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Anomalous vascular bundle sheath structure in *Alloteropsis semialata* leaf blades

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ABSTRACT

Alloteropsis semialata (R.Br.) Hitchc. of the Paniceae, would be expected to exhibit typical eupanicoid leaf anatomy with a single bundle sheath of large parenchymatous cells with specialized chloroplasts and radially-arranged chlorenchyma. Specimens from South Africa showed the following bundle-sheath and mesophyll deviations from the generalized panicoid model: 1. bundle sheath is double; 2. inner bundle sheath is composed of large cells with specialized chloroplasts; 3. outer sheath consists of many smaller cells with few, or without chloroplasts; 4. outline of the third-order bundles is tall and narrow; 5. chlorenchyma is not radially arranged. Other specimens of *A. semialata,* however, were found to have a large-celled outer bundle sheath devoid of chloroplasts and with indistinctly radiate chlorenchyma.

The genus *Alloteropsis* has been placed in the tribe Paniceae of the Poaceae. Species of this genus would, therefore, be expected to exhibit a typical panicoid leaf anatomy. Several specimens of *A. semialata* from South Africa have, however, been observed to exhibit fundamental differences in the structure and composition of the vascular bundle sheaths. The bundle-sheath number is considered to be a diagnositic character of importance in the basic classification of the Poaceae (Metcalfe 1954) and thus the anomalous condition observed in *A. semialata* warrants mention.

The panicoid grasses are generally characterized by the presence or absence of an inner bundle sheath (Avdulov 1931). The single or outer bundle sheath is composed of relatively few, large, inflated parenchymatous cells imparting upon the vascular bundle, *sensu* Metcalfe (1960), a distinctly angular outline. The chlorenchyma cells of panicoid grasses are more or less radially arranged.

Brown (1961) recognized three panicoid subtypes on leaf anatomy, the Paniceae falling under the eupanicoid subtype. This group of tribes is characterized by the inner bundle sheath usually being absent and with the chlorenchyma cells not radially arranged, as seen in transverse section. These cells are normaly tightly packed with few or no air spaces.

Within the panicoid grasses the main line of evolution appears to be from the typical eupanicoid structure towards the development of specialized plastids for starch conversion and storage in the parenchymatous sheath cells (Brown 1958). This is accompanied by a loss of the starch-synthesis function by the chloroplasts of the chlorenchyma, the cells of which show a corresponding, more regular, radial arrangement. Associated with this development is the complete loss of the inner bundle sheath.

Some species of *Panicum*, *Tricholaena*, *Oplismenus*, *Brachiaria* and *Eriochloa*, of the eupanicoid Paniceae, retain an endodermis-like inner bundle sheath (Brown 1958). Tateoka (1956) found, in some species of *Panicum* and other genera, that the cells of the parenchymatous sheath do not have the specialized starch plastids typical of the Paniceae. Thus there are exceptions to the generalized model for the eupanicoid subtype.

Metcalfe (1960) states that single bundle sheaths, radiate chlorenchyma and angular, third-order vascular bundles are diagnostic characters of the genus *Alloteropsis*. These characters are repeated in the descriptions given for *A. cimicina* (L.) Stapf and *Alloteropsis* sp. nov. Specimens of *A. semialata* from South Africa showed considerable differences from these generic characters and from the generalized eupanicoid anatomy.

The following bundle-sheath and mesophyll differences were observed in specimens of *A. semialata* (Figs. 1–4, 6, 7):

1. the bundle sheath of all orders of vascular bundle consists of two layers of parenchymatous cells.

2. the inner bundle sheath is composed of inflated, parenchymatous cells with a large, centrally-situated chloroplast. These cells are larger than those of the outer sheath. The inner bundle-sheath cells are unthickened except in first-order vascular bundles where the radial and inner tangential walls are slightly thickened.

3. the outer bundle sheath is comprised of numerous smaller, thin-walled cells without, or with a few normal chloroplasts.

4. the outline of the third-order vascular bundles is not angular, but tall and narrow.

