MORPHOLOGY OF LODICULES, THEIR VARIABILITY AND IMPORTANCE IN THE TAXONOMY OF THE *POACEAE* FAMILY

by

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INTRODUCTION

The knowledge of the inner and outer structure of lodicules is still incomplete. The use of their morphological variability for the taxonomical characterization is, therefore, negligible. In the set of diacritical features of grasses was most often used the number of lodicules in the floret.

In the last century the morphology of lodicules was investigated in detail by Raspail (1825), who distinguished types of them. The opinion of this botanist and, likewise, of some of his followers, that the shape of lodicules is an outstanding feature of the genus, was corrected so that the structure of the lodicules may be characteristic for a group of species, even for a single species of a genus containing more species (Jozífová, Ms). Some morphological features of lodicules were used also by Kunth (1833) and Nees ab Esenbeck (1843). In his thesis on the structure of grass florets Petermann (1835) introduces an intricate terminology of the lodicule morphology.

HISTORY OF THE PROBLEM

The importance of morphological features of lodicules for the taxonomy of grasses (and, in the same way, of features of the lemma, palea, pistil and caryopsis) was stressed by the German botanist Krause (1903, 1909). It was not till after half a century that the Japanese graminologist Tateoka (1960a:101) evaluated the importance of his pioneer work.

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Unfortunately, Krause had no immediate followers to investigate the lodicules and other parts of grass florets. The importance of lodicules for the taxonomy did not come to the foreground till the era of the grass taxonomy, when it was being stressed that in this group of plants, highly varied and extremely numerous in taxa ± unequivocal taxonomical conclusions can be obtained only by evaluating the results of a comprehensive (complete) investigation of their taxa, i.e. their morphology, histology, cytology, phytogeography, embryology, ecology, chemistry, etc. On this connection it is essential to mention, besides others, Prat (1936), Hubbard (1946, 1948, 1954), Parodi (1958, 1961) and Stebbins (1956). Bergal (1949), who contributed to the detailed knowledge of the lodicule structure of cultivated barleys and to verification of its taxonomical importance. Nietsch (1960, 1961, 1962) makes a mention of size, shape, division and indumentum of the lodicules in the set of the morphological features of the spike characteristics in some wheat cultivars *(Triticum aestivum)*.

Since the fifties of our century, there have appeared agrostological studies where, in the set of features from the sphere of florets, the taxonomic-diacritical importance of lodicules features is being stressed, e.g. the number, growing together, shape, consistence, indumentum and nervature. To their authors belong specially Church (1949), De Wet (1954, 1958), Tateoka (1959, 1960a, 1960b, 1961, 1962a, 1962b, 1964), Reeder and Ellington (1960), Stebbins and Crampton (1961), Parodi (1961), Takagi (1964, 1965) and Jirásek (1966). Stebbins (1956) was the first to deliminate in accordance with shape, nervature, and indumentum the four elementary morphological types of lodicules (festucoid, chloridoid, panicoid and bambusoid) which, together, with the set of further characteristics determine the basic taxonomical content of the chief streams (lines) of development in the *Poaceae* family. Tateoka (1960b, 1961 sec. Takagi 1964:1) included to them also the danthonioid-arundinoid type, and Reeder (1962) the centhothecoid type. Of the systematic criteria in grasses Auquier (1963) introduces, for the floret area only the number, shape and vascularization (nervature) of the lodicules.

The features given by the variability of the outer (and inner) structure of the lodicules are of the same value for the grass taxonomy as the characteristics of other parts of the grass floret, its starting type being designated, at present, by the majority of agrostologists as diplochlamydeic, pentacyclic-trimeric (compare e.g. Butzin 1965). The results of detailed investigations of the variability of the lodicule structure ascertained by analysing voluminous material, the determination of the taxonomic value of criteria obtained, their comparison with other features and thus determining the degree of their suitability of application of certain morphological features of lodicules for the characterization of taxa of grasses in various taxonomical categories, were hitherto outstanding in the graminological literature. The first attempt to fill a small portion of this gap, has been, at present, the manuscript paper by M. Jozífová, who, under the leadership and cooperation of V. Jirásek studied in detail the morphology of lodicules of more than 160 species in 64 grass genera in the Department (Institut) of Botany of the Charles University in Praha during 1964-1966.

The following text, accompanied by original drawings, is the first publication evaluating the obtained results. The above-mentioned workers appreciate very much the offer by the Sociedad Argentina de Botánica to publish their paper in the Society's Bulletin, issued in memory of the outstanding Argentine agrostologist, Profesor Lorenzo R. Parodi with whom V. Jirásek, was probably, as the only one of the Czechoslovak graminologists, for years, in professional contact. They were united in a sincere friendship based on scientific cooperation in the common branch.

Material and methods

The paper contains the results of investigating 151 species of grasses. Their classification into subfamilies, in fact into tribes and genera as well as the nomenclature have been carried out according to Parodi's textbook (1958), and according to the classification of the *Poaceae* family in the Flora of CSR (Jirásek in Dostál et al. 1950). The election of the taxa, especially of the genera has been chosen so that it would be as close as possible to the content of the Parodi's book. In the genera with numerous species, a larger number was investigated so that a true picture of the extent and the character of the lodicule variability would be presented.

For investigating the lodicules the most suitable material are fresh grass florets at a stage, when in bisexual or female florets the style with the stigmas is protruding outside, in male florets the stamina. The lodicules are not perfectly developed till shortly before the opening of the floret (compare also Hackel 1881:348). After flowering they lose their firmness, the fleshy parts of the lodicules becoming soft (festucoid), are ± squashed (panicoid and chloridoid) and, therefore, they miss many of the typical features of their structures. Also the lodicules of herbarium plants show a number of changes, therefore, the are hitherto not very suitable for investigation the lodicules. For that reason, they were used only when no fresh material was available.

The collected fresh material was fixed for later investigations in a 4 per cent formaldehyde solution, in which all floret parts can be preserved unchanged for a long time, and are thus suitable for the work. For permanent microscopical slides (specimens) 5 per cent formaldehyde was found to be the best medium. The fine structures of the lodicules were found unchanged in it after two years. The cover-slide, however, must in most cases be supported in the corners so that the lodicules do not lose their natural appearance. For the support little pieces of a crushed cover-slides are suitable. The cover-slides are framed by asphalt varnish immediately after finishing the microscopical slide and sucking of the superfluous formaldehyde, the best way to do it is to provide it with two layers of varnish, since the formaldehyde rapidly dries out. For each species investigated were the lodicules of a larger number of florets (15-20) per a plant and, likewise, from further individuals of the species from the same locality, however, mostly from several habitats.

MORPHOLOGY OF LODICULES AND THEIR VARIABILITY

The lodicules of the investigated taxa belong, by their structure, basically to some of the types (or approach to it) as deliminated by Stebbins (1956). It is a bambusoid type (compare plate I. A), festucoid (I. B), chloridoid (I.C); or panicoid (I.D). On the lodicules 18 features were investigated which appeared to be the most distinctive for the characterization of the outer and inner structure and the character of its variability. They were elected after evaluating the orientation study of the material. The terms of the descriptive morphology of the leaf-blades shapes have become the basis for their suitable designation. In some cases, however, new terms had to be suggested. The terms are applied in the descriptions of individual features and in the drawing captions where they are used to describe the four basic types of lodicules. More than 200 original drawings of the lodicule structure viewed from abaxial, or sometimes, adaxial side, illustrate well their polymorphy in the limits of the family and their variability in the studied taxa.

1. NUMBER OF LODICULES. — The prevailing majority of grasses possess two lodicules placed abaxially from the pistil, outside the outer whorl of stamina. However, in some species the lodicules are always absent (some species of the genera *Aristida* and *Alopecurus*, further in the genera *Anthoxanthum*, *Nardus*, *Jouvea*, *Lygeum*, *Anomochloa*, *Zoysia*, *Imperata*, etc.). Several representatives of the subfamilies *Bambusoideae*, *Olyroideae*, *Streptochaetoideae*, *Parianoideae*, and in the tribes *Phaenospermeae*, *Streptogyneae*, *Stipeae*, etc., there are three lodicules. The third lodicule, placed in the median of the floret, differs from the others by a simpler structure (Figs. 10, 12, 83b). Butzin (1965:129) mentions: "Die hintere Lodicula ist meist

schwächer ausgebildet, häufig auch nervenlos...". The occurrence of a single lodicule (in the median) may be explained by the growing together of the usual two lodicules of their median, neighbouring margins (Figs. 17, 18, 20-22).

