

1896

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Recommended Citation

Weaver, C. B. (1896) "An Anatomical Study of the Leaves of Some Species of the Genus Andropogon," *Proceedings of the Iowa Academy of Science*, 4(1), 132-137.

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AN ANATOMICAL STUDY OF THE LEAVES OF SOME
SPECIES OF THE GENUS ANDROPOGON.

BY C. B. WEAVER.

The purpose of the following paper and accompanying figures is to make an additional contribution to the work already done toward our knowledge of the leaf anatomy of grasses.

Reference to valuable literature along this line of scientific research may be found in the papers by Misses Pammel and Serrine, on the genera *Sporobolus* and *Panicum*, published in vol. III, of the proceedings of Iowa Academy of Sciences for 1895.

ANDROPOGON PROVINCIALIS.

(Pl. xii, Figs. 2, 3 and 4; Pl. xiv, Fig. 12.)

In this species the epidermal cells (E. C.) are large, nearly round and variable in size. The cuticle (C.) is well developed. The stomata (Sto.) occur in small depressions.

The bulliform cells (B. C.) vary in number from two to six. They seem to merge gradually into the epidermal cells and vary considerably in size. These cells occur between the secondary veins and below the mestome bundles.

In this species four types of bundles occur, viz.: (1) carene, (2) entirely closed, (3) open, (4) larger secondary bundles with stereome (Ste.) both above and below.

The carene (Car.) consists of three large bundles open above and below. The central bundle is but little larger than the secondary bundles. In the hadrome (H) occur the conspicuous pitted and spiral ducts. The chlorophyll-bearing parenchyma cells surrounding the larger bundles are not as conspicuous as those of the smaller mestome bundles. The stereome (Ste.) above the carene is well developed and is wider than the middle larger bundle, while opposite on the lower side of the leaf occur but few stereome cells, and these latter are in direct contact with the epidermal cells. The cells composing the leptome portion (L) of the middle carene bundle are uniform in size.

The uncolored parenchyma cells which occur below and to the side of the middle carene bundle, are large. These cells are in contact with the three large bundles of the carene (Car.) The smaller mestome bundles (M) on either side of the carene occur close together. The chlorophyll-bearing parenchyma cells (C.B.P.) surrounding them are conspicuous. These bundles are not uniform in number on both sides of the mid-rib, which goes to show that the development of the leaf is unequal. On each side of the carene occur four of the larger secondary bundles.

The edges of the leaf are provided with stereome (Ste.) The stereome about the bundles varies in the number of cells.

The cells of the mesophyll (Mes.) occur as dense masses with numerous intercellular spaces. They vary in shape from elongated to spherical. An occasional small trichome (Tri.) (Fig. 4) may be seen.

ANDROPOGON NUTANS.

(Pl. xii, Figs. 1 and 5; Pl. xv, Figs. 14 and 15.)

In this species, as in *A. provincialis*, the epidermal cells (E.C.) are large, nearly round and vary in size. The cuticle (C) is well developed. The conical projections (C. P.) are conspicuous, and more so on the lower than on the upper surface.

The bulliform cells (B. C.) vary in number from two to five. They are more uniform in number than *A. provincialis*, and do not vary so much in size. They occur between the secondary veins and below the smaller closed mestome bundles (M). In this species, as in *A. provincialis*, occur four types of bundles, (1) carene, (2) entirely closed by surrounding chlorophyll-bearing cells, (3) open, (4) large bundles with leptome (L.), and hadrome (H.), more strongly developed. There occasionally occurs a short and sharply pointed trichome emerging from the mestome bundle of the secondary vein. The secondary bundles are open above and below. Stereome (Ste.) occurs on both sides of these bundles.

The carene differs from that of *A. provincialis* in the number of pitted and spiral ducts. Its parts are all well developed. The stereome below the carene is not so abundant as in *A. provincialis*, but the reverse is true of the stereome above the carene. The uncolored parenchyma cells between the bundles and upper stereome are more numerous than in *A. provincialis*.

The mestome bundles are not so close together in this species as in *A. provincialis*. The larger bundles vary in number

on either side of the carene, while the number as a whole is uniform, forty-one and forty-nine. The edges of the leaves are completely filled with stereome (Ste.). The stereome occurs only on the lower side of the smaller closed bundles, and in sections of this species is not so abundant as in *A. provincialis*. The mesophyll (Mes.) is more abundant in *A. nutans* than in *A. provincialis*. In shape and size the cells are about the same. In this portion we find small intercellular spaces. The uncolored parenchyma cells about the carene occur in about the same proportion as in *A. provincialis*.

