual taxa the following qualitative characters are significant: arrangement of spikes, presence or absence of male spike peduncle, female spike shape, as well as the quantitative ones: number of female spikes, male spike length, breadth and length of female spikes.

Glumes of male spikes

In the male spike glume most authors observe colour, shape and rarely length. On the material from the Czech lands, only the length was statistically evaluated. It can be seen from Tab. 10 that there are no considerable differences between arithmetical means. Also, the limits of variability coincide in the whole complex. That is why this character does not sufficiently characterize individual taxa.

Tab. 12. — Ratio of glume length of female spike by perigynium length

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	0.62	0.65	0.76	0.75
s	0.10	0.07	0.09	0.13
$s_{\bar{x}}$	0.01	0.01	0.01	0.01
v	16.12	10.76	11.84	17.33
n	156.00	115.00	134.00	125.00

F = 36.56; degrees of freedom 3, 529; P < 0.99

The colour of the male spike glumes has a low taxonomic value as well. They are in basal part hyaline, only in upper third coloured. In *C. flava* the glume is rusty-brown, in *C. lepidocarpa* yellow-brown, in *C. tumidicarpa* pale rusty-brown and *C. oederi* yellow-brown to brown. There is a pale midrib in the whole complex.

The shape of glume in *C. lepidocarpa* is broadly lanceolate; in the other species elongated-lanceolate. The glume apex is obtuse to subacute.

In conclusion it can be said that the glume of male spike is unreliable for discrimination of *Carex flava*-complex.

Glumes of female spikes

On the glume of female spikes the following features were examined: shape, colour, length, ratio of glume length by perigynium length. The glumes are persistent until complete ripeness of the plants.

The shape in *C. flava* is narrowly ovate with an obtuse to subacute apex. In *C. lepidocarpa* the glume is broadly ovate with an obtuse apex. *C. tumidicarpa* has an ovate glume with an acute apex and its midrib is often elongated in a shorter spine. *C. oederi* has an ovate and acute glume.

The glume colour does not characterize individual taxa clearly. The base of the glume, in the whole complex, is usually pale yellowish and the upper part is rusty-brown with a green midrib.

The glume length of female spikes

The measurements are presented in Tab. 11. Arithmetical means show relatively great differences between *C. flava* and *C. lepidocarpa* as well as between *C. tumidicarpa* and *C. oederi*. However, they cannot be used to distinguish *C. lepidocarpa* from *C. tumidicarpa*. The minimum and maximum, however, clearly demonstrate overlapping of variation range in the whole group. Glume length highly correlates with the greater part of the evaluated characters (Tab. 24). It is highly linearly correlated with perigynium length. This fact also influenced the SDA results. It was proved that when considering 14 selected variables, the glume length does not contribute significantly to discrimination of the studied species and therefore it was not taken into account in the classification functions.

The glume length is presented relatively rarely in the literature. The data mentioned in the literature does not differ from those found by the present author. Only Jermy et Tutin (1968) and Tutin, Clapham et Warburg (1962) mention substantially different data. The former stated the minimum glume length of *C. flava* as being 3.5 mm, the latter 3 mm. The minimum length found on our material was 2.5 mm.

The ratio of glume length of female spikes by perigynium length

The glumes were in all cases shorter than the perigynia. From Tab. 12 it is apparent that only the difference between *C. lepidocarpa* and *C. tumidicarpa* is significant for their discrimination. The glume of *C. lepidocarpa* reaches to the base of the perigynium beak, whilst in *C. tumidicarpa* it reaches at most to one half of it.

In conclusion it may be said that the characters on the glumes of female spikes are rather unreliable for discrimination of individual taxa of *Carex flava*-

Tab. 13. — Length of perigynium (mm)

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	5.02	3.81	3.37	2.77
s	0.42	0.45	0.32	0.37
$s_{\bar{x}}$	0.04	0.05	0.03	0.04
v	8.40	11.84	9.41	13.21
n	100.0	100.0	100.0	103.0
max	6.5	5.1	4.2	3.5
min	4.2	3.0	2.5	1.8

$F = 598.56$; degrees of freedom 3, 402; $P < 0.9995$

complex, but it has been possible to use them as additional secondary characters.

Perigynium

The dimension and the shape of the perigynia have provided the most reliable characters since they show very little variation. The following features have been examined: length, breadth, ratio of length by breadth, shape, length and shape of perigynium beak, ratio of perigynium length by length of perigynium beak[1]).

The perigynium length

The perigynia were measured including the beaks. In Tab. 13 a survey is given of the measurements carried out on material from Bohemia and Moravia.

Arithmetical means show great differences between single species (Fig. 2). Minima and maxima exhibit coincidence of variation ranges in single species, especially in the cases of *C. lepidocarpa* and *C. tumidicarpa*.