2. Growing together of lodicules on their median margins. — The lodicules (pair) are most often free or grown together at the base (*Brachypodium, Oryzopsis,* etc.) or, rarely higher than at their base. By the growing together of two lodicules all along the their median margins originates a single lodicule (*Melica, Glyceria*). The degree of growing together, the place to which the lodicules are growing together, differs often also in a species. Sometimes, however, is the growing together of lodicules a ± constant feature in the genus, e.g. investigated species of the *Poa* genus.

3. Shape of the lodicule. — It is only the bambusoid lodicules which are vertically ± monosymmetrical (all in threes), others are mostly distinctly asymmetrical, panicoid sometimes in the shape of a ± isosceles trapezium. The cause of asymmetry of lodicules being the divided (articulate) lateral margin. In spite of that the festucoid lodicules viewed from the abaxial or adaxial side appear roughly lanceolate, oblong, ovate, obovate or elliptic, sometimes widely linear, as a rule, however, in different combinations of these basic shapes. The chloridoid and panicoid lodicules are ± cuneate to widely cuneate, and the bambusoid ± deltoid, elliptic, obovate or oblong. It is essential to designate the basic shape (outline) of the lodicule, without regard to the protuberance of the adaxial lobe or the abaxial margin on the apical area by the most fitting terms from the descriptive morphology of the leaf-blades. In festucoid lodicules the variability within the limits of the genus, is fairly considerable, while the chloridoid and panicoid lodicules are equaly shaped in such cases. In festucoid lodicules this analogy has been ascertained quite exceptionately (± *Stipa*, ± *Brachypodium*). The shape of the lodicules is considerably dependent on the stage of the floret ontogeny. Especially chloridoid and panicoid lodicules become conspicuously wide after flowering.

4. Ratio of the maximum width of the lodicule to its height (w/h). — In the festucoid and bambusoid lodicules this ratio is mostly < 1, in the chloridoid and panicoid ones ± 1 or > 1. Within a certain range this ratio is constant in a species, especially in the chloridoid and panicoid lodicules it depends on the degree of the floret ontogeny. The lodicules of some genera have ± equal shapes, differing only by the ratio w/h, e.g. *Brachypodium pinnatum* 1/3-1/4, *B. silvaticum* ± 1/2; similary so in the genus *Stipa.*

5. Location of the maximum width of the lodicule (distance from the base). — The panicoid lodicules are widest on the apex, the chloridoid ones not far from it, the festucoid mostly in the lower 1/2 of the lodicule height, rarely above the boundary of the two halves (Figs. 34, 38, 39, 45, 46, 48, 50, 51, 69, 112). Within a certain range the location of the maximum width on the lodicule is constant and significant for the species (Figs. 105 — ± 1/3, 110 — ± on the boundary of the two halves, 109 — ± 2/3).

6. Shape of lodicule margins. — The lateral and median margin (or one of them) are undivided, entire (mostly bambusoid lodicules), or divided in various ways with fine to ± deep cuts giving rise to segments. The irregularity in the division (articulation) of the lodicule margins, in the first place in the festucoid type are considerable. The margins (margin) can, further, be convex or concave in various degrees (with the extremes of the convexness or concaveness in various places of the margin). The margins, however, may also be ± vertical. The shape of the margins of the festucoid lodicules may be considered as a fairly variable feature. Divided is, in the first place, the adaxial lobe, more rarely the apical part of the lodicules. The panicoid lodicules have their lateral and median margin ± vertical and entire, as far as their abaxial margin at the apical plane (area) does not turn into a protuberance in different ways divided (Figs. 122a, 132d). In the chloridoid lodicules ± vertical is only the median margin. In festucoid lodicules most frequently both margins are slightly arched (Figs. 45, 81, 104, 116, 129, 142). Less frequently is the median margin ± straight and, contrariwise, the lateral archwise curved (Figs. 7, 26, 30, 100). Provided both margins in the upper part of the lodicule are arched in the same direction, the lodicule is ± laterally sickle-shaped (Figs. 13, 14, 66, 67, 82, 88-91). In the investigated representatives of the *Andropogoneae* tribe the lodicules are in all the width of ± even thickness, in the genera *Digitaria* and *Setaria* (Figs. 127, 128a, b) they are, however, narrowing towards the margins, or are divided in two lobes on the lateral margin (*Echinochloa crus-galli* - Fig. 126a, b, *Panicum miliaceum* - Fig. 125a, sometimes). The shape of the lodicule margins does not very significantly within the limits of the species. The extent and character of its variability is evident when comparing the drawings (Plates II, III, and IV).

7. Shape of lodicule apex. — They are different in festucoid lodicules (including the bambusoid) and chloridoid (including the panicoid). The difference is connected with the shape of the lodicule outline. In the first pair of types the apex is acute (± 30-90° to > 90° - Figs. 14, 15, 55, 102) or acuminate (< 30° - Figs. 7, 16,

33, 62c, 67, 68, 72). Often is the apex divided in different ways and to different depths (Figs. 60, 76, 78a, b, 136-140). The apical part of the lodicule with the acuminate apex is, as a rule, considerably long, the lodicules protruding above the ovary apex. In the majority of the investigated species with the festucoid lodicules, the shape (angle) of the lodicule apex was constant within a certain range, most often acute apices have been ascertained. Chloridoid and panicoid lodicules have their apices truncate or only slightly convex. Since these lodicules are ± thick and not membraneous, their apices have a little area, the so-called apical area, limited by the adaxial and abaxial margin of the lodicule. It is ± horizontal (Figs. 121, 126), sometimes in addition ± concave (Fig. 129), ± corrugated (Figs. 130, 131), sometimes adaxially inclined (Figs. 5, 128, 133a). Panicoid lodicules are the thickest in the region of the apical area, the chloridoid in the region of their adaxial margin. The apical area is, sometimes, very narrow, i.e. the distance between the adaxial and abaxial margin bein negligible (Fig. 131), in other cases it is ± missing (Fig. 127). In the lodicules of some species (Figs. 125b, 132b, d, 133b) the abaxial margin of the apical area protrudes, sometimes, in its vhole width into a protuberance, varied in shape, length (height), and the direction of the prolongation. Especially in the lodicules of the male floret of *Zea mays* the protuberance is very variable (Figs. 132b, d).

8. ADAXIAL LOBE. — It is developed in the festucoid and chloridoid lodicules. In the festucoid lodicules it is continuously connected to the apical part of lodicule (Figs. 88-91), the transient part forming a ± right to obtuse angle (Figs. 92a, b), or a distinct tooth (Figs. 31, 38, 39, 44). The adaxial lobe is very narrow, therefore ± indistinctive (Figs. 26, 28, 29, 62c, d, 65), in other cases it reaches a ± width of the lodicule body (Figs. 23, 30). Very often, in the festucoid lodicules, it protrudes into protuberance of different size, shape, direction and termination. Mostly, however, it does not reach very high above the upper limit of the swollen region of the lodicule, rarely below it (e.g. Fig. 35). The protuberance belongs to the not varying parts of the festucoid lodicules (several examples in the taxa of the tribes *Poeae*, *Aveneae*, *Phalarideae* and *Agrostideae*). Sometimes, the protuberance of the adaxial lobe is considerably large, the lodicule possessing then seemingly two apices (Figs. 38, 44, 59, 61, 96a, b). Somewhere, the lobe is considerably wide in its upper portion, so that the lodicule is all along of ± the same width, even the widest at the apex (Figs. 60, 61, 78a, b). The adaxial lobe is often divided in different ways (Figs. 32, 34, 43, 45, 54, 55, 57). In chloridoid lodicules the adaxial lobe has, viewed from the abaxial side

± the shape of an isosceles triangle of the lodicule height. It sits on the lodicule body as "a full cup handle".

9. ABAXIAL LOBE. — Present only in festucoid lodicules. Compared with the adaxial one, it is wider (Figs. 27, 29, 47, 52, 65), of ± the same width (Figs. 68-73) or narrower (Figs. 88-97, 114). The abaxial lobe is a free lateral part of the swollen region, in the spot of the narrowing of the swelling into the lodicule edge. The size of the abaxial lobe depends on the stage of the floret ontogeny. Lodicules possessing no the swollen region have also no abaxial lobe. A transversale section through the lodicule will realiably disclose whether both lobes are developed or only the adaxial one, or none, in the first case also the cut between them, and in the second, the edge (the chloridoid lodicules). E.g. Butzin (1965:130) concludes the set of conditions in the transversale sections of lodicules briefly in this way: "Die ursprüngliche Querschnittsform der Lodiculae ist symmetrisch mit symmetrischem Nervenverlauf, z.B. bei *Strepfochaeta, Teinostachyum* und einigen anderen. Aber schon bei der Mehrzahl der *Bambusoideae* werden die beiden vorderen Lodiculae asymmetrisch mit asymmetrischen Nervenverlauf und gleichen einander wie Bild und Spiegelbild. Dieses Verhalten in gesteigerter Form ist in den anderen Unterfamilien die Regel. Oft beobachtet man die sog. «Fischschwanzform» [a fish-tail shape] als Querschnittsbild der vorderen Lodiculae".