ANDROPOGON SCOPARIUS.

(Pl. xlii, Figs. 6 and 8; Pl. xv, Fig. 13.)

In this species the epidermal cells (E. C.) do not differ in detail essentially from *A. provincialis* and *A. nutans*. They are quite variable in size. Cuticle (C.) is well developed. Trichomes (Tri.) are scattered but conspicuous.

The bulliform cells (B. C.) are sufficiently characteristic to distinguish it from all other species studied. They occur as an almost continual row the entire breadth of the leaf with the exception of above secondary bundles, this space is occupied by stereome.

Stereome occurs in groups of from three to eight cells, more uniform in size than in the other species studied. The principal distinguishing feature between this and other members of the genus studied lies in the continuous row of bulliform cells which occurs across the upper portion of the carene (Car.) this, in other species, is occupied by sterome.

The four types of bundles occur in this species as in others studied. The carene is bulged below. Stereome (Ste.) is abundant. The epidermal cells on the lower surface of the leaf below the carene are somewhat irregular with reference to the cell wall, the latter is also stratified.

The uncolored parenchyma occupies the space between the bulliform cells and the bundles of the carene, forming more or less of a continuous row up to and slightly beyond the first secondary bundle, except for such interruptions due to the development of stereome of bundles of third type. Beyond this it is confined to from two to six cells above the mesophyll. Stereome does not occur above carene as in other species studied. Pitted and spiral ducts are large and well developed. Leptome (L.) and hadrome (H.) are well developed in this species.

The mestome portion is compact. The larger secondary mestome bundles occur in sets of three on either side of the carene. The bundles number twenty-four and twenty-eight on either side of carene. The mestome portion extends nearly to the edge of the leaf, where stereome occurs. The edges of the leaf are rounded.

The stereome portion is quite generally distributed and varies not essentially from this portion in other species. The secondary mestome (M.) bundles are not characteristic.

ANDROPOGON SORGHUM.

(Pl. xiii, Fig. 7; Pl. xiv, Fig. 10.)

Cuticle (C.) and epidermal cells (E. C.) are not characteristic. Bulliform cells (B. C.) vary in number from two to eight. Their size is somewhat variable. These cells merge so gradually into the smaller ones which are usually found above the mestome bundles that it is difficult to distinguish them from the epidermal cells on this side of the leaf. The four types of bundles common in other species studied occur also in this species. The carene is distinguished from that of other species studied in that the chlorophyll-bearing parenchyma cells (C. B. P.) are small, not so regular, and do not contain as much chlorophyll as in other species studied. The intercellular space adjoining the ringed duct is large. The stereome (Ste.) above and below carene bundles is conspicuous. Epidermal cells directly below carene are rectangular in shape. The mestome (M.) bundles are not characteristic in this species. The rectangular chlorophyll-bearing parenchyma cells surround the bundles. The mestome bundles are numerous and occupy the same relative position as in other species studied. Edges of leaf have a well-developed stereome. The number of cells varies. The mesophyll (Mes.) is not so dense as in other species. The shape and size of the cells varies considerably. The uncolored parenchyma cells occur above and to sides of upper half of carene. These cells are unusually large, and occupy a large portion of the mid-rib. They gradually become smaller toward the edges of the leaf. Stereome above parenchyma occurs in from two to three rows. The contents of bundles are not essentially different from others already studied. The breadth of the leaf as well as the large mid-rib is sufficient to characterize it.

ANDROPOGON SORGHUM, VAR. HALEPENSE. HACKEL.

