REMARKS ON TAXONOMY OF SOME SPECIES OF *ELYTRIGIA* S.L. (*TRITICEAE*) IN THE LIGHT OF EMBRYO MORPHOLOGY

ROMUALD KOSINA

Institute of Botany, University of Wrocław
Kanonia 6/8, 50-328 Wrocław, Poland

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ABSTRACT

Embryos of 21 accessions of the genus *Elytrigia* s.l. were studied. Characters of scutellum, coleoptile, coleorhiza and epiblast were taken into consideration. Correlation of characters proves an independence of epiblast organogenesis. Principal components analysis reveals high loadings of embryo axis characters in the component I. Length of embryo, width of coleoptile and width of epiblast base were chosen as the best discriminants to distinguish the species. Cluster analysis joins, among other things, *Elytrigia intermedia* and *E. elongata*, *E. elongata* and *E. juncea* as well as *E. repens* and *E. pungens*. PCA shows an intermediate position of *E. nodosa* and *E. intermedia* in relation to *E. elongata* and *E. repens*. *E. geniculata* is an intermediate between *E. juncea* and other species. Scattering of species in the PCA diagram is consistent with Löve's genomic system of the *Triticeae* taxonomy.

KEY WORDS: *Elytrigia* s.l., embryo structure, numerical phenetic approach.

INTRODUCTION

Morphological studies in plants are still justified because the evolution of traits of different kind is realized by different ways (Giles 1984). There is, e.g. in the genus *Hordeum*, some inconsistency between the morphological data and the biochemical/meiotic data (Jørgensen 1986). The below quantitative data on embryo morphology in some members of the *Triticeae* are new for knowledge of these grasses. Such data, e.g. on hybrids, may help to understand the evolutionary pattern in the *Triticeae*, which is reticulate. This pattern is created by at least two factors: allopolyploidy and homoploid recombinational speciation (Jauhar and Crane 1989). The level of the embryo differentiation may also show the evolutionary age of the species, cf. in *Triticum* (Kosina 1995). An analysis of interrelations between embryo traits may reveal developmental synchrony or may distinguish groups of traits closely related, e.g. in the genus *Stipa* (Scagel and Maze 1984) and in *Triticum* (Kosina 1995).

The interpretation of morphology of the grass embryo involved many doubts (Brown 1960). There appeared here as helpful investigations of the embryo mutants, cf. in *Arabidopsis thaliana* (Meinke 1985), in *Oryza sativa* (Nagato et al. 1989) and in *Zea mays* (Clark and Sheridan 1991). The embryogenesis of the distant hybrids in the *Triticeae* shows many interesting patterns (Ivanovskaya 1983). Plant embryogenesis is considered as particularly useful in the genetic analysis (Sheridan and Clark 1987, Meinke 1991). The structure of the grass embryo and its importance for systematics of *Poaceae* Barnh. was studied by Reeder (1957). Some

data on the embryo structure were applied by Baum (1977) for taxonomy of *Triticeae* and by Kosina (1996) in taxonomy of the genus *Bromus*. Baum and Bailey (1984) described also the usefulness of the epiblast morphology for the taxonomy of some species of the genus *Hordeum* L. Recently, Kosina (1995) has noted a significant differentiation in wheat tetraploids with respect to some embryo structures. To distinguish species within different grass genera different sets of the embryo traits may be selected (Kosina 1991c). The development of suspensor and epiblast can be considered as particularly interesting for the above purpose. These organs may, however, undergo significant changes due to mutation, e.g. in *Arabidopsis* (Marsden and Meinke 1985), or to environmental stress, e.g. in *Triticum* L. (Kosina 1989). The goal of the present analysis is, in the first place, to recognize the variation and interrelations between embryo structures studied and then to apply these new data for taxonomy of the genus *Elytrigia*. The area of grass biosystematics related to embryo morphology has been neglected up to now.

MATERIALS AND METHODS

The taxa of the genus *Elytrigia* Desv. studied are named according to Tzvelev's (1976) system and designated by the abbreviations given: *E. caespitosa* ssp. *nodosa* (Nevski) Tzvel. – (CN), *E. elongata* (Host) Nevski – (E), *E. geniculata* ssp. *scythica* (Nevski) Tzvel. – (GS), *E. repens* (L.) Nevski ssp. *repens* – (RR) and ssp. *elongatiformis* – (RE), *E. intermedia* (Host) Nevski ssp. *intermedia* – (II) and ssp. *trichophora* –

Fig. 1. Diagram of the frontal view of *Elytrigia* embryo. s – scutellum, iss – internal scale of scutellum, c – coleoptile, e – epiblast, r – radicle, cp – coleorhizal papilla, 1, 2, 3, 4 – numbers of some characters measured.

