

## Leaf anatomy of the South African Danthoniaceae (Poaceae). XI. *Pentameris longiglumis* and *Pentameris* sp. nov.

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### ABSTRACT

The leaf blade anatomy of *Pentameris longiglumis* (Nees) Stapf and that of an undescribed *Pentameris* species is described and illustrated by means of photomicrographs. It is shown that the anatomical structure of the leaves of the new *Pentameris* species in particular, both transverse sections and abaxial epidermal scrapes, resembles closely that of species placed in the genus *Pseudopentameris*. This anatomical resemblance is closer than that with any *Pentameris* species. It appears, therefore, as if transfer of this new species to *Pseudopentameris* is justified on the anatomical evidence and this indication must be followed up by morphological studies. *Pentameris longiglumis* shows close anatomical resemblance to *P. macracalycina* (Steud.) Schweick. and *P. obtusifolia* (Hochst.) Schweick. and should be classified with these taxa.

### INTRODUCTION

Two little-known and rare danthonoid grass species have been studied anatomically for the first time. *Pentameris longiglumis* (Nees) Stapf is represented by only four specimens in the National Herbarium (PRE) and the other species, as yet undescribed, by three specimens. All these specimens have been included in this study and, although they constitute only a small sample, all available material has been examined. Fortunately both taxa were collected and fixed in the field and consequently accurate comparisons have been possible with other danthonoid grasses included in this study.

The three unnamed specimens are considered to represent a new species of *Pentameris* by the agronomists of the National Herbarium (B. de Winter, pers. comm.). One specimen was originally named *Pseudopentameris macrantha* (Schrad.) Conert but present opinion disagrees and it is felt that these specimens show little in common with *Pseudopentameris* and should be referred to *Pentameris* as a distinct, new and undescribed species.

Although this *Pentameris* sp. nov. is obviously morphologically distinct, Ellis (1985) has drawn attention to the strong anatomical resemblance of this taxon to *Pseudopentameris* and considers this likeness to be taxonomically meaningful. These apparently conflicting opinions require further substantiation and, consequently, the leaf anatomy of this new *Pentameris* species, together with that of *P. longiglumis*, is here described in detail and copiously illustrated. This will enable comparisons to be made with the anatomy of *Pseudopentameris* (Ellis, 1985) and with other *Pentameris* species (Ellis, in press). In addition, morphological studies of the ovary and ripe grain, in particular, are required to reliably establish the natural relationships of these two taxa of uncertain affinity. This information, together with the

anatomical evidence, should confirm the classification of these two species in either *Pentameris* or *Pseudopentameris* — two genera which can easily be separated on the basis of caryopsis structure (Stapf, 1900; Chippindall, 1955; De Wet, 1956; Conert, 1971).

*P. longiglumis* and the undescribed species (which will be referred to as *Pentameris* sp. nov. for convenience) are confined to the extreme south-western Cape Province and appear to occur only on Table Mountain and the Kogelberg Mountains. Both species were collected by the author at the same locality on the Kogelberg and it may, or may not, be significant that *Pseudopentameris brachyphylla* (Stapf) Conert was also present in the same community and in very close proximity to the two *Pentameris* species. Hybridization is, consequently, not ruled out by spatial separation and this possibility must be taken into account when the relationships of these species are considered.

In the following anatomical descriptions, the terminology of Ellis (1976, 1979) is employed together with the following abbreviations:

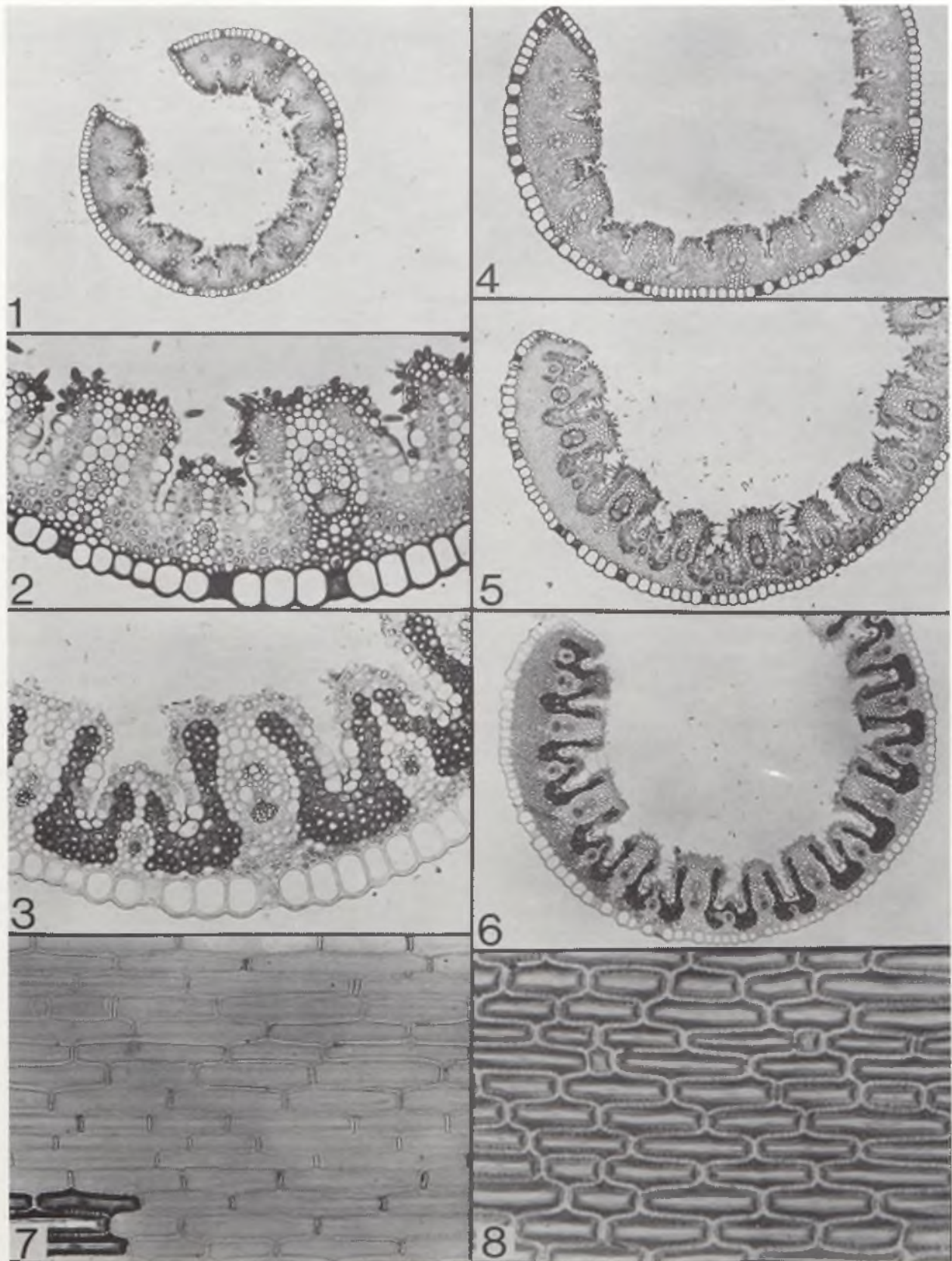
- vb/s — vascular bundle/s
- 1'vb/s — first order vascular bundle/s
- 3'vb/s — third order vascular bundle/s
- ibs — inner bundle sheath; mestome sheath
- obs — outer bundle sheath; parenchyma sheath

### COMBINED ANATOMICAL DESCRIPTION OF *PENTAMERIS LONGIGLUMIS* AND *PENTAMERIS* SP. NOV.

#### *Leaf in transverse section*

*Leaf outline:* broadly U-shaped (Figs 4, 5 & 9) to loosely inrolled (Figs 1 & 11). *Ribs and furrows:* similar adaxial ribs present over all vbs in *Pentameris* sp. nov. (Figs 10 & 12) but ribs associated with 3'vbs smaller than those over 1'vbs in *P. longiglumis* (Figs 2 & 3). Furrows cleft-like, of medium depth. No abaxial rib development. *Median bundle:* not structurally distinct from lateral 1'vbs; distinguishable by location only (Figs 1 & 11). *Vascular bundle arrangement:* 9 or 11 1'vbs in leaf section with a single 3'vb

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FIGS 1-8. — Leaf blade anatomy of *Pentameris longiglumis*. 1-6, leaf blade in transverse section. 1-3, *Ellis 2341*: 1, hollow, cylindrical outline,  $\times 60$ ; 2, well developed, inflated, abaxial, epidermal cells clearly seen,  $\times 400$ ; 3, u-shaped groups of chlorenchyma with densely packed, isodiametric cells,  $\times 400$ . 4, *Taylor 7231*,  $\times 100$ . 5-6, *Marloth 3063*,  $\times 100$ . 7-8, abaxial epidermis, *Ellis 2341*,  $\times 250$ : 7, inflated long cells without distinct costal zones; 8, long cells filled with air showing thickness of cell walls and sinuous outer surface.