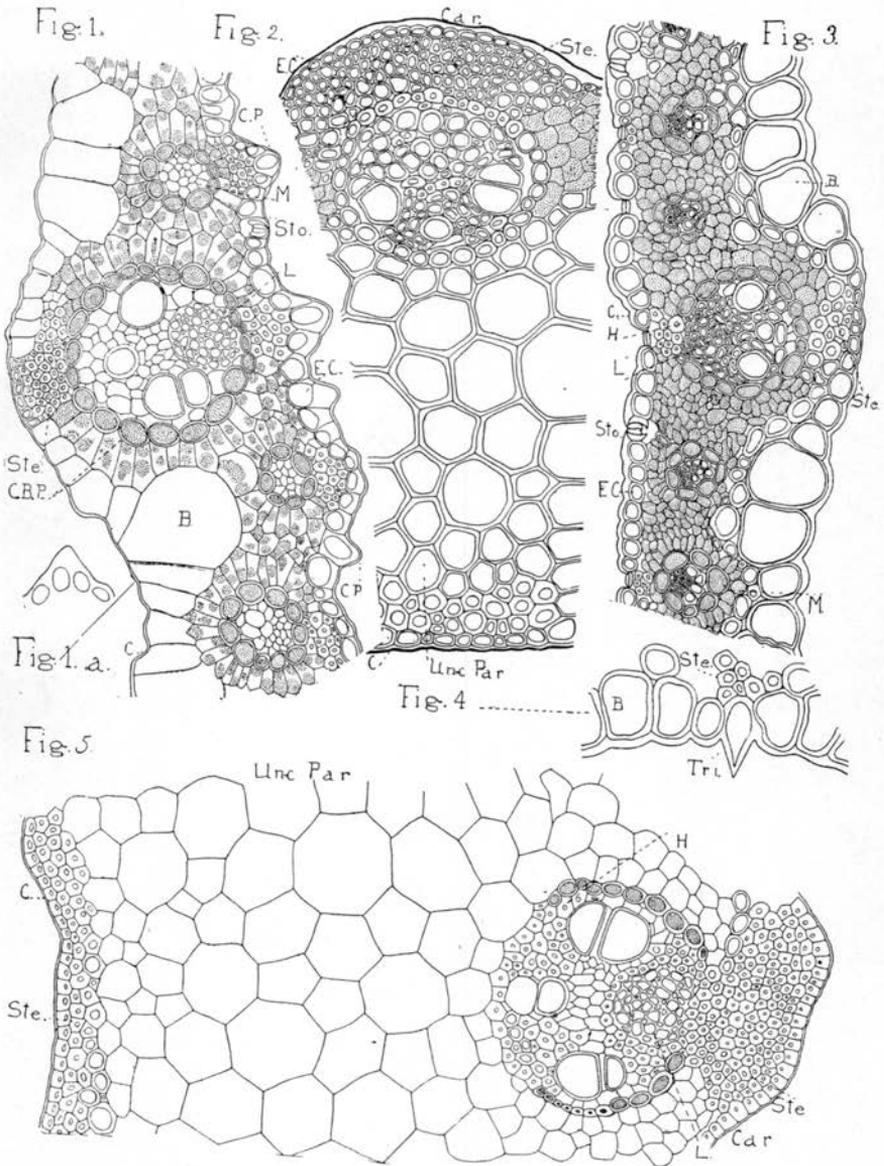
(Pl. xiii, Fig. 9; Pl. xiv, Fig. 11.)

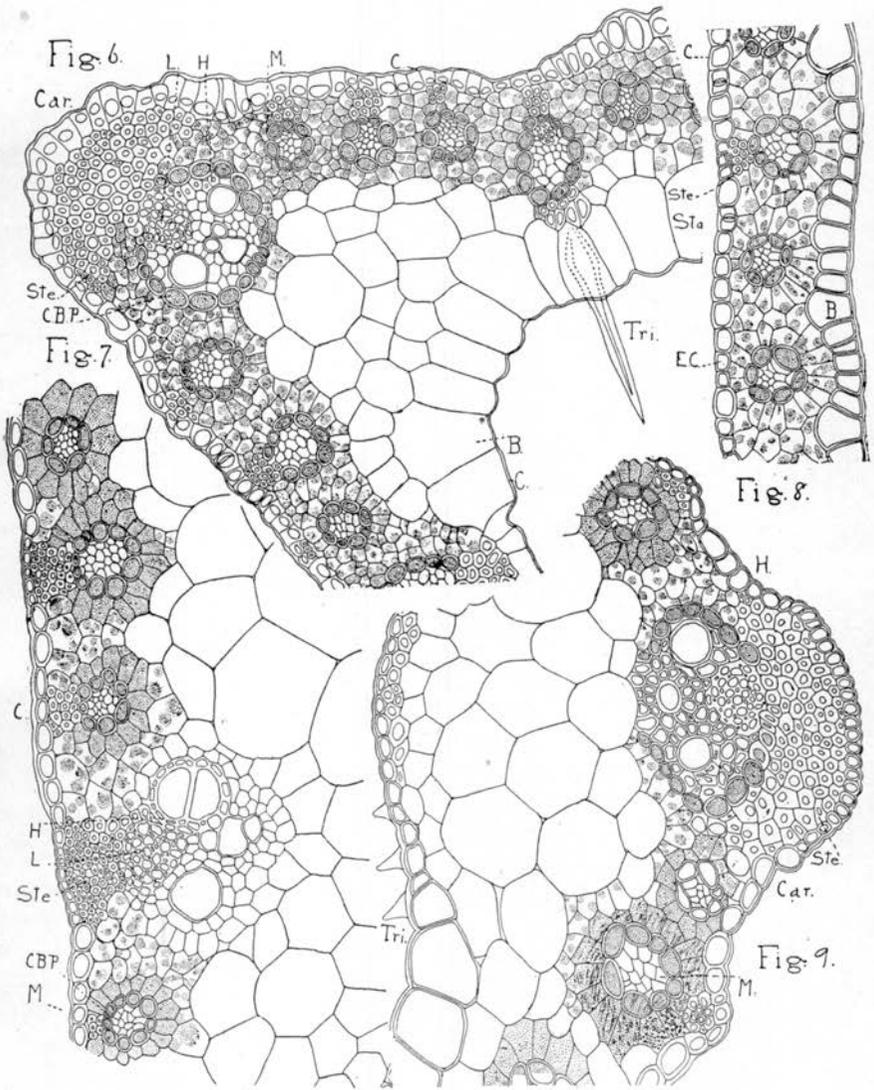
The epidermal cells (E. C.) in this species have a thick cell wall and vary somewhat in size, not as much, however, as in some of the other species. Many of the cells, especially the larger ones, are somewhat elongated. The cuticle is well developed. The bulliform cells (B. C.) vary in number from two to four. These gradually blend into the epidermal cells.