(IT), *E. pungens* (Pers.) Tutin – (P), *E. juncea* ssp. *bessarabica* (Savul. et Rayss) Tzvel. – (JB). However, according to Löve's (1984) treatment they belong to four genera: *Elytrigia* (RR, RE, II, IT, P), *Lophopyrum* (CN, E), *Pseudoroegneria* (GS) and *Thinopyrum* (JB). Accessions were reproduced in the author's collection of *Triticeae* in the Botanical Garden of the Wrocław University. They were planted in uniform conditions of climate and soil and isolated against intercrossing. In random samples of the taxa, each of $n = 30$ embryos, the nine following embryo characters were assessed (see also Fig. 1):

1. Scutellum width
2. Coleoptile width
3. Width of epiblast base
4. Embryo length (including coleorhizal papilla)
5. Embryo axis length (coleoptile plus radicle with papilla)
6. Epiblast height
7. Coleoptile length
8. Radicle length
9. Coleoptile distance from its top to the internal scale of scutellum – a measure of juvenility of coleoptile,

and some character ratios were also calculated:

10. 2/1 (width relation between coleoptile and scutellum)
11. 3/2 (width relation between epiblast and coleoptile)
12. 5/4 (length relation between embryo axis and a whole embryo)
13. 5/6 (length relation between embryo axis and epiblast)
14. 3/6 (shape of epiblast)
15. 7/8 (length relation between coleoptile and radicle)
16. 4/9 (length relation between embryo and coleoptile)
17. 2/7 (shape of coleoptile)
18. 1/4 (shape of embryo).

The material was submitted to one-way classification in completely randomized design. The caryopses were prepared in a formalin : ethanol : acetic acid fixative. The embryos were stained with bromophenol blue for prominence of the epiblast and coleorhizal papilla. Measurements of embryo structures were taken in frontal position. The following statistical methods were applied:

1. Pearson's coefficients of correlation to study interrelations between traits,
2. Multiple regression where a MAXRES statistics was used to select the most informative traits. The MAXRES value is the maximal residual variation of characters not included in a set of representatives, i.e. the characters describing best a given accession.
3. Principal components analysis for two goals:
 - a) a selection of groups of characters displaying a similar nature,
 - b) an ordination of species in the principal components space.
4. A Wilks' lambda statistics to select the characters discriminating best the species studied. $\Lambda = |W|/|C|$, where $|W|$ and $|C|$ are determinants of matrices of the intergroup and total variation, respectively. A set of characters described by the minimal value of lambda has the highest discriminative value.
5. Cluster analysis for grouping of species of a similar phenetic nature.

The calculations with the use of methods of multivariate analysis and numerical taxonomy were performed in the Computer Centre of Wrocław University according to Bartkowiakowa (1982) and Kucharczyk (1982).

RESULTS

Variation of characters

Ranges of means presented in Table 1 when compared to minimal value of means are large for: dimensions of epiblast (nos. 3 and 6), length of embryo axis and length of its components (coleoptile, radicle), juvenility of coleoptile, shape of epiblast, ratio between embryo length and distance of coleoptile to the internal scale of coleoptile, width growth relation between epiblast and coleoptile, length ratio between embryo axis and epiblast. Then, in relation to the above traits, the species are most differentiated. The mean coefficients of variation present a similar level of variability for a given character in all species studied. For characters 1, 2, 4, 5, 7, 8, 10, 12, 15, 17 and 18 the coefficient of variation $\approx 10\%$, for remaining ones $V > 36\%$. Large variation of the epiblast dimensions is observed especially in *E. juncea* ssp. *bessarabica* (see in the Table a minimal value of the epiblast height). In embryos of this species the epiblast was often absent or developed as a small rim.

Correlations of characters

Table 2 presents a correlation matrix for *E. intermedia* subsp. *trichophora*. It contains 44 % of significant correlation coefficients of their total number. The percentage of such coefficients in the matrix for *E. repens* is only 23 %. The linear characters of the embryo are strongly interrelated but the dimensions of epiblast, especially its width, and the measure of coleoptile juvenility are not always so. For these two structures, epiblast and coleoptile, one may accept some independence from other embryo organs. The ratios of characters are significantly correlated only with one of the characters used for calculation of the ratio. There are distinct correlations between length of coleoptile and measurements of the scutellum and the embryo as a whole.