located between successive 1'vbs. Near the margin a pair of 1'vbs may be located adjacent to one another in *P. longiglumis* (Figs 4, 5 & 6). All bundles are located in the centre of the blade. *Vascular bundle structure*: 3'vbs circular to elliptical with well developed phloem; much smaller in *P. longiglumis* (Figs 2 & 3) than in *Pentameris* sp. nov. (Figs 10 & 12). 1'vbs elliptical with phloem adjoining the ibs; very narrow metaxylem vessels. *Vascular bundle sheaths*: obs elliptical; entire around some 3'vbs (Figs 3 & 12) or with abaxial interruption (Fig. 10); 1'vbs with both abaxial and adaxial interruptions; no extensions in *Pentameris* sp. nov. (Figs 11 & 12) but *P. longiglumis* has well developed abaxial and adaxial extensions (Figs 2 & 3). Obs cells not well differentiated from chlorenchyma cells; however, they are distinct due to absence of chloroplasts. Ibs complete around 1'vbs; cells with thicker inner tangential walls (Figs 2 & 12). *Sclerenchyma*: girders associated with all vbs; adaxial girders inversely anchor- or T-shaped (Figs 3 & 10) with relatively long stems; abaxial girders trapezoidal to equidimensional. Fibres with thickened walls but, particularly in *Pentameris* sp. nov., composed mainly of cellulose secondary walls. *Mesophyll*: chlorenchyma not radiate; consists of tightly packed, angular, isodiametric cells (Figs 3 & 10); these cells with characteristic central vacuole and peripheral chloroplasts. No colourless cells. *Adaxial epidermis*: fan-shaped groups of bulliform cells situated at bases of furrows (Figs 3 & 10); bulliform cells better developed in *Pentameris* sp. nov. than in *P. longiglumis*. In *P. longiglumis* epidermal cells papillate and with many prickles (Fig. 2); in *Pentameris* sp. nov. no adaxial papillae or prickles but micro-hairs present on sides of furrows (Fig. 12). *Abaxial epidermis*: no bulliform cells; epidermis consists of very large, conspicuous, regular, somewhat inflated cells with outer-tangential wall slightly thickened. No appendages visible.

#### *Abaxial epidermis in surface view*

*Intercostal long cells*: usually elongated but length may be only slightly greater than width in *Pentameris* sp. nov. (Figs 13 & 14); side walls always angled or bowed outwards giving cells an inflated hexagonal appearance (Figs 7 & 8, 13–16); end walls vertical; anticlinal walls slightly undulating in *Pentameris* sp. nov. (Figs 15 & 16) but less so in *P. longiglumis* (Figs 7 & 8). Cell shape and size is noticeably consistent throughout all intercostal zones and even throughout the whole abaxial epidermis. Pairs of short cells present between successive long cells. No abaxial bulliform cells. *Stomata*: absent on abaxial surface (Figs 7 & 8, 13–16). *Intercostal short cells*: cork-silica cell pairs with silica cell tall and narrow with smooth outline (*P. longiglumis*) or rounded to kidney-shaped (*Pentameris* sp. nov.). Associated with tall and narrow cork cell; narrower than width of adjacent intercostal long cells. *Papillae*: absent. *Prickles and hooks*: absent. *Micro-hairs*: none seen on abaxial epidermal scrapes although micro-hairs were observed in the adaxial grooves of *Pentameris* sp. nov. (Fig. 12). *Macro-hairs*: none present. *Costal silica bodies*: rounded, equidimensional to slightly taller than long (Fig. 16); costal zones narrow and not conspicuous.

#### Specimens examined:

##### *Pentameris longiglumis*

CAPE. — 3318 (Cape Town): Table Mountain (-CD). *Marloth* 3063. 3418 (Simonstown): Platberg, Kogelberg State Forest (-BD). *Ellis* 2341. *Taylor* 7231; Kogelberg, *Esterhuysen* 13326.