The perigynium length is most highly correlated with the length of perigynium beak, which is a logical fact, since the latter is a component part of the former. The perigynium length has the smallest direct dependence on the bract breadth. It was incorporated into the classification function on the

Tab. 14. — Breadth of perigynium (mm)

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	1.45	1.32	1.24	1.08
s	0.25	0.21	0.17	0.14
$s_{\bar{x}}$	0.03	0.02	0.02	0.01
v	16.67	16.15	14.17	12.72
n	100.0	100.0	100.0	103.0
max	2.1	2.0	2.0	1.5
min	0.9	1.0	1.0	0.8

$F = 66.04$; degrees of freedom 3, 402; $P < 0.9975$

[1]) In *C. flava* difficulties arise regarding the ascertainment of perigynium beak length; they are caused by the fact that in this case the perigynium is attenuating gradually into the beak. In Fig. 5 the measurement method of this feature is illustrated, which was used in all instances of measurement.

Tab. 15. — Ratio of length by breadth of perigynium

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	3.51	2.87	2.71	2.58
r	0.48	0.40	0.27	0.29
$s_{\bar{x}}$	0.04	0.04	0.02	0.03
v	13.68	13.94	9.96	11.24
n	156.00	115.00	134.00	125.00

F = **177.36**; degrees of freedom 3, 529; P < 0.999

first place with regard to its highest F — value. This was evaluated by SDA as the one character best separating single species. From F — matrix (Tab. 25) it follows that the perigynium length is able to distinguish all species, but it does not attain the F — value necessary for the highest level of significance. The smallest F — value was found in the pair of *C. lepidocarpa* — *C. tumidicarpa*.

The perigynium breadth

This character is easier to study on living plants because it is subject to change during the desiccating and pressing periods. These changes are perceptible especially in taxa with more inflated perigynia, principally in *C. flava* and *C. lepidocarpa*. *C. tumidicarpa* and *C. oederi* have little inflated perigynia and therefore no great deformations come about in these cases. Even the evaluation of the herbarium material corroborates differences in this character between single species.

A survey of the necessary data for statistical evaluation is given in Tab. 14. Similar to perigynium length, the breadth very closely correlates with the

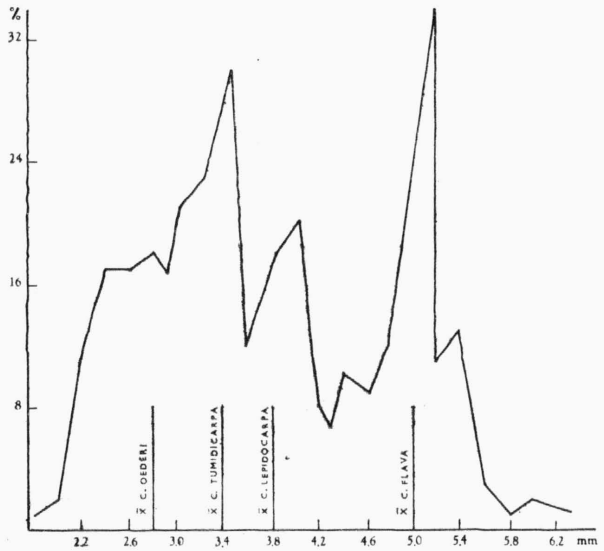

Fig. 2. — Cummulative diagram of variation in bract width in *Carex flava*-complex

Tab. 16. — Length of perigynium beak (mm)

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	1.87	1.30	1.17	0.77
s	0.32	0.29	0.19	0.22
$s_{\bar{x}}$	0.03	0.03	0.02	0.02
v	16.84	22.30	15.83	31.42
n	100.0	100.0	100.0	103.0
max	2.5	2.0	1.8	1.4
min	1.0	0.6	0.7	0.4

F = 309.88; degrees of freedom 3, 402; P < 0.9995

remaining characters of the perigynium. When evaluating the whole set of characters, the perigynium breadth had a very low discrimination value. SDA put this variable on place 10 in the sequence of significance (Tab. 26) with regard to its high correlation with the perigynium length.

Tab. 17. — Ratio of perigynium length by length of perigynium beak

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	2.69	2.95	2 84	3.73
s	0.30	0.41	0.24	0.50
$s_{\bar{x}}$	0.02	0.04	0.02	0.04
v	11.15	13.90	8.45	13.40
n	156.00	115.00	134.00	125.00

F = 202.14; degrees of freedom 3, 529; P < 0.9995

Ratio of perigynium length by perigynium breadth

The data obtained from a statistical evaluation of this character are presented in Tab. 15. The arithmetical means show that *C. flava* has the most narrow perigynium and in the direction of *C. oederi* the perigynium shape begins to extend. The greatest distances in this character were stated between *C. flava* and *C. lepidocarpa*.