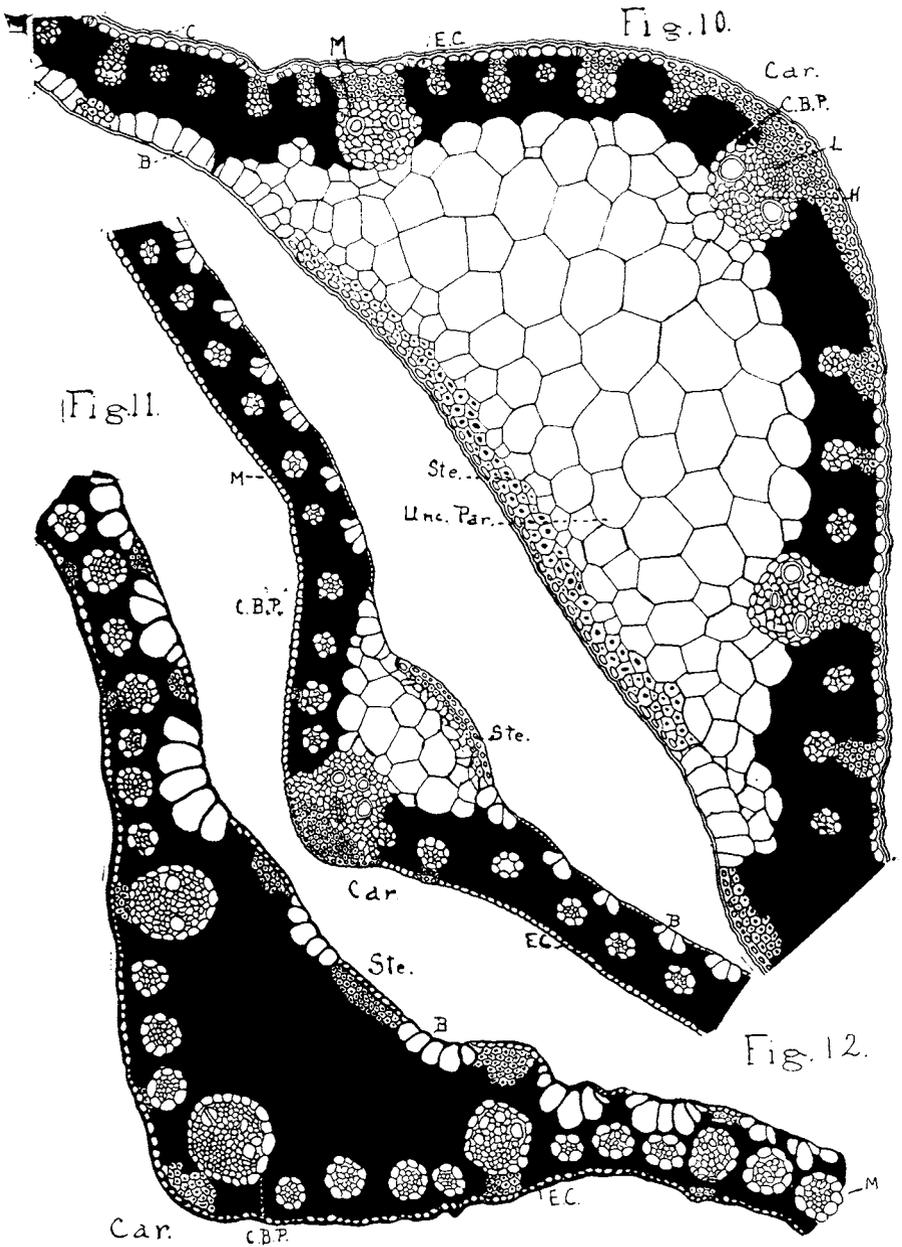
The carene (Car.) consists of five bundles, the large bundles of the mid-rib and two smaller closed mestome bundles on each side; the bundle next to the mid-rib is very small and without stereome. Below the second bundles on each side is found a small group of cells. The large central bundle of the carene does not differ from those of other species. In this variety the leptome (L.) consists of large cells, nearly uniform in size. The pitted ducts occur singly; annular duct is rather large. The interior of the bundle contains very little stereome. Chlorophyll-bearing parenchyma cells surround the bundles and are average in size. Stereome (Ste.) occurs on upper side of leaf, and large bundles are in direct contact with the epidermal cells and consist of two quite regular and distinct layers of cells. The uncolored parenchyma cells are large. The lower surface of mid-rib in this species is decidedly convex. This is also true of *A. sorghum*, but not so marked. The surfaces of the leaf are smooth with the exception of an occasional sharp trichome or conical projection which occurs on the upper surface of the leaf and only in vicinity of the mid-rib. The usual four types of bundles occur. The mestome bundles are not characteristic. The cells of the mesophyll (Mes.) directly surrounding the bundles are elongated. The bundles on either side of the carene occur quite close together. The stereome is confined principally in the vicinity of the carene and larger secondary bundles. The mesophyll portion does not differ materially from that of other species studied. Below stomata (Sto.) occur large intercellular spaces. The edges of the leaf contain conspicuous cells of stereome.