##### *Pentameris* sp. nov.

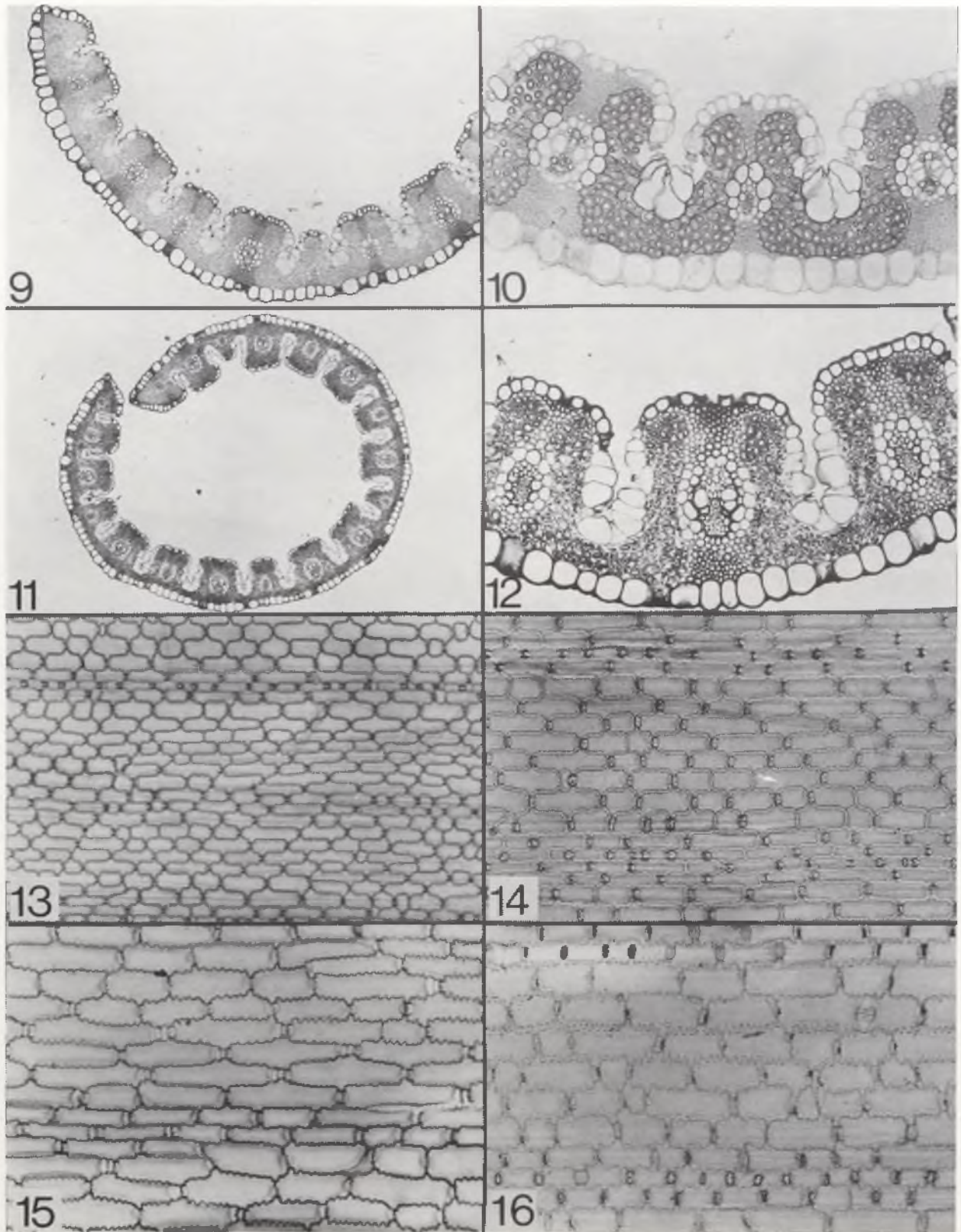
CAPE. — 3418 (Simonstown): Platberg, Kogelberg State Forest (-BD). *Ellis* 2342. 3419 (Caledon): Lebanon State Forest (-AA). *Haynes* 770; Nuweberg, Caledon (-AB), *Taylor* 3023.

#### DISCUSSION AND CONCLUSIONS

A comparison of the leaf blade anatomy of *Pentameris longiglumis* and *Pentameris* sp. nov. with that of the type of the genus, *P. thuarii* Beauv., reveals many significant differences (Ellis, 1985a). The anatomical structure of *P. thuarii* will be fully described and critically evaluated in this subsequent article (Ellis, 1985a), but here it will suffice to say that the leaf anatomy of *P. thuarii* differs substantially from that of each of the other four species presently regarded as belonging to the genus *Pentameris*. In fact the leaf anatomy of *P. thuarii* closely resembles that of several *Pentaschistis* species such as *P. tortuosa* (Trin.) Stapf, *P. silvatica* Adamson and *P. pallescens* (Schrad.) Stapf and it appears as if *Pentameris* is a heterogeneous grouping as currently constituted.

