

VARIATION IN THE LEMMA ABAXIAL EPIDERMIS OF *AVENA STRIGOSA* SCHREB.

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Abstract. Microstructure of abaxial epidermis of lemma is presented for 26 accessions of *Avena strigosa* of different geographical origin and for some other oat diploids. Papillae and duplexes of cork and silica cells are main morphogenetic events in the oat lemma. *A. canariensis* and *A. longiglumis*, characterized by a meristemoid activity of the lemma, are situated in an ordination space outside of the *A. strigosa* group, while a cultivated species *A. brevis* is among accessions of *A. strigosa*. The meristemoid activity of the lemma abaxial epidermis appeared to be a useful taxonomic marker for oat diploids.

Key words: *Avena strigosa*, lemma epidermis, replicas, meristemoids, intra- and inter-specific variation

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Introduction

The microstructures of the abaxial epidermis of lemma are mostly observed in the middle inter-costal region of this bract. In the species of the genus *Triticum* L., such data have been provided by KOSINA (1999a). Long cells with thick sinusoid anticlinal walls and specialized short cells, such as cork and silica cells, linked together in the form of a duplex, round papillae with many pits and hairs of various lengths are developed in a wheat lemma epidermis. The microstructure of the epidermis appeared to be an effective taxonomic marker to discriminate wheat species. In the genus *Bromus* L., these characteristics were useful at the sectional level (KOSINA 1999b). However, CONSAUL & AIKEN (1993) were not so successful in the establishing the discrimination of *Festuca* L. species when they used the palea characteristics. Qualitative differences in the microstructure of glumellae abaxial epidermis were exemplified for many wild grasses by PARRY & SMITHSON (1964,

1966) and by KOSINA (1995) for cereals. Epidermal characteristics of lemma in species taxonomy have been successfully applied such as for the genus *Brachypodium* (KŁYK 2005), a *Bromus secalinus* L. – *B. commutatus* Schrad. – *B. racemosus* L. group (SKOWROŃSKA 2005; KOCHMAŃSKI 2008), an *Avena magna* Murphy et Terrell × *A. longiglumis* Dur. amphiploid and its parental species (ŚWIETLIKOWSKA 2008), and for perennials and annuals of the genus *Lolium* L. (KAWA 2008).

Material and methods

Seeds of diploid species of the genus *Avena* L. have been obtained from the following collections: Federal Centre for Breeding on Cultivated Plants in Braunschweig, Germany; National Germplasm Resources Laboratory, Aberdeen, USA; the Vavilov's Institute (VIR) in St. Petersburg, Russia; Botanic Gardens in Moscow, Russia; and Rennes, France. As well as they were gathered from the cultivated fields of Podhale region, S Poland. 26 accessions of

A. strigosa Schreb. (As1 to As26 marked as symbols in the diagram) and 4 accessions of other diploids (*A. canariensis* Baum, Rajhathy et Sampson (Ac3), *A. longiglumis* Dur. (Al17), *A. wiestii* Steudel (Aw4), and *A. brevis* Roth (Ab11)) were cultivated on small plots in the same soil and climatic environment in the grass collection maintained by R. Kosina.

The study material was treated as originating from a completely randomised one-way classification design. Varnish replicas prepared according to HILU & RANDALL (1984) were microscopically analysed for the microstructure of abaxial epidermis of the first flower lemma in the spikelet. Replicas were taken from the central point of the lemma, a little below the awn attachment. Frequencies of meristemoid cytokinetic events in epidermis observed in the form of papillae, hooks, hairs, cork and silica cells in duplexes, single short cells and anticlinal walls perpendicular to the lemma axis were estimated for random samples $n=30$. Analyses made for hexaploid oats (KOSINA & WARZYCH 2002) and for bromegrasses (KOSINA & ZAWERBNA 2002) proved that such size of a random sample is sufficient for a quantitative study of the lemma characteristics.

Observations were made under an Amplival microscope and pictures were taken with a Zenith TTL camera and Fuji 400 film. Multivariate data (arithmetic means) for oat accessions treated as Operational Taxonomic Units (OTUs) were numerically elaborated according to ROHLF (1994) with the use of non-metric multidimensional scaling method. The matrix of average taxonomic distances between OTUs was an initial matrix to set OTUs in the form of minimum spanning tree in an ordination space.

Results and discussion

Morphogenesis of the spikelet glumellae is more complex compared to normal grass leaves. The abaxial epidermis of the glumellae contains several differentiated cells; sometimes they express special metabolism, for instance cork and silica cells in duplexes. The awn formed in the middle or lower part of the lemma induces

an original morphogenesis in the adjacent parts of epidermis (WARZYCH 2001).

In the *A. strigosa* and *A. wiestii* accessions, a dead meristemoid field exists just above the awn. No short cells are formed there by anticlinal divisions of the long cells of epidermis. However, a qualitative difference is noted in relation to such a field between both the above species and *A. canariensis*. In the latter, many meristemoids are active in the field (FRANAS 2003).