10. LODICULE EDGE. — It is formed by the lateral margin of the swelling from the spot where the swollen region is decreasing (festucoid lodicules) or on the boundary all along the whole length (height) of the lodicule on the lateral margin opposite to the adaxial lobe (chloridoid lodicules). In the festucoid lodicules the edge is either short, when it ends not high up above the upper margin of the swollen region, a medium edge provided it continues ± as far as to the 1/2 part of the lodicule streching between the upper margin of the swollen region and the lateral margin and, finally, a long edge when it reaches as far as to the lateral margin, i.e. to the spot where the abaxial lobe ends, resp. passess into the lodicule body. The length of the edge depends on the type of the transition of the swollen region of the lodicule into its membraneous region. In some representatives of the *Aveneae, Phalarideae* and *Agrostideae* tribes the edge is absent, elsewhere its is, as a rule, distinctive, e. g. in *Hordeae, Stipeae,* the majority of *Poeae.* The lodicules of some species of the investigated genera were without the edge (Figs. 93a, b, 94a, b, 104), other species, on the other hand, were provided with the edge (Figs. 95a, b, c, d, 96a, b, 101-103). In lodicules of taxa with ± short edge it is, as a rule, indistinctive (some of the investigated species of the genus *Poa).* The distinctiveness of the edge depends on the

stage of the floret ontogeny. In panicoid (? and bambusoid) lodicules the edge is absent since there is no adaxial lobe.

11. Lodicule corners. — Are present in panicoid and chloridoid lodicules. They are formed by the places of connection of the adaxial and abaxial margin of the apical area with the lateral and median margin of the lodicule. Viewing the lodicule from the abaxial (adaxial) side they have a shape of a ± 60-90° angle. The corners are either ± acute (Figs. 129, 130a, b, 131a, b) or are orbicular (Figs. 5, 127). It seems that the type of orbicularness of the corners depends on the stage of the floret ontogeny.

12. Lodicule consistence. — The festucoid and bambusoid lodicules are mostly in their upper ± 1/2 membraneous. The extent of the membraneous part of the lodicule depends on the extent in the swollen region, i.e. how far the swelling reaches from its base. The chloridoid and panicoid lodicules are thick and fleshy all along. The panicoid ones are the thickest at the apex, i.e. in the region of the apical area, the chloridoid in the region of the adaxial margin of this area, i.e. ± in their upper 1/6-1/4.

13. Lodicule swelling. — The swollen region is important only (?) in the festucoid lodicules, where there is a distinctive difference between the fleshy thickened lower, and the membraneous upper region of the lodicule. The chloridoid and panicoid lodicules are fall fleshy, nevertheless, they are thicker in their upper part. Besides the location of the swollen region, for the festucoid lodicule is important the shape of the swelling, its extent (range) thickness and the type of its passing into the membraneous part of the lodicule. Jozífová (1966: 33, Ms) distinguishes a slow passing, a not-abrupt passing. The differences are, together, shown in the length of the lodicule edge. In the first case, the edge stops ± as far as at the lateral margin of the lodicule, in the second case, the edge is short and, in the third, it is absent. The type of the passing of the swelling into the membraneous region of the lodicule can best be ascertained on a deliminated abaxial side of the lodicule, as it appears on its median-sagittal (longitudinal) section. In a slow passing of the swelling, its decrease continues as far as to ± not far under the lodicule apex (Figs. 134, 135) elsewhere, right to the apex itself (Figs. 7-9, 11). When investigating the material, the most frequent passing was the un-abrupt one, whereas the abrupt passing of the swelling was comparatively rare (Figs. 45, 46, 48-51). The shape of the swelling on the abaxial side of the lodicule is unequivocally shown by a transversale section in its thickest region. Ascertained were two extreme cases: flattened swelling (some representatives of the tribe *Hordeae*, species of the genera *Lolium* and *Avena*), and swelling

distinctively convex (most of the investigated material). The character of swelling depends largely on the stage of the floret ontogeny. In festucoid lodicules the swelling is but rarely absent (Figs. 136-141). The swollen region is either ovate (Figs. 7-9, 13, 45-55), most of the representatives of the tribe *Hordeae,* or widely elliptic to ± orbicular (Figs. 56, 57, 62a, b, c, d, 76, 82, 105). The swollen region stretches from the lodicule base into its various heights, e.g. to 1/5 (Fig. 72), 1/5-1/4 (Figs. 62a, b, c, d), 1/4 (Figs. 7, 73), 1/3 (Fig. 33), to 1/2 (Figs. 47-53), and the like. If the swollen region is only on the ± lodicule base, its apical region is considerably long.

14. Lodicule indumentum. — The lodicules are mostly glabrous, rather rarely hairy. For the indumentum ascertained is the distribution, density, shape, length and structure (number of cells) of the hairs. In the investigated of the *Hordeae* and *Seslerieae* tribs ascertained were always hairy lodicules, with hairs either on the margins only (Figs. 101, 103, 104, 136, 137, 140) or also in different degrees of density on the abaxial side of the lodicule above the swollen region (Figs. 100, 102, 105, 110-113), there with the hairs ± shorter than at the margins. Fairly rich indumentum was ascertained in cultivated (cultural) grasses-cereals (Figs. 97, 105, 109a, b, 110-113) or their relative wild species (Figs. 106a, 107a, b). Some taxa are distinguished with an irregular occurrence in the indumentum (Figs. 74, 75, 137). In the lodicules of the species *Holcus lanatus* hairs were ascertained only on the abaxial side of the swelling (Fig. 63), elsewhere only in the zone of the passing of the swollen region in the membraneous region of the lodicule (Figs. 72a, b). The types of indumenta and the structures of hairs were studied in detail in cultivars of double-row and multi-row barleys by Bergal (1949). He concludes that (l.c.p. 215): "...la pilosité de la lodicule peut servir pout l'identification des variétés". Bambusoid lodicules are the least hairy at the upper part of the margin, as a rule, however, right to the lower 1/2 with various density of hairs, having hairs often also at the abaxial side, particularly in the part of lodicule without the distinctive nervature. Prevailing are, similarly as in all other types of lodicules, unicellular hairs, only in a few species of bambusoid grasses, Takagi (1964, 1965) ascertained bi— or polycellular hairs. In panicoid lodicules hairs grow only at the lodicule apex, i.e. on the abaxial and adaxial margin of the apical area, especially in the corners (Figs. 129, 132a, b, c). The type of the lodicule indumentum may be, according to the results of the present investigations, considered for a distinguishing feature for the species. Therefore, it is necessary to pay an exceptionate attention to the indumentum when investigating the set of lodicule features.

15. Vascularization. — The nervature is well perceptible on the bambusoid, panicoid an chloridoid lodicules, further in the danthonioid-arundinoid lodicules (Tateoka 1960b, 1961, compare also Takagi 1964:2) and centothecoid ones (Reeder 1962:641). Vascularized lodicules were ascertained also when studying the material in *Oryza sativa*, *Leersia oryzoides* and in some species of the genus *Aristida*. Festucoid lodicules have no nervature (?). Regarding conspicuous morphological changes of these lodicules in their ontogeny the complete absence of vascular traces can hardly be assumed. It could be so only in lodicules of negligible sizes. Bergal (l.c.) ascertained nervature on transversale sections through lodicules only in barleys cultivars with the so-called large lodicules. He writes (p. 201): "...ces faisceaux des cellules ... sous forme de groupes de cellules conductrices réunies par trois ou quatre, à membrane non épaissie. Ces faisceaux des cellules, de section plus petite que les autres cellules, au nombre d'une vingtaine environ, sont dispersés dans la partie la plus épaissie de l'organe". In the lodicules of barley cultivars with the so-called small lodicules the mentioned author had found no nervature. The nervature in festucoid lodicules may thus be least assumed at least in the swelled region. Since in the festucoid lodicules it is not distinctive when viewed from the surface, this type of lodicules may be designated as "with concealed (obscure) nervature". About the lodicule nervature writes i.e. Butzin (1965:147) that: "Fur jede Lodicula wird ein Mutterbündel abgegeben, dass sich gleich darauf mehrfach aufteilt. Diese Aufteilungszone kann bis zur Basis zurückverlagert sein, so dass scheinbar zwei oder mehr Bündel in die Lodicula einziehen". According to Bergal (l.c.p. 207) the dimensions of the lodicules in the first, however, the presence of vascularization, and thus the function of the lodicules in cultivated barleys (and certainly in all grasses with festucoid lodicules with a prominent of swollen region) are in an absolute correlation with the type of the floret opening (blossoming) of the plants. "Toutes les variétés à grandes lodicules sont chasmogames, toutes les variétés à petites lodicules sont cléistogames". According to the data hitherto found it seems that the vascularization of panicoid and bambusoid lodicules is richer than that of the chloridoid (and centothecoid, and danthonioid-arundinoid ones). The vascular traces are mostly in larger numbers and are more frequently branched (at different heights from the lodicule base). The rich nervature was found especially in representatives of the *Andropogoneae* tribe. When typifying the nervature the degree of its distinctiveness is ascertained, the course of the vascular traces, i.e. especially the number of vascular traces entering the lodicule on its base separately, and the form of their branching. The aboundance and course of the nervature may be ascer-

tained by serial transversale sections at different heights through the lodicule, in the festucoid lodicules in the swollen region. The degree of the distinctiveness of the lodicule vascularization depends on the stage of the floret ontogeny.