5. the chlorenchyma cells are not tabular and radially arranged as seen in section, but are hexagonal to inflated in shape, with no definite pattern of arrangement. Furthermore, these cells are distinctly larger than the outer and inner bundle-sheath cells.

This anomalous structure was observed in the following specimens, the voucher specimens being deposited in the National Herbarium, Pretoria.

TRANSVAAL.—2528 (Pretoria): National Botanical Gardens, Brummeria (–CA) 5–11–1969 *R. P. Ellis 2*; 1–12–1972 *R. P. Ellis 1244*; Faerie Glen (–CD) 22–11–1972 *R. P. Ellis 721*. NATAL.—2729 (Volksrust): Clontarf Siding, Newcastle (–DB) 12–11–1969 *R. P. Ellis 36*.

This structure bears a superficial resemblance to the bundle sheaths of the genus *Aristida* of the aristidoid subtype of the panicoid grasses (Brown 1958). Aristidoid grasses are characterized by two parenchyma sheaths and no endodermis-like inner sheath, but the chlorenchyma is distinctly radiate. In the sheaths of *Aristida* the larger inner-sheath cells also possess abundant chloroplasts, more than in the smaller, outer bundle-sheath cells (Lommasson 1957).

Other specimens of *A. semialata* were found to have a large-celled, outer bundle sheath devoid of chloroplasts, a typical mestome or inner bundle sheath around the larger bundles and the chlorenchyma indistinctly radiately arranged (Figs. 5, 8).

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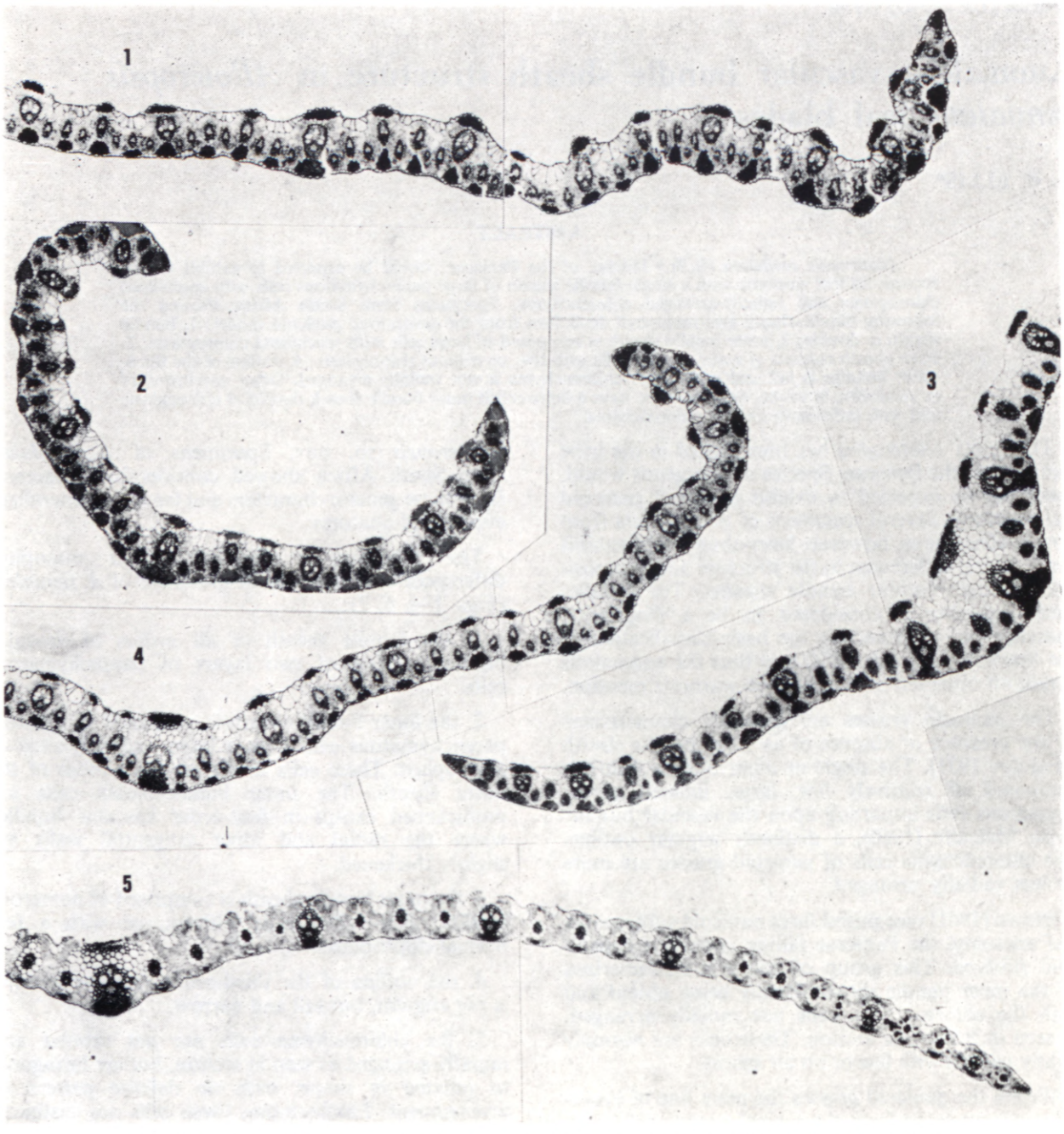