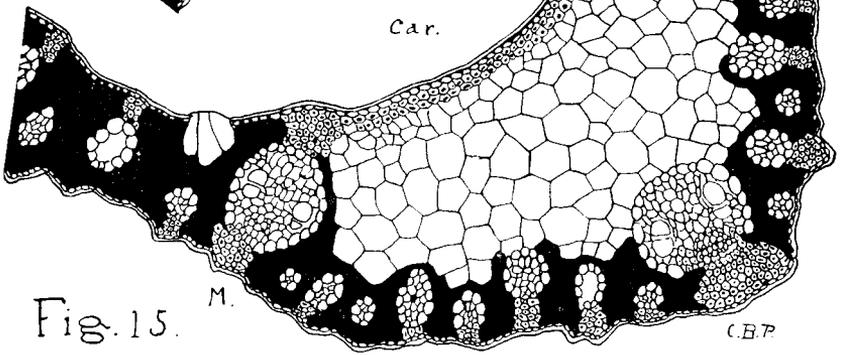
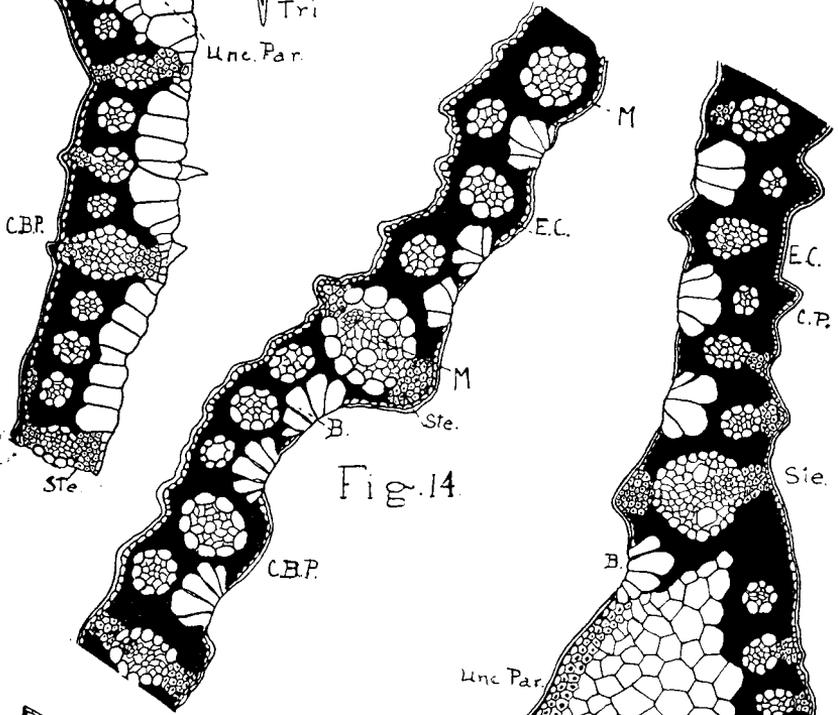
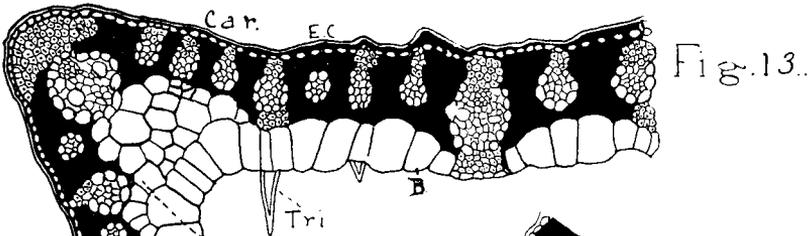
COMPARISON.

