

THE PHARMACOGNOSY OF THE ASPIDOSPERMA BARKS OF BRITISH GUIANA*

PART VI. THE MICROSCOPY OF THE BARK OF *Aspidosperma oblongum* A.DC. AND SUMMARY OF PARTS I-VI

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In Parts I to V of this series of papers the barks of five species of *Aspidosperma* have been described and illustrated. The present paper deals with the anatomy of a sixth bark, *Aspidosperma oblongum* A.DC, summarises the results of all six papers and provides keys for the identification of the six barks either in the whole state or in powder.

MATERIAL

The material used consisted of three samples of bark previously designated 5A, 5B and 5C collected in British Guiana in 1949, 1950 and 1954 respectively.

EXPERIMENTAL

Line drawings to illustrate the diagnostic characters of outer and inner surfaces of the bark of *Aspidosperma oblongum* and of tissue distribution as seen in smoothed transverse section are given in Figure 1, A, B and C.

Histology of the bark of A. oblongum (Figs. 1, 2, 3 and 4).

The thick cork consists of some forty to one hundred layers of rectangular to somewhat tangentially-elongated cells. The cell walls are thin and are unligified or very slightly lignified (Fig. 1, C and D, *ck* and Fig. 3, A, *ck*). One to three layers of thin-walled and rectangular to somewhat tangentially-elongated cells form the phellogen. This produces, on its inner surface, a well-marked phelloderm as a compact tissue some eight to twenty cells in radial thickness, in which are a few thin-walled, slightly tangentially-elongated, parenchymatous cells but the majority are sclerotic and form a more or less continuous band. Individual sclereids (Fig. 1, D, *phe* and Fig. 3, A, *phe*), rectangular to somewhat isodiametric, arranged more or less in radial files with the corresponding phellogen and cork cells; the cell walls are thick and lignified, traversed by simple or branched pits with lumen small but somewhat variable in size. Cortex consists of thin-walled, starch-containing parenchymatous cells with small intercellular spaces together with sclereids arranged in groups of varying sizes. The sclerotic cells are similar to those found in the phelloderm. Somewhat tangentially-elongated latex canals (Fig. 2, A, *lat* and Fig. 3, C, *lat*), R and H = 28 to 58 to 90 μ and T = 126 to 150 to 180 μ , are found associated with the sclereid groups and lying in the