Choice of the representatives

(numerical details not presented)

The analysis of multiple regression was used to establish the MAXRES value (maximal loss of information about the characters not included in the set of representatives). The ana-

Fig. 2. Localisation of embryo characters of the genus *Elytrigia* along axes of the first two principal components after Varimax rotation. The value and sign (+ a line arrowed up, - a line arrowed down) of the third component are shown. For this purpose the axis of the second component has been used. Variation exhausted by components for all characters: PC I, PC II, PC III. Character number/sum of variation exhausted by three components.

lysis was two-stage. At first it was performed for linear embryo characters (a choice of representatives was made arbitrarily for MAXRES < 0.500) and separately for ratios. The best representatives for the characters measured were: nos. 3, 4, 6, 9, (MAXRES = 0.294), and for ratios: nos. 10, 11, 13, 15, 16, 17, 18 (MAXRES = 0.181). The above representatives were analysed jointly once again and a final set of representatives for MAXRES = 0.312 is: 6, 9, 10, 11, 13, 15, 16, 17, 18. Then, the characters: height of epiblast, the coleoptile juvenility, shapes of embryo and coleoptile, but also several character ratios are all important to characterize the embryo.

Principal components analysis (PCA) for characters

The characters of embryo axis: 1, 2, 4, 5, 6, 7, 8, 15, 17 display the greatest loadings in the component I (Fig. 2). The characters of epiblast (excluding its height): 3, 11, 13, 14 exhibit the greatest loadings in component II. Component III (see arrows in Fig. 2) well describes coleoptile juvenility, length ratio of embryo axis and of embryo, and shape of embryo (characters nos. 9, 12, 18). The characters nos. 10 and 16 are described by remaining components. Some of characters are poorly described by three components. These are the

character nos.: 6, 9, 10, 13, 15, 16, 17 (a variation exhausted below 50 % of the total). Measurements of the epiblast and of the trait no. 9 have distinctive position in the diagram when compared each other and in relation to other direct measurements of the embryo. This supports earlier conclusion drawn from the correlation analysis.

Discriminative value of characters (Table 3)

The characters: length of embryo (no. 4), width of coleoptile (no. 2), width relation between epiblast and coleoptile (no. 11) and width of epiblast base (no. 3) are, in decreasing order, the most important for the discrimination of taxa. The chosen eight discriminants (nos. 4, 2, 11, 3, 6, 15, 9, 10) are well scattered along the axes of principal components (Fig. 2). An exception are nos. 2 and 4, but when they are chosen together the Wilks' lambda value decreases distinctly. Additionally, a difference between these traits is visible in the percentage (14%) of variation explained by the three principal components (see Fig. 2). Character no. 11, being a ratio of nos. 3 and 2, has a separate position within the PCA diagram. Therefore, this trait has its own informative value and may be also used as a discriminant.

TABLE 1. Basic statistical parameters of embryo characters of the genus *Elytrigia*.

Character number	Range of means	Mean coefficient of variation (in per cent)
1	0.66 – 1.18 (in mm)	8
2	0.39 – 0.69 (in mm)	9
3	0.02 – 0.30 (in mm)	36
4	1.01 – 1.99 (in mm)	9
5	0.72 – 1.64 (in mm)	10
6	0.00 – 0.04 (in mm)	43
7	0.37 – 0.91 (in mm)	12
8	0.35 – 0.74 (in mm)	11
9	0.04 – 0.19 (in mm)	57
10	0.53 – 0.61 (a ratio)	7
11	0.24 – 0.68 (a ratio)	36
12	0.74 – 1.04 (a ratio)	5
13	6.54 – 17.90 (a ratio)	53
14	0.77 – 4.55 (a ratio)	54
15	0.97 – 1.44 (a ratio)	12
16	11.90 – 48.10 (a ratio)	60
17	0.71 – 1.08 (a ratio)	11
18	0.54 – 1.02 (a ratio)	8