FIGS. 1–5.—Leaf blade outline of **Alloteropsis semialata** in transverse section. A11×6,25, bright field. Fig. 1, *Ellis* 2. Fig. 2, *Ellis* 721. Fig. 3, *Ellis* 1244. Fig. 4, *Ellis* 36. Fig. 5, *Ellis* 733.

The specimens exhibiting this structure are: TRANSVAAL.—2530 (Lydenburg): Belfast (–CA) 6–2–1904 *Burtt-Davy 1323*. 2531 (Komatipoort): Ida Doyer Nature Reserve (–CC) 21–1–1971 *R. P. Ellis 378* and NATAL.—3030 (Port Shepstone): Eureka Farm, Izotsha (–CD) 20–12–1971 *R. P. Ellis* 733.

These specimens conform reasonably closely to the Metcalfe (1960) description for the genus except for the lack of chloroplasts in the sheath cells and the presence of a double bundle sheath.

The occurrence of two distinct types of anatomical structure within a single species is unexpected and further investigation is required. Chippindall (1955) notes that *A. semialata* is exceedingly variable in inflorescence size and form and it is not improbable that these anatomical differences are correlated with morphological ones.

REFERENCES

AVDULOV, N. P., 1931. Karyo-systematische Untersuchung der Familie Gramineen. *Bull. Appl. Bot. Genet. Plant Breed.*, Suppl. 44: 1–428.

BROWN, W. V., 1958. Leaf anatomy in grass systematics. *Bot. Gaz.* 119: 170–178.

BROWN, W. V., 1961. Grass leaf anatomy: Its use in systematics. *Recent Advances in Botany*. I: 9th International Bot. Congress 1959: University of Toronto Press.

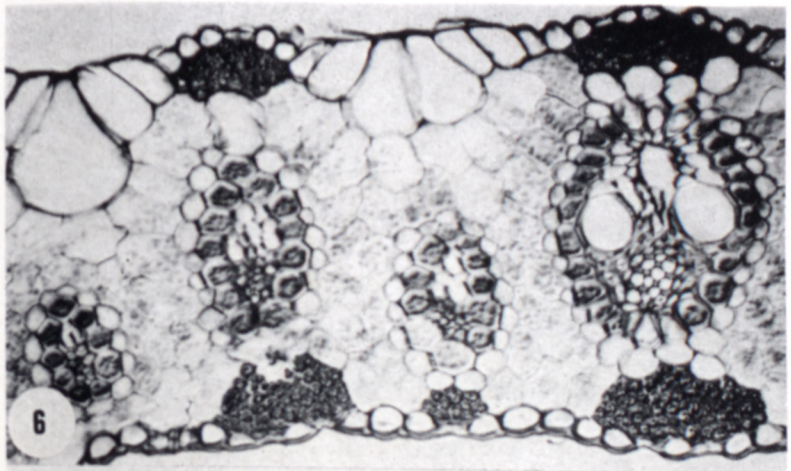
CHIPPINDALL, L. K. A., 1955. In Meredith *et al.* Grasses and Pastures of South Africa. Johannesburg: Central News Agency.