16. Ratio of the lodicule height to the height of the ovary. — The lodicules reach with their apex to the ± top of the ovary, they protrude over it or do not reach it. The first and second case occurs mostly in festucoid lodicules, the last one in the panicoid and chloridoid ones. In other types of lodicules it will be necessary to verify the character of this feature on the material. The lodicules not reaching the top of the ovary were found, e.g. in some species of the genera *Poa* and *Bromus,* further in *Oryzopsis virescens, Dactylis glomerata, Cynosurus cristatus, Agropyrum cristatum, Avenastrum pubescens, Hierochloë australis, Baldingera arundinacea, Agrostis canina, Phleum pratense* and *Catabrosa aquatica.* According to present results of the investigations, it seems that in perfectly developed lodicules the ratio of the lodicule height to the height of the ovary is a constant feature. Sometimes it does not vary within the limits of the genus (*Stipa, Sesleria, Avena, Lolium*-the lodicules not protruding over the top of the ovary), or it differs among the species or their groups in the genus (*Agrostis canina, A. rupestris*-the lodicules not reaching the ovary top, in *Agrostis vulgaris* and *A. alba* the lodicules protruding over the top of the ovary). In some investigated species of the genus *Poa* the lodicules ± reach, in some others they protrude, and in some furthers they do not reach to the ovary. Similarly in some studied species of the genus *Bromus* the lodicules reach to 2/3, in others only to 1/2 of the ovary length, and in some species of the genus *Koeleria* the lodicules protrude over the ovary top while in others they only ± reach it.

17. Relation between the location of the lodicules and the palea. — In festucoid lodicules with both lobes at the lateral margin, the ends of the palea margins are freely placed into the cut between the lodicule lobes. In the chloridoid lodicules the end of the palea margins are on the abaxial side of the adaxial lobe, resp. between that lobe and the lodicule edge. In panicoid lodicules the margin ends of the palea are placed on the adaxial side (behind the lodicules) or on the abaxial side (before the lodicules), covering partly their lateral margin. The mutual relation of the lodicules and the palea can reliably be ascertained by a transversale section through the floret in such a distance from its base that the cut of the lodicule ± in its central part (festucoid lodicule), or the lodicule in the upper part (chloridoid and panicoid lodicules). In this connection mentions e.g. Arber (1934:152) that: "The spikelet of rice (*Oryza*

sativa) shows the unusual feature that the lodicules are joined to the margins of the palea at its base...". Also Butzin (l.c.) makes known the growing together of the lodicules to palea in *Uniola latifolia* Michx. ("Die Ränder der Lodiculae sind mit ihr-der Vorspelze-an der Basis verwachsen", p. 57), or in *Eragrostis mexicana* (Hornem.) Link ("Die Lodiculae sind ihr-der Vorspelze-ganz an der Basis angewachsen", p. 100). In other, resp. in all types of lodicules, the relation between the location of the lodicules and the palea has to be found by the further investigating the material.

18. Lodicules of grasses of the bisexual and male florets (sometimes ± suppressed) or male and female florets. — In some taxa the lodicules have the same structure in both types of the florets *(Arrhenatherum, Hierochloë)*, in others the lodicules of the male florets (or ± suppressed ones) and bisexual ones, differ (Figs. 111a, b, 112a, b, 128a, b, c, 129a, b, 130a, b, 131a, b).

Discussion

In the taxa investigated lodicules with differing structure in various degrees and directions were ascertained. The formation of individual morphological features of lodicules is very polymorphic within a family, in the species, eventually in the genera no distinctive variability has, however, been found. The degree of the constancy of lodicule features is, however, different in various genera and also, in some species. Within the boundary of the family the variability is considerable in the growing together of lodicules, in the shape of the lateral and median margins and the adaxial lobe. When evaluating the degree of constancy of the morphological features of the lodicules, and thus their importance for the taxonomy, it is necessary to regard that all are ± dependent on the stage of the floret ontogeny. In this regard it is essential to consider, in the first place, the variability of the width of the lodicule and its lobes, the shape and extent of the swollen region, the ratio of the height of the lodicule to the height of the ovary, and the total shape of the chloridoid and panicoid lodicules.

The most variable are the festucoid lodicules their polymorphy depending especially on the shape of the adaxial lobe, the lodicule apex and the extent of the swollen region. The panicoid lodicules are ± uniform in their shapes, almost always cuneate, sometimes with a striking protuberance on the abaxial margin of the apical area. Variable, however, is the nervature (the number of vascular traces and the fashion of their branching), the shapes of the corners and of the apical area and the type of the indumentum. In the chloridoid lodicules it is particularly the adaxial lobe which is variable (the ratio of its maximum width to the same measurement of the lodicule), and the shape of the corners. Basically they remind chloridoid lodicules (when viewed from the abaxial or adaxial side), the immage of a "cup with a full handle" (the adaxial lobe).

The festucoid lodicules are characterized by the following features: the outline shape, the ratio of the lodicule height to the height of the ovary, the apex, the indumentum, the edge, the adaxial lobe, the location (distance) of the maximum width of the lodicule from the base, the number of lodicules in the floret (other than two, which is normal), the shape of the lateral a median margins, the protuberance on the adaxial lobe, sometimes also the growing together of the lodicules In the chloridoid and panicoid lodicules it is the shape of the corners, of the adaxial and abaxial margins, the nervature, the apex (especially the formation of its area) and the indumentum. The number of lodicules and their shapes are not, in these cases, important. By studying the material it was ascertained that with the festucoid lodicules even the species may be determined by means of the set of the above features, in the chloridoid and panicoid ones "only" the genus, since the differences in the species with these types of lodicules cannot be ± reliably determined on the lodicules. It is very difficult to characterise genera with a larger number of species by means of lodicules only, or to deliminate a tribes with a larger number of genera. The polymorphy in the structure of the lodicules in the species or genera is, however, almost always the warning to a certain degree of non-uniformity of the relationships in the present genus or tribe, eventually also in the subfamily of the grasses.

Remarkable is the comparison of the morphological polymorphy of the lodicules and the determination of the type of their structure with the conclusions to which came Reeder (1957, 1961, 1962) by studying the structure of the embryo (median-sagittal section) and of the coleoptile (transversale section). To the types, which this author designated as festucoid or chloridoid-eragrostoid, belong according to the lodicule features, the festucoid and chloridoid types. An exception have been, up to now, the genera *Glyceria* and *Melica* (the embryo is festucoid, the lodicule is a single one, median, reminding by its shape panicoid type with indistinctive nervature). The types, where panicoid lodicules have been ascertained, belong, according to the structures of the embryo and coleoptile, all to the panicoid types. An exception makes at present only the lodicules of the male florets of *Zea mays* (a striking protuberance from the abaxial margin of the apical area) and the lodicules of *Panicum miliaceum*, which have an indistinctive nervature (only in the herbarium specimens?). In the representatives of the genera according to the structure of embryo and coleoptile of the arundinoid-danthonioid types ascertained were lodicules of various structures. In the genera *Phragmites* and *Danthonia* they were ± panicoid (? also the genus *Sieglingia*). The lodicules of *Phragmites communis* are on their adaxial side ± 1/3-1/4 of the width from the lateral margin convex, and by this part they enclose the ovary, the other part of the lodicules being thicker than the convex part. The lodicules contact each other by these parts and protrude conspicuously in the abaxial direction. A very similar exception is among the representatives of the lodicules with chloridoid types on the genus *Molinia*. In the investigated species of the genus *Danthonia* ascertained was a strikingly small w/h ratio for the panicoid lodicules (conspicuous < 1) and an orbicular truncate apex (? in herbarium specimens only). In the investigated species of the genus *Aristida* festucoid lodicules have been determined, but the nervature has been distinctly proceeding right to the apical region. In the genera *Oryza* and *Leersia* which are, according to Reeder by the structure of the embryo and the coleoptile of the oryzoid-olyroid type, the lodicule structure is likewise of a different type. The lodicules of *Leersia oryzoides* are "aristidoid", i.e. festucoid with a distinctive nervature. The lodicules of *Oryza sativa* approach ± most to the panicoid type. On the abaxial margin of the apical area there is a protuberance, the lodicules are doubled at the lateral margins, sometimes even joined with the palea margin The bambusoid type of the grasses according to the structure of the embryo and coleoptile has also a bambusoid type of the lodicules.