Numerical analysis of taxa

Fig. 3 presents the cluster analysis made by Ward's method and with the use of Mahalanobis' D^2 . A correlation coefficient between distances and cophenetic values is 0.500. A phenon line arbitrarily drawn at the level of 10 % of D^2 value separates six clusters: 1. *caespitosa* subsp. *nodosa*; 2. *caespitosa* ssp. *nodosa*, *intermedia* ssp. *intermedia*, *intermedia* ssp. *trichophora*; 3. *intermedia* ssp. *trichophora*, *elongata*; 4. *elongata*, *intermedia* ssp. *intermedia*; 5. *intermedia* ssp. *intermedia*, *elongata*, *junceae* ssp. *bessarabica*, *geniculata* ssp. *scythica*; 6. *repens* both subspecies, *pungens*. An ordination of taxa along axes of two principal components (see Fig. 4) exhibits the intermediate character of *E. intermedia* ssp. *trichophora*, *E. caespitosa* ssp. *nodosa* and *E. intermedia* ssp. *intermedia* between *E. repens* and *E. elongata*. *E. repens*, *E. juncea* and *E. elongata* are the taxa in which the values reach extrema. *E. geniculata* ssp. *scythica* occupies an intermediate position between *E. juncea* ssp. *bessarabica* and *E. intermedia* (both subspecies). *E. juncea* ssp. *bessarabica* is very distant to all other taxa. *E. pungens* is close especially to *E. repens* ssp. *repens*. The species appear to be uniform in relation to value and sign (see arrows in Fig. 4) of the third component. Some exceptions are: *E. repens* ssp. *elongatiformis* when compared with ssp. *repens* and two accessions of *E. elongata* close to *E. intermedia* ssp. *intermedia*.

DISCUSSION

The coefficients of variation presented (Table 1) exhibit particularly high values for characters of epiblast, coleoptile juvenility and for their ratios. Both organs (epiblast and coleoptile) can be noticeably changed by environmental stress or in distant hybrids (Kosina 1989; Kosina and Heslop-Harrison, in press). Disturbances in their development may indicate instability of the taxon, as it was observed for some wheat tetraploids (Kosina 1995). It was related to the evolutionary age of

the species, cf. *turgidum* wheats versus *timopheevi* wheats within the genus *Triticum*. Large variation of these characters in the species of the genus *Elytrigia* may be a result of cytogenetic imbalance caused by spontaneous crossings. During embryogenesis in *Hordeum*, the scutellum and coleorhiza develop first of all, followed by the coleoptile, and lastly by the epiblast (Kosina, unpublished). The structures developing later are more sensitive to mutagenesis since more nucleus divisions occur before their initiation takes place, e.g. epiblast.

The low correlations of epiblast dimensions with other embryo characters, firstly, prove a weak covariation of these structures and, secondly, corroborate the developmental independence of this structure like in the genus *Triticum* (Kosina 1995). The choice of representatives (the first stage) indicates once again the lack of developmental connection between epiblast and coleoptile juvenility. Information on the remaining measurable embryo characters is highly related to the embryo length. One should add that the width of epiblast base and height of epiblast are both important for description of an embryo. This should indicate two stages of epiblast development: 1. initiation of epiblast rim, 2. its later development as a flat structure. The epiblast can be arrested at the first stage and it is interpreted as a lack of this structure (Baum 1977). The two-stage development of the epiblast is confirmed by the PCA diagram for characters (see Fig. 2) – the characters nos. 3, 4, 6, 9 are well scattered along PC axes. The choice of discriminants shows some convergence with the analysis of the most representative characters – the discriminants are also well distributed along PC axes. A set of discriminants may be different for different species or genera, e.g. to distinguish hexaploid species of *Triticum* or species within the genus *Bromus* measurements of the coleorhizal papilla as well as information on lateral roots are necessary (Kosina 1991c, 1996).

The given phenogram (Fig. 3) based on discriminants shows the central position of *Elytrigia caespitosa* ssp. *nodosa* as well as the intermediate character of some forms of *E. trichophora*, *E. intermedia* and *E. repens*. Cluster no. 6 is composed of

TABLE 2. Matrix of the significant correlation for the embryo characters in *Elytrigia intermedia* ssp. *trichophora* (n = 60, r x 100).

Character number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
18	59...	25.	-	-	-	-	-	-	-	-45...	-	-	-	-	-	-	-
17	-51...	-34..	-	-70...	-79...	-31.	-85...	-46...	51...	26.	-	-52...	-27.	-	-73...	-41..	-
16	-	-34..	-	-	40..	26.	48...	-	-86...	27.	-	54...	-	-	44...	-	-
15	60...	63...	-	56...	63...	-	86...	-	-54...	-	-	38..	-	-	-	-	-
14	-	-	49...	-	-	-	-	-	-	-	52...	-	87...	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	36..	-	-	71...	37..	51...	39..	-62...	-	-	-	-	-	-	-	-
11	-	-	96...	-	-	41..	-	-	-	-	-	-	-	-	-	-	-
10	-52...	28.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	-25.	-43...	-	-	-47...	-	-57...	-	-	-	-	-	-	-	-	-	-
8	40..	40..	-	65...	69...	41...	51...	-	-	-	-	-	-	-	-	-	-
7	73...	75...	-	82...	88...	35..	-	-	-	-	-	-	-	-	-	-	-
6	-	29.	51...	29.	42...	-	-	-	-	-	-	-	-	-	-	-	-
5	62...	63...	-	83...	-	-	-	-	-	-	-	-	-	-	-	-	-
4	69...	59...	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	67...	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