Synchronisation of the cell cycle or morphogenetic induction in linear sets of cells in monocotyledonous plants is responsible for the development of series of epidermal short cells (CROXDALE 2000).

The middle part of the lemma is the most advanced in morphogenesis. For two accessions of *A. strigosa*, replicas of this part are shown in Fig. 1. The most common types of meristemoids are those that create papillae and cell duplexes (cork cell + silica cell). The latter are less visible in Fig. 1 and a distinct difference is visible between both the replicas. The frequency of meristemoids in the accession As10 is lower and in As13 higher. Both accessions are distant from each other in the minimum spanning tree diagram (Fig. 2). Other oat diploids, *A. canariensis* (Ac3) and *A. longiglumis* (Al17) are distant from *A. strigosa* accessions. In the tree, *A. brevis* is situated among *A. strigosa* units. Accessions of *A. strigosa* situated in extreme positions in the diagram (Fig. 2), As1 and As22 origin from Germany, As13 from Spain, As18 (hidden behind As16) from Portugal and As16 was collected in Podhale, S Poland. In *A. strigosa*, the geographical trend of the accession origin is not documented in the diagram. Similar analyses of glumellae epidermal characteristics made with the use of non-metric multidimensional scaling showed a good discrimination of wild, weedy and cultivated types within a tetraploid complex of *A. barbata* Pott ex Link – *A. abyssinica* Hochst. – *A. vaviloviana* (Maltz.) Mordv. (KOSINA & WACH 2002) and separated fatuoids in a complex of *A. sterilis* L. – *A. fatua* L. – *A. sativa* L. (KOSINA & BIELEWICZ-RZEPKA 2002). A clear discrimination of *A. longiglumis* and *A. canariensis* versus *A. strigosa* has also been

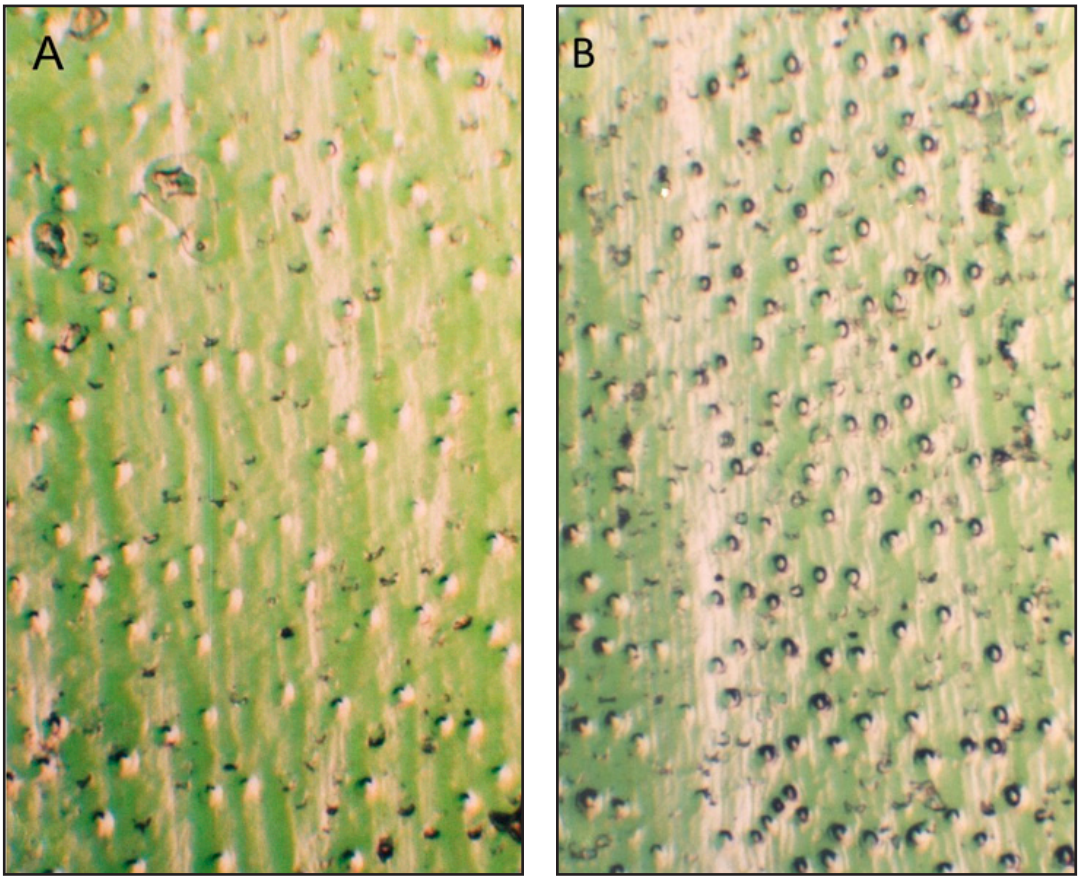


Fig. 1. Varnish replicas of abaxial epidermis of lemma in two *Avena strigosa* accessions. **A** – As10; **B** – As13.

proved on the molecular level for RFLP and RAPD (ALICCHIO *et al.* 1995; NOCELLI *et al.* 1999; LOSKUTOV & PERCHUK 2000).