It must be emphasized that this close likeness of *P. thuarii* to several *Pentaschistis* species has, as yet, not been evaluated using morphological criteria. Although this similarity relates only to the anatomical features of the leaf blade at present, the indications are that these anatomical resemblances reflect the natural relationships of this group of species. Of particular note are the distinctive micro-hairs, shared by *Pentameris thuarii* and the *Pentaschistis* species mentioned above, in which the basal cell is very much longer than the very short, tapering apical cell. Micro-hair characteristics are generally considered to be reliable indicators of taxonomic affinity (Clifford & Watson, 1977) and, consequently, the grouping of *Pentameris thuarii* with these taxa sharing similar micro-hairs, amongst other characteristics, appears justified.

On the other hand, a comparison of the leaf anatomy of *P. longiglumis* and *Pentameris* sp. nov. with that of *Pseudopentameris* (Ellis, 1985) shows very close agreement — particularly between *Pentameris* sp. nov. and both *Pseudopentameris macrantha* and *P. brachyphylla*. These latter three taxa have virtually identical leaf anatomy in all respects and the anatomical description given for *Pseudopentameris* (Ellis, 1985) would suffice more than adequately to describe both the transection and abaxial epidermis of *Pentameris* sp. nov. Several important anatomical diagnostic features shared by these three taxa are: the presence of ribs of similar size and shape over all vascular bundles; the sclerenchyma girders composed of unligified fibres; micro-hairs located in the adaxial furrows; abaxial epidermal cells inflated to hexagonal in shape and costal zones indistinct; absence of epidermal appendages and stomata on abaxial epidermis. These anatomical features distinguish *Pseudopentameris* from the rest of the danthonoid grasses and, in combination, are shared by no



FIGS 9-16. — Leaf blade anatomy of *Pentameris* sp. nov. 9-12, leaf blade in transverse section. 9-10, *Ellis* 2342: 9, outline,  $\times 100$ ; 10, densely packed chlorenchyma cells in u-shaped groups,  $\times 400$ . 11-12, *Haynes* 770: 11, hollow, cylindrical in outline,  $\times 60$ ; 12, detail of inflated abaxial epidermal cells. Note also that sclerenchyma girders are not fully lignified,  $\times 400$ . 13-16, abaxial epidermis in surface view. 13-14, *Ellis* 2342: 13, arrangement of costal and intercostal zones,  $\times 160$ ; 14, long cells with distinctive shape,  $\times 250$ . 15, intercostal and costal long and short cells, *Haynes* 770,  $\times 250$ . 16, detail of costal and intercostal epidermal cells, *Taylor* 3023,  $\times 250$ .

other genus. The almost identical anatomy of *Pentameris* sp. nov. and *Pseudopentameris* is surely indicative of close phylogenetic relationship and this study strongly suggests that this undescribed grass should actually be placed in the genus *Pseudopentameris* where it conforms exactly with the generic anatomical circumscription.

This undescribed species is, therefore, virtually identical to *Pseudopentameris* in leaf anatomy. However, *Pentameris longiglumis*, with which it has been linked morphologically, and with which it grows in the field, differs in several basic respects from the typical *Pseudopentameris*-type of anatomy. These differences will be enumerated and discussed fully because they serve to distinguish *Pseudopentameris* from the remaining group of species presently assigned to *Pentameris*. This applies particularly to *P. macrocalycina* (Steud.) Schweick. and *P. obtusifolia* (Hochst.) Schweick. but not to *P. dregeana* Stapf. Anatomical differences between *P. longiglumis* and *Pentameris* sp. nov. have been adequately illustrated (Figs 1–8 and 9–16) and are briefly as follows:

a) Ribs associated with third order vascular bundles smaller than those over the first order bundles. Compare Figs 2 & 3 with Figs 10 & 12.

b) The third order bundles are much smaller in comparison with the first order vascular bundles.

c) Abaxial and adaxial bundle sheath extensions are present and consist of parenchyma cells which gradually become thicker towards the epidermis (Fig. 3). In *Pseudopentameris* the girder, or extension cells are more fibre-like with narrower diameters (Fig. 12).

d) The cells of the bundle sheath extensions and the fibres in contact with the epidermis are distinctly lignified and stain red with safranin and fast green. Fig. 2, where a green filter was used to accentuate the red lignified tissue, should be compared with Fig. 12 where the sclerenchyma tissue of the girders is stained the same colour and density as the cellulose-walled parenchyma of the mesophyll.