Tab. 18. — Length of nut (mm)

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	1.97	1.80	1.58	1.55
s	0.20	0.16	0.12	0.13
$s_{\bar{x}}$	0.02	0.02	0.01	0.01
v	10.00	8.89	7.50	8.67
n	100.0	100.00	100.00	103.00
max	2.6	2.1	2.0	1.9
min	1.5	1.5	1.4	1.3

F = 162.58; degrees of freedom 3, 402; P < 0.999

Tab. 19. — Length of nut beak (mm)

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	0.20	0.21	0.13	0.11
s	0.07	0.05	0.05	0.03
$s_{\bar{x}}$	0.01	0.01	0.01	0.00
v	35.00	25.00	38.47	27.27
n	100.0	100.0	100.0	103.0
max	0.5	0.3	0.2	0.2
min	0.1	0.1	0.1	0.1

F = 112.61; degrees of freedom 3, 402; P < 0.9975

The perigynium shape in *C. flava* is elongately elliptical, in *C. lepidocarpa* obovate to broadly obovate. The least difference exists between *C. tumidicarpa* and *C. oederi*. In both taxa the shape is broadly obovate.

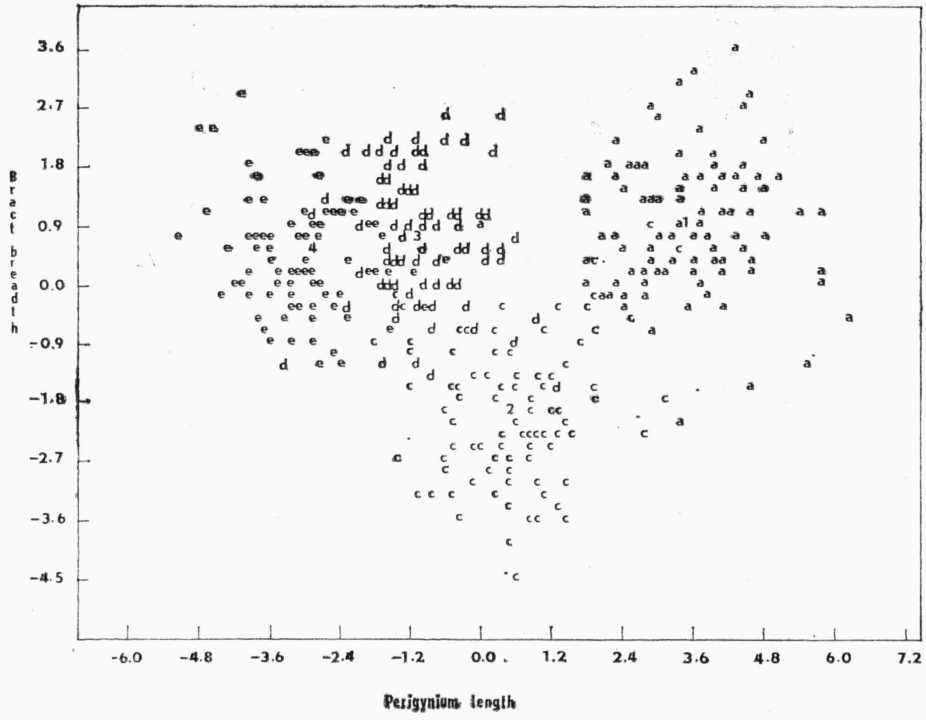

Fig. 3. — Scatter plot of group means and all cases of two canonical variables — perigynium length and bract breadth. — 1 group mean of *C. flava*. — 2 group mean of *C. lepidocarpa*. — 3 group mean of *C. tumidicarpa*. — 4 group mean of *C. oederi*. — a values of *C. flava*. — c values of *C. lepidocarpa*. — d values of *C. tumidicarpa*. — e values of *C. oederi*.

The length of perigynium beak

This character is commonly used in keys and descriptions. Large distance between means in single species are evident from Tab. 16. Only between *C. lepidocarpa* and *C. tumidicarpa* are there relatively small differences.

The high correlation was ascertained between perigynium length and the length of perigynium beak. SDA gives very interesting results. When computing F — statistics for all selected characters, the length of beak had the second highest F — value. After excluding the influence of the perigynium length from the evaluated set of variables, the F — value of beak length fell abruptly from place 2 to place 11. This fact can be explained by its high linear dependence on the perigynium length. In the final results of SDA the