Therefore, it may be concluded, that the lodicules of the investigated taxa of grasses which, according to the studies by Reeder belonged by the structure of the embryo and coleoptile to the bambusoid, festucoid, panicoid, chloridoid-eragrostoid, danthonioid-arundinoid or oryzoid-olyroid types belonged by the set of their morphological features to some of these types. The difference in the structure of lodicules has been ascertained only in taxa which, according to the Reeder's investigations should belong to the danthonioid-arundinoid or, resp. to the oryzoid-olyroid type. It is also not excluded, that by a detailed study of the generic and specific contents of the present tribes also their new types will be deliminated by means of the set of features of the lodicules, i.e. except the centothecoid, perhaps also, the aristidoid, oryzoid and the like types. Owing to the limited amount of the material which could be investigated, it has, hitherto, been suitable to assign the taxa with a varied lodicule structure to some of their basic types, namely to the festucoid *(Leersia, Aristida)*, chloridoid *(Molinia)* and panicoid *(Phragmites, Danthonia, ? Oryza)*. It is, however, suggested that the festucoid type should be designated as pooid since the nominate subfamily of the *Poaceae* family is *Pooideae* (formerly *Festucoideae*).

SUMMARY

The aim of this paper was to draw attention to a utterly forgotten importance of the morphological features of the grass lodicules and the character of their variability for the taxonomy of the *Poaceae* family. The results of the future detailed investigation of the outer and inner structure of the lodicules can evindently help to carry out a new evaluation of the relationships among the taxa and to suggest, on the basis of this natural delimitation, the contents of at least some of the medium taxa, i.e. genera, tribes, subfamilies.

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THE CAPTIONS EXPLANATORY NOTES

Plate I.A – The bambusoid type of the lodicule; *I.B* - The festucoid type of the lodicule; *I.C* - The chloridoid type of the lodicule; *I.D* - The panicoid type of the lodicule; 1 - the lodicule viewed from the abaxial side; 2 - transversale section through the lodicule (in the festucoid lodicule ± through the centre of the swollen region, in the chloridoid ± in the place of the maximum width of the adaxial lobe);

3 - a longitudinal section through the lodicule (in the median); 4 - mutual location of the lateral margin of the lodicule and the palea margin (transversale section); a - lodicule height; b - lodicule width; c - swollen region; d - apical region (part); e - apex; f - median margin; g - lateral margin; h - adaxial lobe; i - abaxial lobe; j - edge; k - cut (between the adaxial and abaxial lobe); l - transient zone from the abaxial lobe to the edge; m - indumentum (hairs); n - abaxial side; o - adaxial side; p - adaxial margin of the apical area; r - abaxial margin of the apical area; s - area on the lodicule apex (apical area); t - nervature (vascularization); u - corners; v - palea margin.

Plates II, III and IV. — On the drawings the lodicule is mostly viewed from the abaxial side, of the lodicule pair it is the right-hand lodicule; in case the drawing represents the lodicule as viewed from the adaxial side, the test for the individual plates has always, the abbreviation "adax. side" in parentheses behind taxon name. Following are the symbols and numbers in the following order: the ratio of the lodicule height to the ovary height (+: the lodicule protrudes above the apex of the ovary + 1/3: the lodicule protrudes above the top of the ovary by ± 1/3 of its height; ± : the lodicule reaches ± the top of the ovary; — : the lodicule does not reach the ovary top; — ⅔: the lodicule reaches to the lower ± ⅔ of the ovary height); the minimum and the maximum measured height of the lodicules; the average height of the lodicules in μm (± of ten measurements).

PLATE II

1. *Sasa albo-marginata* Mak. et Shib. (+; 1720-2030; 1900 μm).
2. *Bambusa arundinacea* Willd. (+; 1670-2440; 1830 μm).
3. *Oryza sativa* L. (p = the palea margin, adax. side; —; 442-635; 535 μm).
4. *Leersia oryzoides* (L.) Sw. (adax. side; — ¾; 387-461; 428 μm).
5. *Phragmites communis* Trin. (adax. side; —; ±; 430-480; 450 μm).
6. *Danthonia provincialis* Lam. et DC. (adax. side; —; 680-920; 810 μm).
7. *Stipa capillata* L. (+ ⅓; 1350 μm).
8. *Stipa joannis* Celak. (+ ⅓; 2285 μm).
9. *Stipa pulcherrima* C. Koch (+ ⅓; 3000 μm).
10. *Stipa* L. - the third lodicule.
11. *Oryzopsis virescens* (Trin.) Beck (—; 840 μm).
12. *Oryzopsis virescens* (Trin.) Beck - the third lodicule.
13. *Cynosurus cristatus* L. (±; 540-610; 572 μm).
14. *Lolium perenne* L. (+; + ⅓; 760-880; 824 μm).
15. *Lolium remotum* Schrank (+; + ⅓; 730-990; 878 μm).
16. *Lolium multiflorum* Lam. (+ ⅓; 1020-1420; 1230 μm).
17. *Melica* L. (adax. side; *M. nutans* L.: —; 590-600; 617 μm; *M. uniflora* Retz.: —; 575 μm; *M. picta* C. Koch: —; 550-840; 745 μm).
18. *Melica* L. (adax. side; *M. ciliata* L.: —; 310-410; 343 μm; M. *altissima* L. —; 545 μm; *M. transsilvanica* Schur: —; 400-470; 440 μm).
19. *Briza media* L. (+ ¼; 870-1050; 1000 μm).
20. *Glyceria* R. Br. (adax. side; — ⅓; *G. aquatica* (L.) Wahlb.: 200-394; 241 μm; *G. fluitans* (L.) R. Br., *G. plicata* Fries, *G. nemoralis* Uechtr.-Koern.: 281-374; 331 μm).
21. *Glyceria* R. Br. - the transversale section through the lodicule.
22. *Glyceria* R. Br. (adax. side; — ⅓; *G. aquatica* (L.) Wahlb., *G. fluitans* (L.) R. Br., *G. plicata* Fries, *G. nemoralis* Uechtr.-Koern.).
23. *Bromus erectus* Huds. (— ⅔; 1440-1600; 1540 μm).
24. *Bromus monocladus* Dom. (— ⅔; 1000-1080; 1045 μm).
25. *Bromus inermis* Leyss. (— ⅔-½; 1440-1660; 1558 μm).
26. *Bromus sterilis* L. (— ⅓-½; 920-950; 942 μm).
27. *Bromus tectorum* L. (— ⅓-½; 920-1010; 978 μm).

28. *Bromus squarrosus* L. (– ½; 900-1080; 988 μm).
29. *Bromus mollis* L. (– ½; 750-940; 870 μm).
30. *Bromus ramosus* Huds. subsp. *benekenii* (Lange) Sch.-Kell. (– ⅔; 1130-1200; 1178 μm).
31. *Festuca silvatica* (Poll.) Vill. (±; 630-770; 720 μm).
32. *Festuca gigantea* (L.) Vill. (±; 850-1130; 1060 μm).
33. *Festuca arundinacea* Schreb. (+ ½; 1820-2030; 1900 μm).
34. *Festuca uechtritziana* Wiesb. (+ ¼; 950-1100; 1002 μm).
35. *Festuca pratensis* Huds. (+; 1000-1130; 1065 μ m).
36. *Festuca heterophylla* Lam. (±; 740-820; 780 μm).
37. *Festuca versicolor* (Tausch) Kraj. (+; 850-920; 780 μm).
38. *Festuca rubra* L. (±; 760-850; 805 μm).
39. *Festuca trichophylla* Ducros (±; 860-1000; 920 μm).
40. *Festuca picta* Kit. (+; 810-900; 945 μm).
41. *Festuca supina* Schur (+; 990-1070; 1030 μm).
42. *Festuca pseudodalmatica* Kraj. (+ ¼; 920-1170; 990 μm).
43. *Festuca valesiaca* Schleich. (+; 840-930; 890 μm).
44. *Bellardiochloa violacea* (Bell.) Chiov. (±; 710-780; 760 μm).
45. *Poa annua* L. (–; 453-505; 454 μm).
46. *Poa bulbosa* L. (+; 486-742; 556 μm).
47. *Poa laxa* Haenke (±; 555-701; 608 μm).
48. *Poa supina* Schrad. (–; 473-566; 516 μm).
49. *Poa molinerii* Balb. (±; 531-580; 555 μm).
50. *Poa nemoralis* L. (±; 594-639; 628 μm).
51. *Poa alpina* L. (–; 682-740; 707 μm).
52. *Poa granitica* Br. Bl. (–; 790-1000; 900 μm).
53. *Poa palustris* L. (±; 575-701; 621 μm).
54. *Poa remota* Fors. (–; 600-701; 642 μm).
55. *Poa pratensis* L. (–; 352-482; 423 μm).
56. *Sclerochloa dura* (L.) P. Beauv. (±; 590-800; 708 μm).
57. *Puccinellia distans* (Jacq.) Parl. (±; 620-770; 678 μm).
58. *Dactylis glomerata* L. (– ⅔; subsp. *euglomerata* Hay.: 660-730; 690 μm; subsp. *polygama* (Horvat.). Dom.: 500-610; 551 μm; subsp. *slovenica* Dom.: 660-800; 740 μm).
59. *Koeleria glauca* (Schkuhr) DC. (+ ¼ – ⅓; 1000-1100; 1036 μm).
60. *Koeleria tristis* Dom. (+; 1100-1320; 1205 μ).
61. *Koeleria gracilis* Pers. (±; 590-810; 712 μm).
62. *Arrhenatherum elatius* (L.) Presl (+ ½-⅔; 1650-2600; 1925 μm).
63. *Holcus lanatus* L. (+ ¼ – ⅓; 940-1130; 1064 μm).
64. *Holcus mollis* L. (+ ½; 830-900; 861 μm).
65. *Avena* L. (±; *A. sativa* L.: 1030 μm; *A. fatua* L.: 1010-1133; 1061 μm; *A. sterilis* L.: 1150-1208; 1415 μm).