., .., ... Significance levels at alpha = 0.05, 0.01, 0.001, respectively

both subspecies of *E. repens*. The problem of close morphological affinity of both subspecies is considered by Dewey (1980). It is more clear in the light of wide morphological variability in *E. repens* (Prokudin 1982, Kosina 1991a). Both subspecies are considered within the common wide range of karyotypes (Petrova 1975, Dewey 1980). These and *E. pungens* may belong to the common genus (Löve 1984).

The ordination of forms along PC axes (Fig. 4) only partly corroborates the specificity of sections proposed by Tzvelev

(1976). The position of *E. pungens* could suggest its hybrid origin from *E. juncea* x *E. repens* (Tzvelev 1976), but emphasizing an evident similarity to *E. repens* ssp. *repens* (see a value and sign of the third component). *E. pungens* is geographically restricted to coastal and interior regions of Western Europe. The coastal area is also typical for *E. juncea* ssp. *bessarabica*. Concluding from the Cauderon's study, Dewey (1984) accepted one genome in common for *E. juncea* and *E. pungens*. A relationship between *Thinopyrum bessara-*

TABLE 3 Choice of embryo characters with the highest value of discrimination for species of the genus *Elytrigia*.

Numbers of characters in the discriminative set																		Wilks' lambda
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.244
-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.126
-	+	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	0.082
-	+	+	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	0.050
-	+	+	+	-	+	-	-	-	-	+	-	-	-	-	-	-	-	0.034
-	+	+	+	-	+	-	-	-	-	+	-	-	-	+	-	-	-	0.024
-	+	+	+	-	+	-	-	+	-	+	-	-	-	+	-	-	-	0.017
-	+	+	+	-	+	-	-	+	+	+	-	-	-	+	-	-	-	0.013
-	+	+	+	-	+	-	-	+	+	+	-	-	-	+	-	+	-	0.010
-	+	+	+	-	+	+	-	+	+	+	-	-	-	+	-	+	-	0.006
+	+	+	+	-	+	+	-	+	+	+	-	-	-	+	-	+	-	0.005
+	+	+	+	-	+	+	-	+	+	+	-	-	-	+	-	+	+	0.005
+	+	+	+	-	+	+	-	+	+	+	+	-	-	+	-	+	+	0.004
+	+	+	+	+	+	+	-	+	+	+	+	-	-	+	-	+	+	0.003
+	+	+	+	+	+	+	-	+	+	+	+	+	-	+	-	+	+	0.003
+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	0.003
+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	0.002
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	0.002

+ or -: a character present or absent in the discriminative set

Fig. 3. Dendrogram for species of the genus *Elytrigia* in an analysis of embryo characters according to Ward's method. Applied set of discriminants: nos. 2, 3, 4, 6, 9, 10, 11, 15. Coefficient of cophenetic correlation, $r = 0.50$.

bicum and *Lophopyrum elongatum* (designated as JB and E in this study) drew attention of the students. Jauhar (1988) reckoned genomes of both species as homoeologous at best, while Wang and Hsiao (1989) recognized these genomes even as homologous. *In situ* hybridization of the total genomic DNA revealed almost identity of both genomes (Kosina and Heslop-Harrison, in press). Morphology of the embryo of both species is, however, different as it is apparent in the PCA diagram. They are also distant with respect to the set of isozymes (Jarvie and Barkworth 1990). Hence it may be concluded that morphological diversification is induced by rather small genetic changes, cf. Gottlieb's (1984) review, which are invisible in a fluorescence pattern of hybridization of the genomic DNA. *E. geniculata* ssp. *scythica* is here as distant from *E. elongata* as with relation to some isozymes (Jarvie and Barkworth 1990). Both kind of data, embryo morphology versus isozymes, do not fit well when distances between *E. elongata* and *E. intermedia* are compared. There is here incongruence of the data. It is exemplified also by others (Giles 1984, Jørgensen 1986, Kellogg 1989). Both species have, however, one or more genomes in common (Dewey 1984). Embryo morphology may, nevertheless, conform well with other kind of data, e.g. in the genus *Bromus* (Kosina 1996). A scatter diagram (see Fig. 3) partly corroborates Kellogg's (1989) considerations on the distant relationships between *Thinopyrum* (JB) and *Lophopyrum* (CN and E) based on morphology. The diagram fits very well the Löve's system of the *Triticeae* taxonomy based on genomic relationships. Concluding from