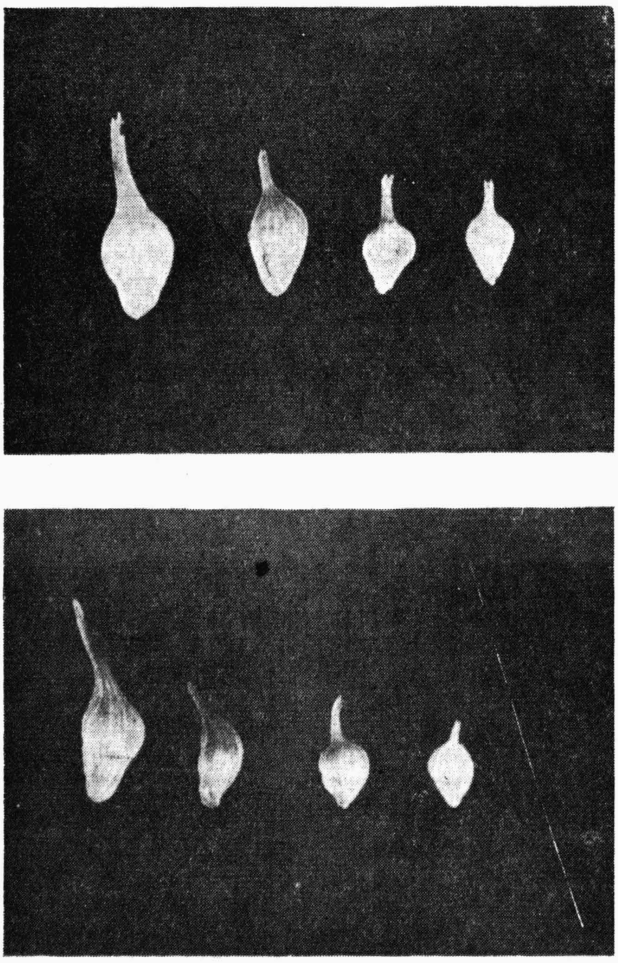

Fig. 4. — Shapes of perigynia of *Carex flava* L., *C. lepidocarpa* TAUSCH, *C. tumidicarpa* ANDERSS., *C. oederi* RETZ. (from the left to the right). — A: dorsal view. — B: lateral view.

Tab. 20. — Ratio of nut length by length of nut beak

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	10.60	8.72	13.11	14.60
s	2.72	1.52	2.67	1.50
$s_{\bar{x}}$	0.22	0.14	0.23	0.13
v	25.66	17.43	20.37	10.27
n	156.00	115.00	134.00	125.00

F = 168.11; degrees of freedom 3, 529; P < 0.999

length of the perigynium beak has a very low discrimination value (see Tab. 26). In the case SDA shows that when searching for a minimum count of characters that would be able to differentiate the taxonomically critical group, the minimum correlated characters are those that assert themselves. On the contrary, the set of the highly dependent variables is not suitable for the discrimination of the critical group, although, if evaluated independently, they can show great differences between individual taxa.

Ratio of perigynium length by length of perigynium beak

The arithmetical mean in *C. oederi* differs considerably from those of the other species (Tab. 17). *C. oederi* has the shortest beak with regard to perigynium length. On the contrary, *C. flava* has the longest beak with regard to the same length. The values of means in *C. lepidocarpa* and *C. tumidicarpa* show that, though the absolute length of beak in *C. lepidocarpa* is greater than in *C. tumidicarpa*, the relative length is greater in the latter. The variation range of *C. tumidicarpa* is wholly included in that of *C. lepidocarpa*. It is possible to state that the ratio of perigynium length to length of perigynium beak is able to separate well C. oederi only from the study group.

In addition to the quantitative characters in the perigynium some qualitative ones were also observed. The most important character is the shape

Tab. 21. — Breadth of nut (mm)

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	1.10	0.94	0.98	0.86
s	0.16	0.08	0.07	0.07
$s_{\bar{x}}$	0.02	0.01	0.01	0.01
v	14.55	8.89	7.00	7.78
n	100.0	100.0	100.0	103.0
max	1.5	1.2	1.2	1.0
min	0.8	0.8	0.8	0.7

F = 100.00; degrees of freedom 3, 402, P < 0.9975

of the perigynium. While *C. flava* and *C. lepidocarpa* have arcuate-deflexed perigynia, which are in *C. flava* gradually, in *C. lepidocarpa* suddenly, attenuated into a beak, *C. tumidicarpa* and *C. oederi* have straight ones suddenly attenuated into a beak. The perigynium of *C. tumidicarpa* is slightly curved, but only sometimes (see Fig. 4).

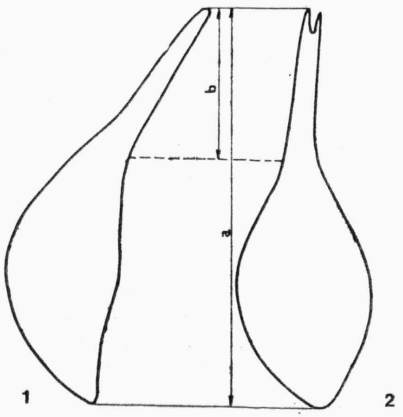

Fig. 5. — The outline of the perigynium of *Carex flava* L.: 1 — lateral view, 2 — front view, a — length of perigynium, b — length of perigynium beak.

The nut

The following characters were observed: shape, colour, length, breadth, length of nut beak, ratio of nut length to length of nut beak, nut length to nut breadth and perigynium length to nut length.

The nut shape can be characterized in all species as obovoid-trigonous. In the literature, when mentioned, it is described as obovoid, only BERGGREN (1963) gives an elliptical shape for *C. oederi* and SOEST et al. (1954) mentions a globular shape.