PLATE III

66. *Aira caryophyllea* L. (±; 342-385; 362 μm).
67. *Corynephorus canescens* (L.) P. Beauv. (+ ⅓; 480-600; 547 μm).
68. *Avenastrum besseri* (Griseb.) Koczw. (+ ½; 1215-1333; 1285 μm).
69. *Avenastrum pubescens* (Huds.) Opiz (–; 583-658; 609 μm).
70.? *Avenastrum compressum* (Heuff.) Deg. (+ ½; 1530-1580; 1550 μm).
71. *Avenastrum versicolor* (Vill.) Fritsch (+ ½; 935-1125; 1003 μm).
72. *Avenastrum pratense* (L.) Opiz (+ ½; 1740-1790; 1755 μm).
73. *Avenastrum planiculme* (Schrad.) Opiz (+ ½; 1520-1735; 1642 μm).
74. *Deschampsia caespitosa* (L.) P. Beauv. (±; 580-740; 644 μm).
75. *Deschampsia flexuosa* (L.) Trin. (±; 600-640; 620 μm).

76. *Trisetum flavescens* (L.) P. Beauv. (±; 740-820; 778 µm).
77. *Trisetum alpestre* (Host) P. Beauv. (±; 700-940; 828 µm).
78. *Trisetum ciliare* (Kit.) Dom. (±; 800-1020; 916 µm).
79. *Hierochloë odorata* (L.) Wahlb. subsp. *odorata* (+ ⅓; 1220-1570; 1350 µm).
80. *Hierochloë odorata* (L.) Wahlb. subsp. *pannonica* Chrtek et V. Jirás. (+ ⅓; 750-1000; 898 µm).
81. *Hierochloë australis* (Schrad.) Roem.-Schult. (– ¼-½; 430-560; 482 µm).
82. *Baldingera arundinacea* (L.) Dumort. (– ½; 480-620; 533 µm).
83. *Lasiagrostis calamagrostis* (L.) Link (+ ¼; 830-870; 858 µm; b = the third lodicule).
84. *Calamagrostis canescens* (Web.) Roth (±; 680-720; 707 µm).
85. *Calamagrostis arundinacea* (L.) Roth (±; 670-840; 722 µm).
86. *Calamagrostis villosa* (Chaix) Gmel. (±; 610-650; 634 µm).
87. *Calamagrostis epigeios* (L.) Roth (±; 610-810; 719 µm).
88. *Agrostis alba* L. (+; 520-600; 544 µm).
89. *Agrostis vulgaris* With. (+; 460-520; 492 µm).
90. *Agrostis canina* L. (–; 470-500; 480 µm).
91. *Agrostis rupestris* All. (–; ± 470-520; 488 µm).
92. *Apera spica-venti* (L.) P. Beauv. (±; 460-590; 519 µm).
93. *Phleum pratense* L. (– ½; 360-468; 426 µm).
94. *Phleum boehmeri* Wibel (±; 481-548; 515 µm).
95. *Phleum alpinum* L. (±; 695-782; 742 µm).
96. *Phleum hirsutum* Honckeny (±; 782-855; 816 µm).
97. *Secale cereale* L. (+ ½; 1448-1874; 1675 µm).
98. *Elymus arenarius* L. (+ ½; 1465-1582; 1564 µm).
99. *Elymus glaucus* Reg. (+; 732-874; 808 µm).
100. *Cuviera europaea* (L.) Koel. (+; 666-749; 692 µm).
101. *Agropyrum caninum* (L.) P. Beauv. (±; 1650-1880; 1765 µm).
102. *Agropyrum repens* (L.) P. Beauv. (+; 1400-1750; 1535 µm).
103. *Agropyrum intermedium* (Host) P. Beauv. (±; 1490-1850; 1695 µm).
104. *Agropyrum cristatum* (L.) Gaertn. (–; 950-1100; 1010 µm).
105. *Triticum diccocum* Schrank (– ⅔; 917-958; 927 µm).
106. *Aegilops ovata* L. (±; 792-934; 887 µm).
107. *Aegilops cylindrica* Host (±; 876-975; 910 µm).
108. *Hordeum jubatum* L. (±; 509-550; 525 µm).
109. *Triticum aestivum* L. (±; 850-1050; 948 µm).
110. *Triticum spelta* L. (– ⅔; 1000-1100; 1045 µm).

PLATE IV

111. *Hordeum murinum* L. (a = ☿ : ±; 1050-1130; 1085 µm; b = ♂ : 925-960; 945 µm).
112. *Hordeum distichum* L. (a = ☿ : ±; 845-935; 860 µm; b = ♂ : 535-592; 575 µm).
113. *Hordeum vulgare* L. (– ⅔; 710-750; 735 µm).
114. *Pholiurus pannonicus* (Host) Trin. (+; 1160-1310; 1240 µm).
115. *Eragrostis* P. Beauv. (– ½; *E. minor* Host: 180-254; 232 µm; *E. pilosa* (L.) P. Beauv.: 133-160; 147 µm).
116. *Catabrosa aquatica* (L.) P. Beauv. (– ½; 347-387; 362 µm).
117. *Cynodon dactylon* (L.) Pers. (– ½; 310-430; 356 µm).
118. *Cleistogenes serotina* (L.) Keng (– ¾; 540-1110; 645 µm).
119. *Diplachne dubia* (H.B.K.) Scribn. (–; 445-526; 415 µm).
120. *Diplachne fusca* (L.) P. Beauv. (–; 303-416; 354 µm).
121. *Pappophorum scabrum* Kunth (–; 242-294; 267 µm).
122. *Pappophorum mucronulatum* Nees (–; 788-1008; 865 µm).

123. *Sporobolus argutus* Kunth (+; 167-194; 186 μm).
124. *Aristida* sp. (adax. side; +; 890-960; 938 μm).
125. *Panicum miliaceum* L. (adax. side; +; 460-690; 620 μm).
126. *Echinochloa crus-galli* (L.) P. Beauv. (– ⅔; 440-480; 464 μm).
127. *Digitaria ciliaris* (Retz.) Koel. (adax. side; – ½; 354-402; 378 μm).
128. *Setaria* P. Beauv. (adax. side; a, b = ♀ ; c = the suppressed floret; *S. glauca* (L.) P. Beauv.: – ¾; 750-850; 793 μm; c –; 440-550; 500 μm; *S. italica* (L.) P. Beauv.: – ½; 510-560; 540 μm; *S. viridis* (L.) P. Beauv.: – ½; 420-490; 460 μm; *S. verticillata* (L). P. Beauv.: – ½; 460-580; 551 μm).
129. *Sorghum saccharatum* (L.) Moench (– ¾; a = ♀ : 630-680; 650 μm; b = ♂: 520-570; 555 μm).
130. *Bothriochloa ischaemum* (L.) Keng (– ¾; a = ♀ : 454-581; b = ♂ : 367-467; 423 μm).
131. *Chrysopogon gryllus* (Torn.) Trin. (– ¾; a = ♀ : 720-940; 830 μm; b = ♂ : 600-760; 692 μm).
132. *Zea mays* L. (adax. side, ♂; 490-700; 565 μm, measured to adax. margin; 810-1130; 935 μm, measured to abax. margin).
133. *Molinia* Schrank (– ⅔; *M. arundinacea* Schrank: 620-690; 655 μm; *M. coerulea* (L.) Moench: 460-700; 590 μm).
134. *Brachypodium pinnatum* (L.) P. Beauv. (+; 1340-1420; 1380 μm).
135. *Brachypodium silvaticum* (Huds.) P. Beauv. (+ ¼; 1350-1620; 1400 μm).
136. *Sesleria tatrae* (Deg.) Deyl (+; 870-1630; 1310 μm).
137. *Sesleria calcaria* (Pers.) Opiz (+; 530-2080; 900 μm).
138. *Sesleria sadleriana* Janka (+; 1040-1800; 1330 μm).
139. *Sesleria uliginosa* Opiz (+; 1130-1480; 1340 μm).
140. *Sesleria heufleriana* Schur (+; 1100-1630; 1330 μm).
141. *Oreochloa disticha* (Wulf.) Link (+; 1350-1666; 1520 μm).
142. *Milium effusum* L. (±; 650-760; 693 μm).