the embryo morphology it is possible to distinguish genera *Thinopyrum*, *Pseudoroegneria*, *Elytrigia* and *Lophopyrum*. The latter two have overlapping ranges of variation. Some accessions of *Lophopyrum elongatum* are very similar to *Elytrigia intermedia* ssp. *intermedia*.

Some kind of instability noted in *E. juncea* ssp. *bessarabica* for the epiblast development (see also Kosina 1991b) is confirmed by Heneen's (1963) data about an extreme cytogenetic anomaly in some individual of *Thinopyrum junceum*. Aberrations were found in root as well as in ovular tissues. In multiple hybrid involving *Thinopyrum distichum*, a close relative of *Elytrigia juncea* ssp. *bessarabica*, profound cytogenetic alterations correlated with instability of the epiblast development were also reported (Kosina and Heslop-Harrison, in press).

CONCLUSIONS

1. Among embryo traits studied in the species of the genus *Elytrigia* (*Triticeae*) the dimensions of epiblast and distance between coleoptile and internal scale of scutellum are very variable. *E. juncea* ssp. *bessarabica* reveals some instability of epiblast development.
2. Correlation analysis proves an independence of epiblast development, especially at the moment of its initiation. There are also close interrelations between traits of the embryo axis.

3. Dimensions of epiblast, embryo length including coleorhizal papilla and distance of coleoptile from internal scale of scutellum are sufficient to describe the embryo of *Elytrigia*.
4. Within the PCA diagram it is easy to distinguish a group of embryo traits, dimensions of epiblast and shape of embryo and of its organs. Length of embryo, width of coleoptile, width relation between epiblast and coleoptile and width of epiblast base were found to be well discriminating the species.
5. Cluster analysis proves a close relationship between *E. elongata* and *E. juncea* ssp. *bessarabica* as well as between *E. repens* and *E. pungens*.
6. Ordination analysis by means of PCA supports the LÖVE's genomic treatment of the *Triticeae* including the species analyzed into four genera: *Elytrigia*, *Lophopyrum*, *Pseudoroegneria* and *Thinopyrum*. *Lophopyrum* and *Elytrigia* have overlapping ranges of variation.

Fig. 4. Distribution of species of the genus *Elytrigia* along the first two principal components in an analysis of embryo characters. The value and sign (+ a line arrowed up, - a line arrowed down) of the third component are presented. The axis of the second component has been used for this purpose. PCI, PCII, PCIII - variation exhausted by components for all the taxa studied. Applied set of discriminants: nos. 2, 3, 4, 6, 9, 10, 11, 15.

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UWAGI O TAKSONOMII NIEKTÓRYCH GATUNKÓW RODZAJU
ELYTRIGIA S.L. (*TRITICEAE*) W ŚWIETLE MORFOLOGII ZARODKA

STRESZCZENIE

Badano morfologię zarodka gatunków szeroko ujmowanego rodzaju *Elytrigia*. Analizowano cechy tarczki, koleoptyla, koleoryzy i epiblastu. Analiza macierzy korelacji dowodzi niezależności organogenezy epiblastu. Pierwsza składowa główna opisuje oś zarodka. Długość zarodka i szerokości koleoptyla i podstawy epiblastu okazały się cechami najlepiej dyskryminującymi badane gatunki. Analiza skupień wykazała podobieństwo fenetyczne między *Elytrigia intermedia* i *E. elongata*, *E. elongata* i *E. juncea* oraz między *E. repens* i *E. pungens*. Diagram PCA przedstawia pośrednią pozycję *E. nodosa* i *E. intermedia* między *E. elongata* i *E. repens*. *E. geniculata* jest pośrednia wobec *E. juncea* i pozostałych gatunków. Rozmieszczenie gatunków na diagramie PCA jest zgodne z genomowym systemem Löve zastosowanym w taksonomii plemienia *Triticeae*.

SŁOWA KLUCZOWE: *Elytrigia* s.l., morfologia zarodka, fenetyczna analiza numeryczna.