The nut colour must be judged only when wholly ripe. Thus *C. flava* and *C. lepidocarpa* have a pale brown and *C. tumidicarpa* and *C. oederi* a dark brown nut. In all species the nut is glabrous and polished.

Tab. 22. — Ratio of length by breadth of nut

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	1.79	1.92	1,60	1.80
s	0.16	0.17	0.11	0.15
$s_{\bar{x}}$	0.01	0.02	0.01	0.01
v	8.94	8.85	6.87	8.34
n	156.00	115.00	134.00	125.00

$F = 110.5$; degrees of freedom 3, 529; $P < 0.9975$

Tab. 23. — Ratio of perigynium length by nut length

	C. flava	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
$\bar{x}$	2.64	2.09	2.15	1.81
s	0.26	0.20	0.16	0.21
$s_{\bar{x}}$	0.02	0.02	0.01	0.02
v	9.84	9.56	7.44	11.60
n	156.00	115.00	134.00	125.00

F = 372.37; degrees of freedom 3, 529; P < 0.9995

The nut length

Although the arithmetical means are significantly different (Tab. 18), it is not possible to use this character by itself for discrimination of single species. From the values of minima and maxima it is evident that there is mutual overlapping of variability in individual taxa.

The nut length is most highly correlated with the perigynium length. SDA gives analogous results as in cases of the perigynium breadth and length of the perigynium beak. The F — value of the nut length suddenly falls, after excluding the influence of perigynium length. Thus the nut length is found in place 9 in the sequence of significance of final results.

Tab. 24. — Values of correlation coefficients

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	—	0.52	0.02	0.54	0.54	0.31	0.65	0.43	0.60	0.55	0.47	0.51	0.31	−0.03
2	0.52	—	0.08	0.33	0.32	0.34	0.44	0.28	0.42	0.45	0.21	0.39	−0.02	0.30
3	0.02	0.08	—	0.45	−0.05	0.15	−0.01	−0.02	−0.01	0.01	0.05	−0.01	0.10	−0.12
4	0.54	0.33	0.05	—	0.64	0.53	0.65	0.39	0.60	0.49	0.50	0.41	0.39	−0.14
5	0.54	0.32	−0.05	0.64	—	0.33	0.74	0.45	0.70	0.56	0.55	0.47	0.45	−0.21
6	0.31	0.04	0.15	0.53	0.33	—	0.35	0.26	0.34	0.28	0.25	0.23	0.25	−0.32
7	0.65	0.44	−0.01	0.65	0.74	0.35	—	0.59	0.90	0.72	0.76	0.63	0.54	−0.22
8	0.43	0.28	−0.02	0.39	0.45	0.26	0.59	—	0.56	0.38	0.52	0.57	0.38	−0.14
9	0.60	0.42	−0.01	0.60	0.70	0.34	0.90	0.56	—	0.66	0.64	0.60	0.47	−0.17
10	0.55	0.45	0.01	0.49	0.56	0.28	0.72	0.39	0.66	—	0.49	0.53	0.28	−0.13
11	0.47	0.21	0.05	0.50	0.55	0.25	0.76	0.52	0.64	0.49	—	0.56	0.64	−0.22
12	0.51	0.39	−0.01	0.41	0.47	0.23	0.63	0.57	0.60	0.53	0.57	—	0.33	−0.06
13	0.91	−0.02	0.10	0.39	0.46	0.25	0.54	0.38	0.47	0.28	0.64	0.33	—	−0.36
14	−0.03	0.29	−0.12	−0.14	−0.21	−0.32	−0.22	−0.14	−0.17	−0.13	−0.22	−0.06	−0.36	—

Key to Table 24

1 = leaf breadth
2 = bract breadth
3 = length of bract sheath
4 = length of female spike
5 = breadth of female spike
6 = length of male spike
7 = perigynium length
8 = perigynium breadth
9 = length of perigynium beak
10 = glume length of female spike
11 = nut length
12 = nut breadth
13 = length of nut beak
14 = number of female spikes

Tab. 25. — F matrix (this contains F values computed from test the equality of group means for each pair of *Carex flava*-complex)

Included character — perigynium length; degrees of freedom 1. 399

Carex	*flava*	*lepidocarpa*	*tumidicarpa*
lepidocarpa	480.01^{+++}		
tumidicarpa	884.26^{+++}	61.27^{+}	
oederi	1680.42^{++++}	358.06^{+++}	121.83^{++}

Included characters — perigynium length, bract breadth; degrees of freedom 2. 398

Carex	*flava*	*lepidocarpa*	*tumidicarpa*
lepidocarpa	312.16^{++++++}		
tumidicarpa	445.18^{++++++}	142.28^{+++++}	
oederi	839.83^{++++++}	231.56^{++++++}	72.11^{++++}

Included characters — perigynium length, bract breadth, length of male spike; degrees of freedom 3. 397

Carex	*flava*	*lepidocarpa*	*tumidicarpa*
lepidocarpa	237.84^{++++++}		
tumidicarpa	330.12^{++++++}	94.73^{++++++}	
oederi	561.54^{++++++}	168.37^{++++++}	65.03^{++++++}

$^{+} = p < 0.25$; $^{++} = p < 0.10$; $^{+++} = p < 0.05$; $^{++++} = p < 0.025$; $^{+++++} = p < 0.01$; $^{++++++} = p < 0.005$

The length of nut beak

The nut beak is formed by a persistent part of the style. Useful statistical data are summarized in Tab. 19. It can be seen from the arithmetical means that the greatest distances exist between *C. lepidocarpa* and *C. tumidicarpa*, but the upper and lower limits of variability overlap in all species.