Received January, 1967.

AN APPENDIX TO THE TEXT

A considerable time (more than one year) passed away between the finishing of this study and its publication, a time long enough for discovering of new results also in investigations of the variability in morphology of grass lodicules as well as in the utilization of the complex of lodicule characteristics in taxonomy of the *Poaceae* family.

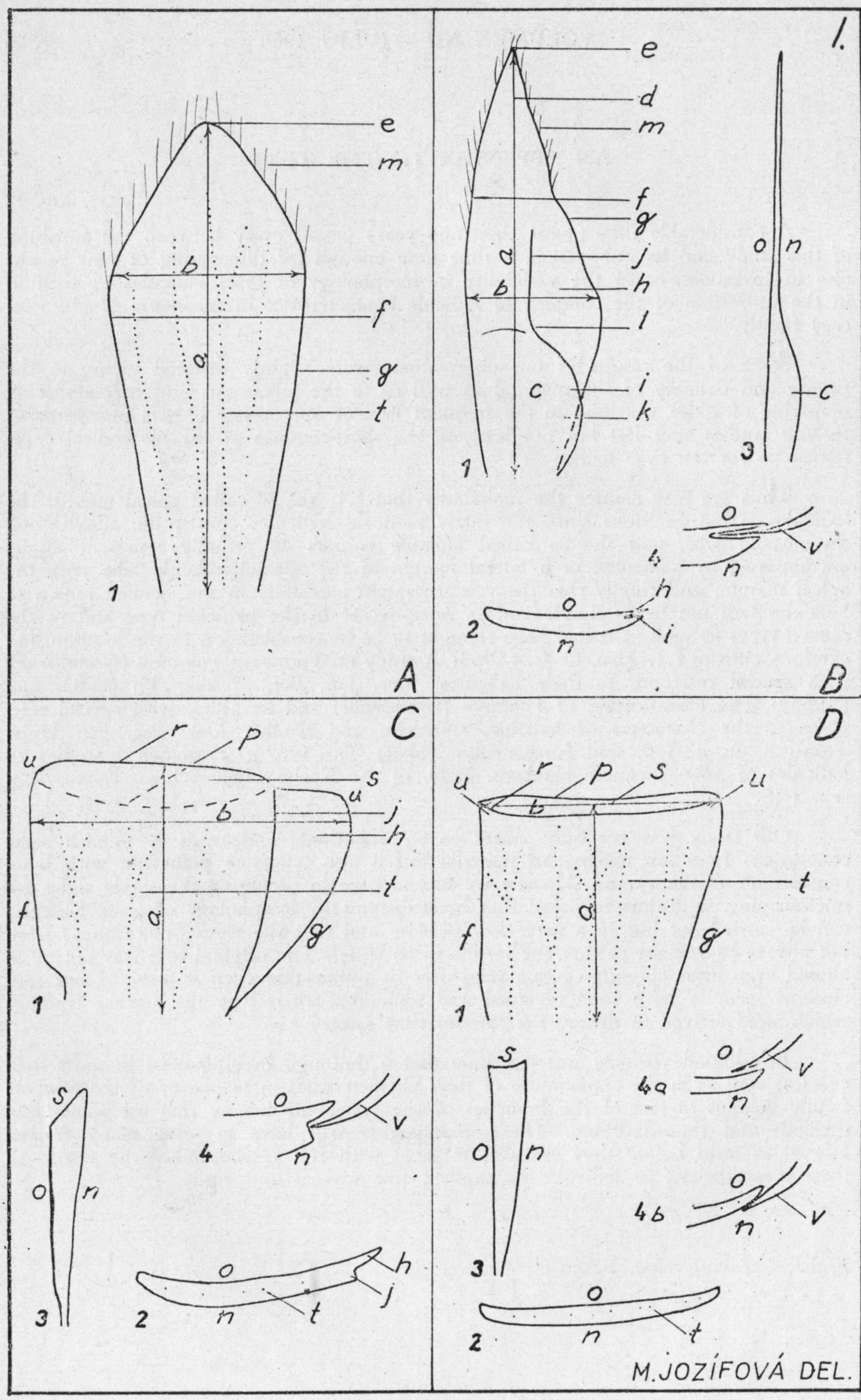
Some of the results of our observations were slightly distored owing to the finesse and delicacy of the material as well as to the labourious and time-absorbing preparing of slides, and also to the frequent lack of appropriate objects indispensable for our studies and, last but not least, to the short-comings of the methodical experiences as for the time being.

Thus we may assume the probability that f.i. the so called apical area of the lodicules is but fictitions since the many panicoid lodicules consist the adaxial and the abaxial lobe, and the so called lodicule corners do actually represent angles encompassed by a median or a lateral margin of the adaxial lodicule lobe with the apical margin, and finally that the vascularization especially in the swollen region of lodicules will not be as simple and as unequivocal in the panicoid type and in the related types as well as it had been thought to be in consideration to the location and extent. Compare f.i. Hsu, C. C. (1963: A study on Formosan *Panicum (Gramineae)*, with special reference to their lodicules. Jour. Jap. Bot., Tokyo, 38: 75-85, and (1965): The classification of *Panicum (Gramineae)* and its allies, with special reference to the characters of lodicule, style-base and lemma. Jour. Fac. Sci. Univ. Tokyo 3, 9: 43-150, and further also Takagi T. (1967): Histological studies of lodicules of some Japanese bamboos. Publ. of the Kacho High School, Kyoto, Pag. sep. 1-18.

Our study was not only meant as an intentional endeavour to publish some conclusions from our analysis of material but it also wants to point out with what considerable difficulty and slowness we had to cope in preparing the stable slides for microscoping, and thus to prove that investigaitons in morphology of grass lodicules can be carried out but in a very slow velocity and that the ways (procedures) need not always be straight neither the results to be equal. The original text was not to be altered even after elapsing of one year after its publication even if some of our conclusions seem to have been revalued and somewhat altered by the further findings which were arrived to during the interim time span.

In addition we may just conclude that a thorough investigations in grass lodicules as well as in the exploitation of their characteristics in taxonomy of the *Poaceae* family belongs to one of the branches of the systematic botany that are some than difficult and time-absorbing. The graminologists will have to solve many further labourious tasks before they are able to label with full responsability the results of their investigations in lodicules as explicit, unequivocal and finite.