A comparison of the species of the genus *Andropogon* which have been studied at this time shows general similarity in anatomical arrangement of parts, and yet, in each species occur characters sufficient to distinguish it. The bundles have the same general arrangement and structure, except some minor









characters. The opened and closed bundles are variable in number and difficult to distinguish, as many of the smaller mesotome bundles are very small and close together.

These species can be distinguished by the following key: Bulliform cells in groups of two to four, occasional short trichomes. *A. provincialis*.

Bulliform cells narrow and long, two to five in number, in some cases decidedly unequal, short trichomes very numerous. *A. nutans*.

Bulliform cells three to eight, uniform in size, forming an almost continuous row, also above the carene, trichomes conspicuous. *A. scoparius*.

Bulliform cells vary in number from two to eight, in definite groups, gradually merge into the epidermal cells; smooth. *A. sorghum*.

Bulliform cells vary in number from two to four, gradually blending into the epidermal cells. Trichomes few and small near carene. *A. sorghum*, var. *Halepense*.

CONCLUSION.

In conclusion it may be said that each species of the genus presented here has individual peculiarities which are strong enough to distinguish it from other species of the genus. I believe also that a study of the anatomical characters offered in grasses will show characters enough to distinguish genera and, in many cases, species and even varieties, as for example, in *A. sorghum* and *A. sorghum*, var. *Halepense*. By these studies one may receive material aid in the classification and the determination of many grasses.

Thanks are due to Mr. Barnes of Blue Grass, who kindly sent the leaves of *A. sorghum*, var. *Halepense*.

EXPLANATION OF PLATES.

The same letter is used for the same character in all of the figures. C., cuticle; E., epidermis; E. C., epidermal cells; Sto., stomata; Tri., trichome; C. P., conical projections; B. C., bulliform cells; Unc. Par., uncolored parenchyma; C. B. P., chlorophyll-bearing parenchyma; Mes., mesophyll; Ste., stereome; M., mestome; Car., carene; H., hadrome; L., leptome.

The figures are all drawn with camera to the same scale. Low power with one half inch Beck objective; detailed drawings with one-sixth inch Beck objective.

Figs. 1-9 are reduced three times; Figs. 10-15 not reduced.

PLATE xii, Figs 1 and 5, *Andropogon nutans*; Figs. 2, 3 and 4, *Andropogon provincialis*.

PLATE xiii, Figs 6 and 8, *Andropogon scoparius*; Fig. 7, *Andropogon sorghum*. Fig. 9, *A. sorghum*, var. *Halepense*.

PLATE xiv, Fig. 10, *A. sorghum*; Fig. 11, *A. sorghum*, var. *Halepense*; Fig. 12, *A. provincialis*.

PLATE xv, Fig. 13, *A. scoparius*; Figs. 14 and 15, *A. nutans*.