The nut beak length correlates most highly with the nut length. The SDA output has this character on place 4 in the sequence of significance.

Tab. 26. — The sequence of significance of selected characters obtained by means of stepwise discriminant analysis

Number of sequence	Character	Approximate F-statistic	Degrees of freedom	
1	Length of perigynium	598.553	3	399.00
2	Breadth of bract	265.503	6	796.00
3	Length of male spike	188.248	9	966.34
4	Length of nut beak	149.671	12	1048.01
5	Number of fem. spikes	123.439	15	1090.82
6	Breadth of leaf	107.055	18	1114.89
7	Length of bract sheath	94.468	21	1129.03
8	Breadth of nut	85.225	24	1137.52
9	Length of nut	77.684	27	1142.56
10	Breadth of perigynium	71.011	30	1145.40
11	Length of female spike	65.483	33	1146.77
12	Length of perigyn. beak	60.844	36	1147.12

Tab. 27. — Comparison of morphological characters of species of *Carex flava*-complex (dimensions in mm)

Characters	*C. flava*	*C. lepidocarpa*	*C. tumidicarpa*	*C. oederi*
Plant height (cm)	(10–)50–70(–80)	(20–)30–50(–80)	(7–)10–20(–35)	(2–)5–10(–30)
Leaves	As long as or	Shorter than stem	Longer, seldom	Usually longer
length	shorter than stem	usually reach up to half of stem	shorter than stem	than stem
breadth	(1.1–)3.1(–5.2)	(0.8–)2.3(–3.7)	(0.9–)2.4(–4.0)	(0.4–)1.7(–2.9)
ligule	(0–)0.6(–1.2)	(0–)0.1(–0.4)	(0–)0.2(–0.4)	(0–)0.1(–0.2)
Bracts	Several times	Shorter than	Longer than	Longer than
length	longer than inflorescence	inflorescence	inflorescence	inflorescence
	(0.6–)2.3(–4.0)	(0–)1.1(–2.9)	(0.7–)2.1(–3.4)	(0.3–)1.4(–2.6)
sheath length	(0–)2.6(–7.1)	(0–)4.0(–13)	(0–)3.4(–10)	(0–)2.5(–7.7)
Male spikes	Sessile	Peduncled	Peduncled	Sessile or shortly peduncled
length	(4.3–)13.5(–22.7)	(5.2–)15.3(–25.5)	(2.9–)14.3(–25.6)	(0–)9.5(–20.8)
Female spikes	Elliptical or ovate, contiguous, lowest sometimes remote	Elliptical or ovate, distant	Globular or terete, upper distant or contiguous, lowest often remote	Globular or terete, contiguous
number	(0.8–)2.6(–4.5)	(0.6–)2.0(–3.3)	(1.0–)3.0(–4.7)	(0.6–)3.2(–5.8)
length	(4.8–)12.2(–19.6)	(5.7–)10.7(–15.8)	(4.9–)9.7(–14,5)	(3.1–)8(–13)
breadth	(3.1–)8.7(–14.4)	(4.2–)7.1(–10.1)	(3.7–)6.3(–9)	(2.1–)5.3(–8.5)
Glume length of male spike	(2.6–)3.8(–5)	(2.5–)3.6(–4.6)	(2.7–)3.8(–4.9)	(2.1–)3.4(–4.8)
Glume length of female spike	(2–)3(–4.1)	(1,4–)2.4(–3.3)	(1.3–)2.5(–3.7)	(0.6–)2(–3.4)
Perigynium	Arcuate deflexed,	Arcuate deflexed	Straight, suddenly	Straight, suddenly
shape	gradually attenuate into a beak	often suddenly attenuate into a beak	attenuate into a beak	attenuate into a beak
length	(3.8–)5(–6.3)	(2.5–)3.8(–5.2)	(2.4–)3.4(–4.3)	(1.7–)2.8(–3.9)
breadth	(0.7–)1.5(–2.2)	(0.7)1.3(–2.0)	(0.7–)1.2(–1.8)	(0.7–)1.1(11.5)
beak	(0.9–)1.9(–2.8)	(0.4–)1.3(–2.2)	(0.6–)1.2(–1.7)	(0.1–)0.8(–1.4)
Nut length	(1.4–)2.0(–2.6)	(1.3–)1.8(–2.3)	(1.2–)1.6(–1.9)	(1.2–)1.6(–1.9)
breadth	(0.6–)1.1(–1.6)	(0.7–)0.9(–1.2)	(0.7)0.9(–1.2)	(0.7–)0.9(–1.1)
beak	(0–)0.2(–0.4)	(0.1–)0.2(–0.4)	(0–)0.1(–0.3)	(0–)0.1(–0.2)

The ratio of nut length by length of nut beak

The statistical results are given in Tab. 20. This character is not very suitable for the discrimination of the *Carex flava* — complex. Although there are relatively large differences between individual taxa, the variation ranges coincide in the whole group. An important difference was found between *C. lepidocarpa* and *C. tumidicarpa*.