In the *Bromus secalinus* – *B. commutatus* – *B. racemosus* group, a minimum number of meristemoidalevents in the lemma epidermis has been detected in the accession of *B. commutatus*, while a maximum number in a putative hybrid *B. racemosus* × *B. commutatus* (SKOWROŃSKA 2005). The same approach showed a large taxonomic distance between a perennial *Brachypodium sylvaticum* (Huds.) P. Beauv. and annual *B. distachyon* (L.) P. Beauv. Other species of this genus were intermediate to them (KŁYK 2005). Meristemoidal characteristics of the lemma also appeared to be valuable for the evaluation of taxonomic distances between an amphiploid *Avena magna* × *A. longiglumis* and its parental species (ŚWIETLIKOWSKA 2008).

A maternal dominance has been detected in the amphiploid.

In the *Lolium* species, papillae are the main morphogenetic event in the lemma epidermis (KAWA 2008). Perennial *L. multiflorum* Lam. described by lemma epidermis characteristics is well distinguished in an ordination space from annuals *L. temulentum* L. and *L. remotum* Schrank. *L. rigidum* Gaud. appeared to be close to *L. multiflorum*. Thus, meristemoid characteristics of abaxial epidermis of lemma describe well inter-specific differences as well distances between the species and their hybrid progeny.

The arrangement of OTUs in the ordination space shows (Fig. 2) that the statistics of a curvilinear regression between a line connecting the points of maximal values of x and y axes (coefficient of correlation $r = -1$)

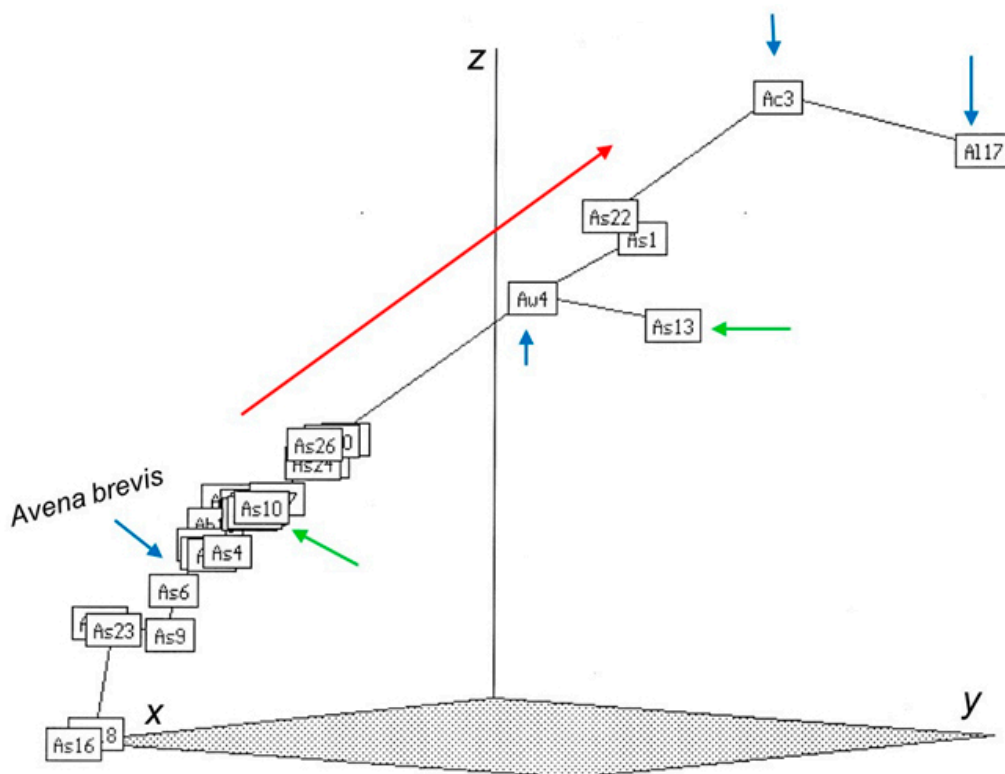


Fig. 2. A set of *Avena strigosa* (As) accessions and other oat diploids *A. canariensis* (Ac), *A. brevis* (Ab), *A. longiglumis* (Al) and *A. wiestii* (Aw) (see **blue arrows**) distributed in an ordination space in the form of minimum spanning tree. **Green arrows** show the As accessions presented in Fig. 1. A diploid cultivated species *A. brevis* is hidden within the *A. strigosa* set. The **red arrow** shows a directional trend of increased meristemoid frequency in the set of accessions.

and values of the z axis can be new taxonomic characteristics, and such type of approach has already been pointed for other grasses by KOSINA (2004).

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