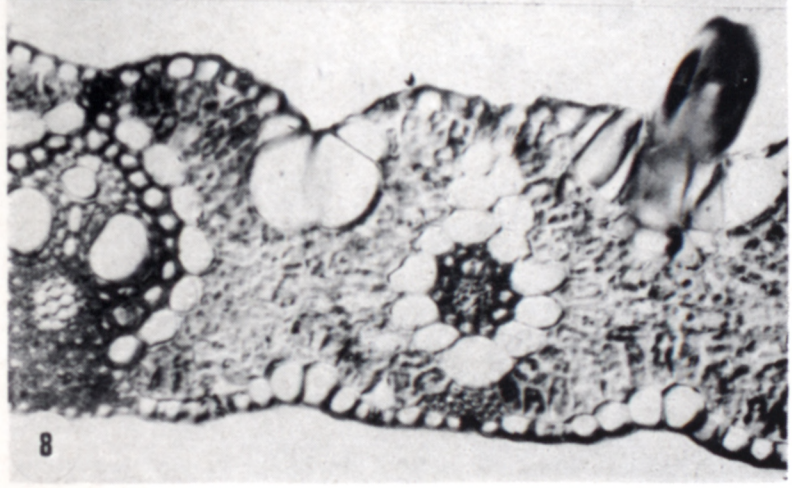
LOMMASSON, R. C., 1957. Vascular bundle sheaths in the genus *Aristida*. *Phytomorphology* 7 (3–4): 364.

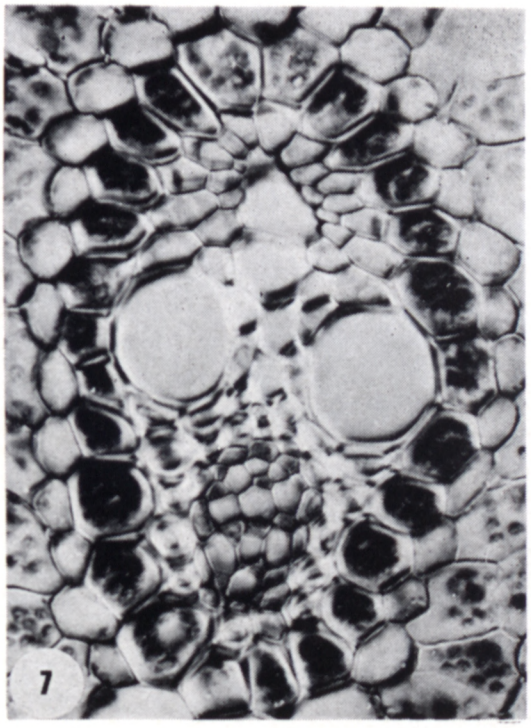
METCALFE, C. R. 1954. Recent work on the systematic anatomy of the Monocotyledons. *Kew. Bull.* 4: 523–532.

METCALFE, C. R., 1960. *Anatomy of the Monocotyledons. I. Gramineae*. Oxford: Clarendon Press.

TATEOKA, T., 1956. Re-examination of anatomical characteristics of the leaves in Eragrostoideae and Panicoideae (Poaceae). *J. Jap. Bot.* 31: 210–218.







FIGS. 6–8.—Transverse sections of the leaf blade of **Alloteropsis semialata.** Fig. 6, *Ellis* 36×40 interference contrast. Fig. 7, *Ellis* 36×100 interference contrast. Fig. 8, *Ellis* 733×40 interference contrast.