The nut breadth

The absolute values of nut breadth means show only small differences, as do the limits of variability in evaluated species. The nut breadth has the highest linear correlation with the perigynium length; this character occupies place 8 in the sequence of significance of the observed set. It stands before the nut length because of its smaller dependence on the perigynium length. The statistical data are given in Tab. 21.

Ratio of length by breadth of nut

This character is important only for separating *C. lepidocarpa* and *C. tumidicarpa*. In the remaining taxa only small differences can be seen. Although the absolute nut breadth is greatest in *C. flava* and smallest in *C. oederi*, the relative nut breadth is greatest in *C. tumidicarpa* and smallest in *C. lepidocarpa* (Tab. 22). From this fact it follows that *C. lepidocarpa* has the most prolonged and *C. tumidicarpa* the relatively broadest nut.

Ratio of perigynium length by nut length

This is frequently used taxonomic character in the *Carex flava*-complex. A survey of the observed statistical data is given in Tab. 23. Arithmetical means between *C. flava* and *C. lepidocarpa* show relatively large distances, the same holds in the cases of *C. tumidicarpa* and *C. oederi*. The smallest differences were found between *C. lepidocarpa* and *C. tumidicarpa*; that is between taxa that differ most in absolute nut length.

The ratio of perigynium length without beak to nut length was also observed; this ratio can be successfully used when separating single species. It was ascertained that the nut in *C. flava* fills up 1/3 to 1/2 of perigynium, in *C. lepidocarpa* 1/2, in *C. tumidicarpa* 1/2 to 2/3 and in *C. oederi* 2/3 to 3/4.

SUMMARY

The results of the SDA method are summarized in Tab. 26. The SDA method evaluated 12 characters which significantly separated individual members of the group which was studied. Even three characters — perigynium length, bract breadth and length of male spike are able to discriminate members of *Carex flava* — complex at a high level of significance. In addition to the quantitative characters, some qualitative characters are important for the separation of members of the complex; they consist especially of the arrangement of the spikes in the inflorescence and the shape of the perigynium. A survey of the variability of morphological characters is given in Tab. 27. The features are characterized by x, and ± 3s (except plant height; in this case there are given empirically ascertained values).

SOUHRN

Byla provedena analýza 37 vybraných morfologických znaků u druhů *Carex flava* L., *C. lepidocarpa* Tausch. *C. tumidicarpa* Anderss. a *C. oederi* Retz. ze skupiny *Carex flava* na území ČSR. Ke studiu byly použity herbářové položky následujících institucí: BRNM, BRNU, MJ, PR a PRC. Byly hodnoceny znaky jak na generativních tak vegetativních částech rostlin. Ze 17 statisticky hodnocených znaků bylo 14 podrobeno důkladnějšímu matematickému zpracování za použití metody diskriminační analýzy (SDA). Tato metoda umožňuje nalézt soubor obsahující minimální počet znaků, který je schopen vysoce spolehlivě rozlišit jednotlivé druhy studované skupiny. Pro tuto úlohu byl použit program BMDP7M a jeho strojový výpočet byl proveden ve spolupráci s Matematickým střediskem biologických ústavů ČSAV.

Výška rostlin nebyla statisticky vyhodnocována vzhledem k značné variabilitě, která silně závisí na ekologických podmínkách stanoviště. Ani morfologické znaky na listech nevykazovaly velkou stabilitu. Podrobněji byla zpracována šířka listů. Tento znak z celého komplexu nejlépe odděluje druh *C. oederi*. Diskriminační analýza zařadila šířku listů na 6. místo v pořadí významnosti 14 sledovaných znaků pro rozlišení jednotlivých druhů. Ze statistického zpracování délky jazýčku vyplynul pouze výraznější rozdíl mezi druhem *C. flava* a ostatními členy skupiny.

Na listenu byla největší pozornost věnována jeho šířce. Tento znak dobře odděluje *C. lepidocarpa* od ostatních druhů. Diskriminační analýza vyhodnotila šířku listenu jako druhý nejvýznamnější znak, který je schopen, spolu s délkou perigynia, vysoce spolehlivě rozlišit skupinu *Carex flava*. Na listenu byla dále sledována délka pochvy a tvar antiliguly. Oba znaky jsou však

pro určování poměrně nespolehlivé, ačkoliv délka pochvy byla diskriminační analýzou zařazena na 7. místo v pořadí významnosti hodnocených znaků. Jeho praktickou využitelnost při rozlišování zástupců komplexu věk snižuje jeho velká variabilita.