Praha, Czechoslovakia, February, 1968.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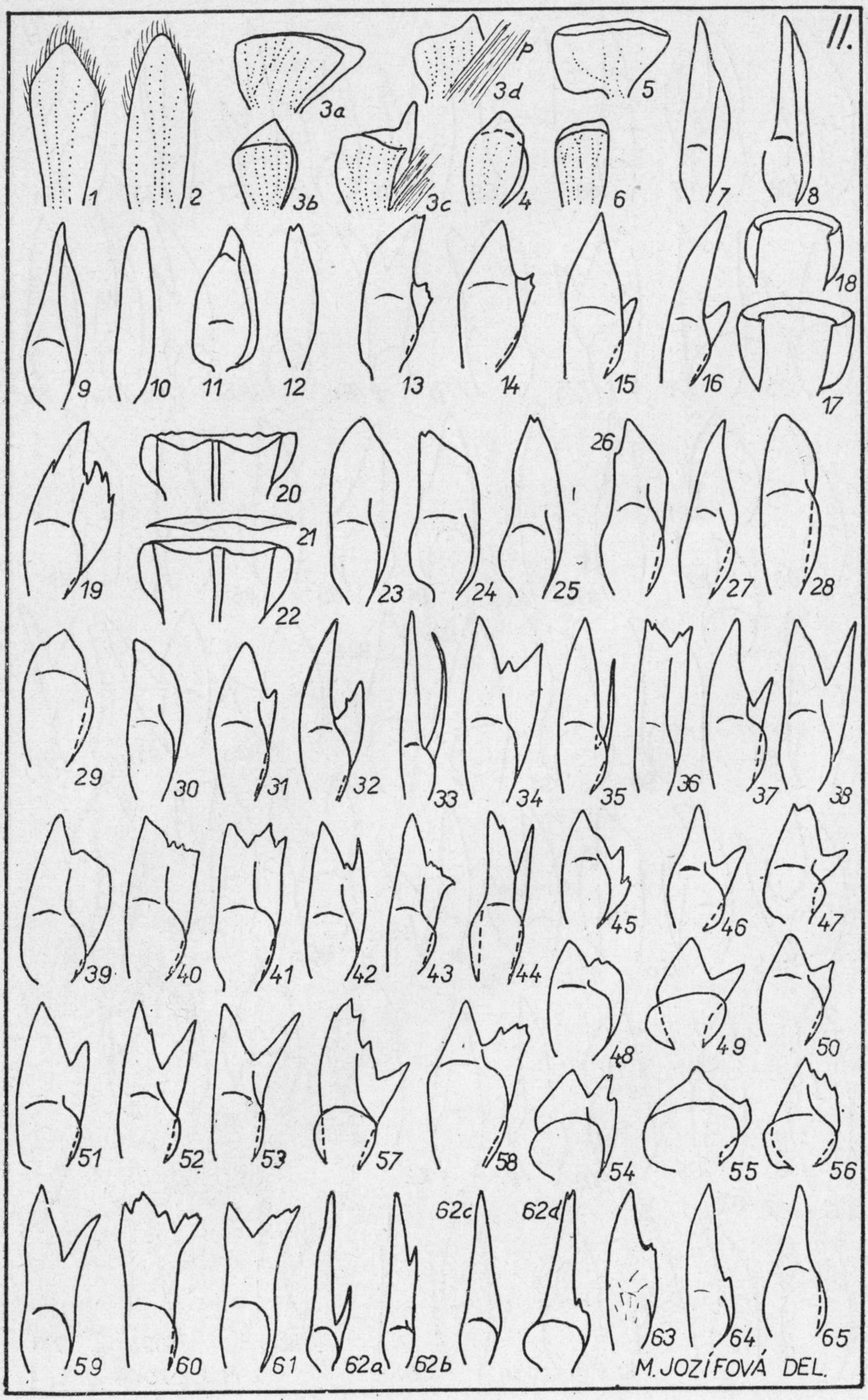
M.JOZÍFOVÁ DEL.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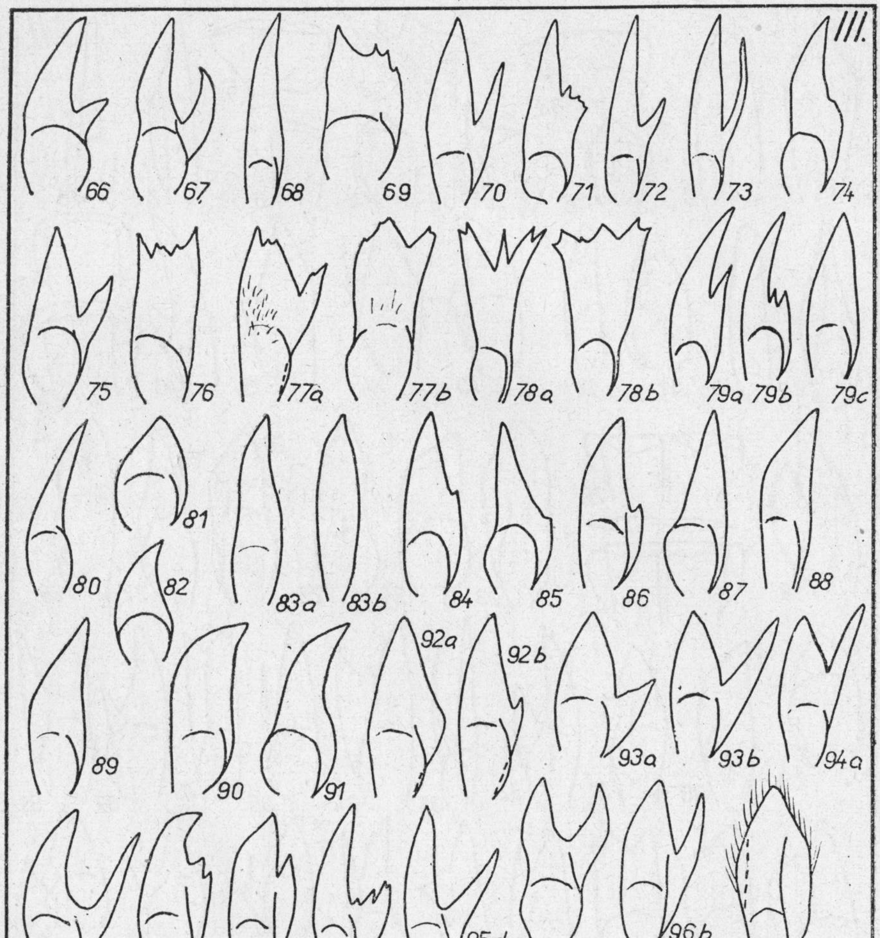
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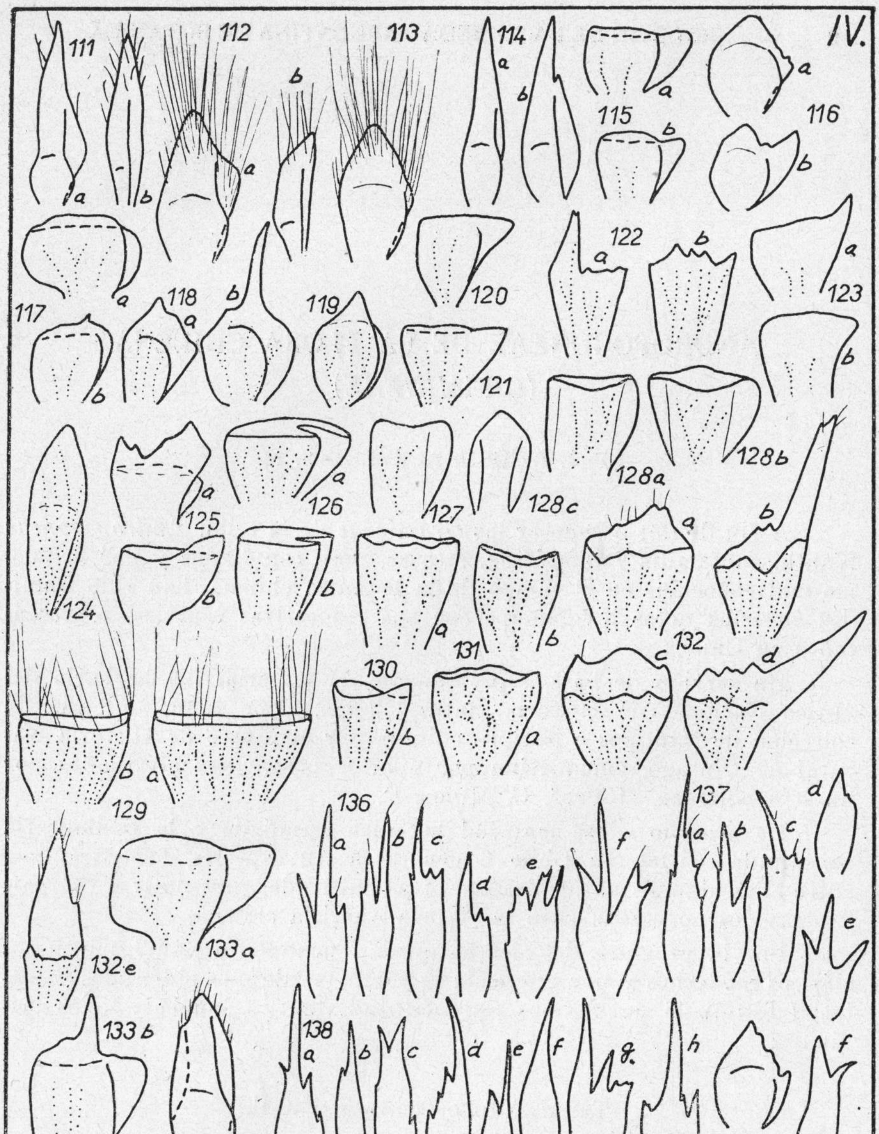
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133 b
134
135
136 a b c d e f
137 a b c d e f
138 a b c d e f g h
139 a b c d e
140 a b c d
141 a b c
142
M. JOZÍFOVÁ DEL.