e) Adaxial bulliform cells at the bases of the furrows are poorly developed in comparison to those of *Pentameris* sp. nov. Compare Figs 3 & 10.

f) The adaxial epidermal cells of *P. longiglumis* are distinctly papillate (Fig. 2) whereas no papillae are present on either epidermis of *Pentameris* sp. nov. (Fig. 12).

g) Adaxial micro-hairs are not distinguishable as in *Pentameris* sp. nov. (Fig. 12) where they are clearly visible on the sides of most adaxial furrows.

h) The shape of the intercostal long cells differs slightly in surface view. The cells are more elongate, with thicker anticlinal walls and without obvious undulations in *P. longiglumis*, as a comparison of Figs 7 & 8 with Figs 15 & 16 will show.

i) The intercostal silica cells are tall and narrow and often are not associated with a cork cell in *P. longiglumis*, whereas in *Pentameris* sp. nov. they tend to be rounded to kidney-shaped as in *Pseudopentameris* (Ellis, 1985).

For these reasons, *P. longiglumis* is not considered as being as closely associated with *Pseudopentameris* as *Pentameris* sp. nov. is. If all these taxa are placed in the same genus, then leaf anatomy will become so heterogeneous as to be meaningless. However, there is strong agreement in the anatomical characteristics listed above between *P. longiglumis* and *P. macrocalycina* and *P. obtusifolia* in particular (Ellis, in press) and these three taxa again appear to reflect a natural grouping best accorded generic status apart from *Pseudopentameris* and *Pentameris thuarii*. As *P. thuarii* is the type of the genus, a new genus will have to be created for *P. longiglumis*, *P. macrocalycina* and *P. obtusifolia* (and perhaps *P. dregeana*) if the morphological evidence corroborates the anatomical evidence presented here.

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#### UITTREKSEL

*Die blaaranatomie van Pentameris longiglumis (Nees) Stapf en van 'n onbeskryfde Pentameris spesie word beskryf en geïllustreer deur middel van fotomikrograwe. Dit word bewys dat die anatomiese struktuur van die blaar van die nuwe Pentameris spesie in besonder, beide die dwarsnigte en abaksiale epidermale skrapings, noue ooreenkomste met spesies wat in die genus Pseudopentameris geklassifiseer word, toon. Hierdie anatomiese ooreenkoms is groter as dié met enige van die Pentameris spesies. Gevolglik dui anatomiese kenmerke aan dat die insluiting van die nuwe spesie in die genus Pseudopentameris verkieslik is bo plasing in die genus Pentameris. Hierdie aanduiding moet deur morfologiese studies gevestig word. P. longiglumis, aan die ander kant, behoort saam met P. macrocalycina (Steud.) Schweick. en P. obtusifolia (Hochst.) Schweick. geklassifiseer te word, weens noue ooreenkomste van die blaaranatomie.*

#### REFERENCES

- CHIPPINDALL, L. K. A., 1955. In D. Meredith, *The grasses and pastures of South Africa*. Johannesburg: CNA.
- CLIFFORD, H. T. & WATSON, L., 1977. *Identifying grasses: data, methods and illustrations*. St. Lucia: University of Queensland Press.
- CONERT, H. J., 1971. The genus *Danthonia* in Africa. *Mit. bot. StSamml., Münch.* 10: 299–308.
- DE WET, J. M. J., 1956. Leaf anatomy and phylogeny in the tribe Danthoniaceae. *Am. J. Bot.* 43: 175–182.
- ELLIS, R. P., 1976. A procedure for standardizing comparative leaf anatomy in the Poaceae. I. The leaf blade as viewed in transverse section. *Bothalia* 12: 65–109.
- ELLIS, R. P., 1979. A procedure for standardizing comparative leaf anatomy in the Poaceae. II. The epidermis as seen in surface view. *Bothalia* 12: 641–672.
- ELLIS, R. P., 1985. Leaf anatomy of the South African Danthoniaceae (Poaceae). X. *Pseudopentameris*. *Bothalia* 15: 561–566.
- ELLIS, R. P., 1985a. Leaf anatomy of the South African Danthoniaceae (Poaceae), XII. *Pentameris thuarii*. *Bothalia* 15: 573–578.
- STAPF, O., 1900. Gramineae. In R. Thiseleton-Dyer, *Flora Capensis*, Vol. 7. London: Reeve.