Velice významné jsou znaky na květenství. Pro *C. flava* a *C. oederi* je typický přisedlý samčí klásek a pod ním nahloučené klásky samičí. *C. lepidocarpa* a *C. tumidicarpa* mají většinou samčí klásek stopkatý a samičí klásky vzájemně oddálené. Tvar samičích klásků je podobný u druhů *C. flava* a *C. lepidocarpa* (eliptický až vejčitý) a u *C. tumidicarpa* a *C. oederi* (kulovitý nebo válcovitý). Ze srovnání hodnot pro délku a šířku vyplývá, že *C. flava* má samičí klásek nejdelší a nejširší, pak následuje *C. lepidocarpa*, *C. tumidicarpa* a *C. oederi*. Diskriminační analýza určila délku samčího klásku jako nejvýznamnější znak. Délka samičího klásku však měla v konečných výsledcích SDA velmi nízkou diskriminační hodnotu, vzhledem ke své vysoké korelaci s délkou perigynia. Šířka samičího klásku se v souboru 14 vybraných znaků již statisticky významně nepodílela na rozlišení členů studovaného komplexu. Ze všech kvantitativních znaků hodnocených na samičích klascích diskriminační analýza určila jako nejvýznamnější počet samičích klásků v květenství. Tento znak zařadila na 5. místo v pořadí významnosti hodnocených znaků.

Znaky sledované na plevách samčího a samičího klásku neukázaly významnější rozdíly využitelné pro běžné určování zástupců komplexu.

Mezi diakritické znaky skupiny *Carex flava* agg. patří délka perigynia. Vzhledem ke své nejvyšší F-hodnotě byl diskriminační analýzou určen jako znak, který nejlépe rozlišuje danou skupinu. Tento fakt pak ovlivnil pořadí všech dalších hodnocených znaků. Zároveň však SDA ukázala, že délka mošničky není schopna odlišit všechny druhy, zejména *C. lepidocarpa* a *C. tumidicarpa*, na nejvyšší hladině významnosti. Teprve při použití 3 znaků, délky perigynia, šířky listenu a délky samčího klásku, dosahovaly F-hodnoty úrovně potřebné pro vysokou statistickou průkaznost mezi všemi dvojicemi druhů. Ačkoliv u druhu *C. flava* byla zjištěna největší absolutní šířka perigynia, která klesala v pořadí *C. lepidocarpa*, *C. tumidicarpa* a *C. oederi*, z hodnot poměrů délky a šířky perigynia vyplývá, že relativně nejužší mošničku má *C. flava* a směrem k druhu *C. oederi* se tvar mošničky rozšiřuje. Šířka perigynia byla vzhledem ke své vysoké korelaci s délkou perigynia zařazena až na 10. místo ve výsledcích diskriminační analýzy. Podobné výsledky ukázalo i vyhodnocení délky zobánku perigynia. Ačkoliv hodnoty aritmetických průměrů se statisticky průkazně liší, vzhledem k značné lineární závislosti tohoto znaku na délce mošničky byl metodou SDA zařazen až na 12. místo v souboru sledovaných znaků. Z kvalitativních znaků na perigyniu je velice důležitý jeho tvar. *C. flava* a *C. lepidocarpa* mají mošničky obloukovitě zakřivené a nafouklé, u *C. flava* se perigynium postupně, u *C. lepidocarpa* náhle, zužuje v zobánek. *C. tumidicarpa* a *C. oederi* mají zpravidla perigynia přímá, slabě nafouklá, náhle zúžená v zobánek. *C. tumidicarpa* má mošničku v některých případech také slabě zakřivenou.

Ačkoliv u délky a šířky nažky byly zjištěny statisticky vysoce průkazné rozdíly v hodnotách aritmetických průměrů, výrazné překrývání horních a dolních hranic variační šíře mezi jednotlivými druhy, snižuje jejich praktickou využitelnost pro rozlišení jednotlivých zástupců komplexu. Vzhledem k vysoké korelaci s délkou perigynia byly tyto znaky zařazeny až na 9. a 8. místo v souboru 14 sledovaných znaků. Ze všech znaků na nažce diskriminační analýza nejvýše ohodnotila délku zobánku nažky. Je nutné zdůraznit, že všechny znaky na nažce jsou velmi důležité pro rozlišování dvojice *C. lepidocarpa* a *C. tumidicarpa*.

Konečné výsledky diskriminační analýzy ukázaly, že ze 14 hodnocených znaků přispívalo k rozlišení zástupců komplexu dvanáct. Přitom již tři znaky (délka perigynia, šířka listenu a délka samčího klásku) rozlišovaly jednotlivé zástupce komplexu na vysoké hladině významnosti.

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