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ASPIDOSPERMA OBLONGUM

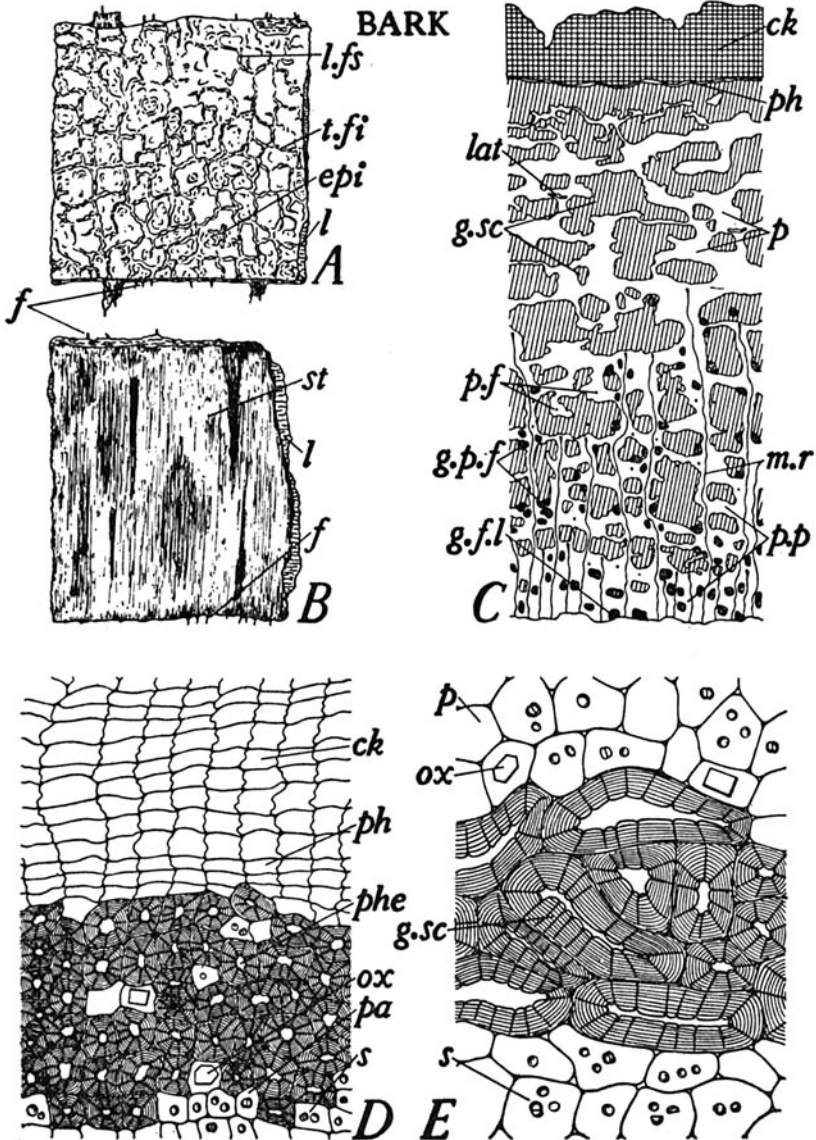


FIG. 1. *Aspidosperma oblongum* bark, macroscopical characters and T.S.:—A, outer surface $\times \frac{1}{2}$; B, inner surface $\times \frac{1}{2}$; C, smoothed T.S. $\times 12$; D, cork, phloem and phelloderm; E, cortex; D and E, $\times 200$; *ck*, cork; *epi*, epiphyte; *f*, fibre; *g.f.l*, group of phloem fibres with large lumen; *g.p.f*, group of phloem fibres with narrow lumen; *g.sc*, group of sclereids; *l*, laminations; *lat*, latex canal; *l.fs*, longitudinal furrow; *m.r*, medullary ray; *ox*, crystal of calcium oxalate; *p*, cortical parenchyma; *pa*, cortical parenchyma found associated with phellodermic sclereids; *ph*, phellogen; *phe*, phellodermic sclereids; *p.f*, isolated phloem fibre with narrow lumen; *p.p*, phloem parenchyma; *s*, starch; *st*, longitudinal striation; *t.fi*, transverse fissure.

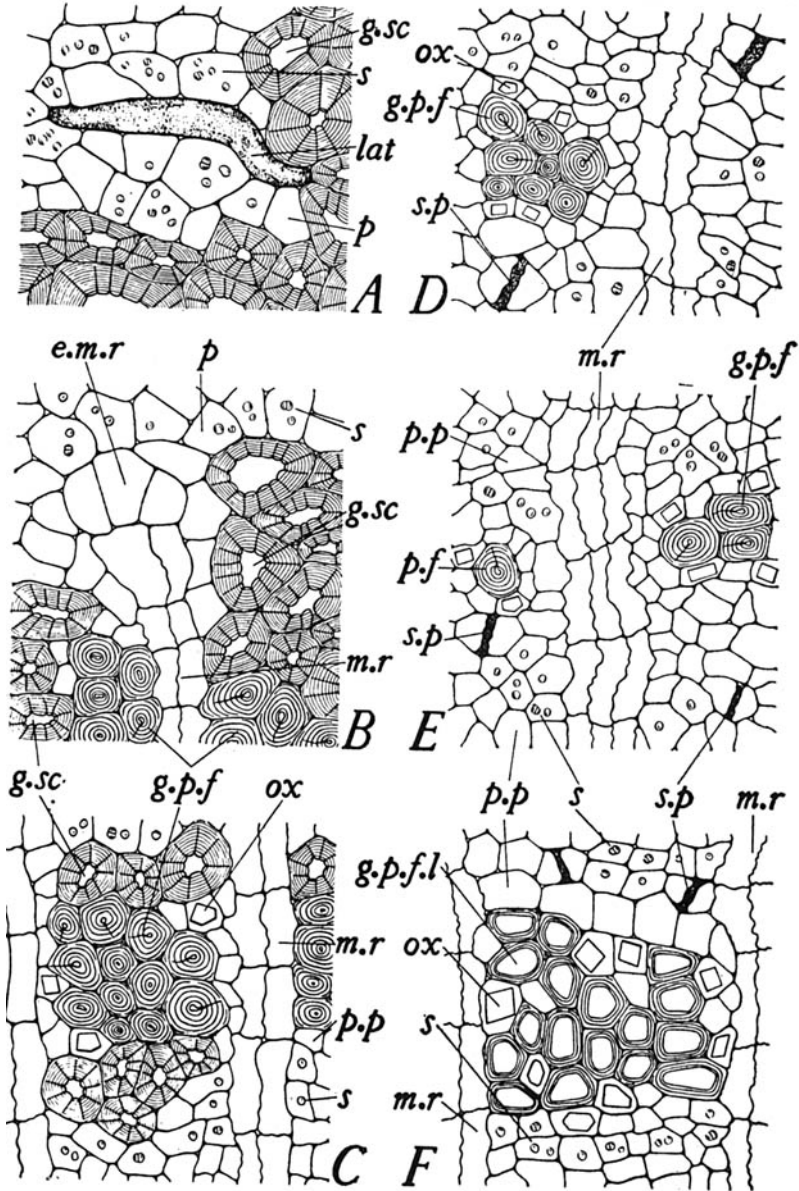


FIG. 2. *Aspidosperma oblongum* bark in T.S.:—A, cortex; B, innermost cortex and outermost phloem; C, D and E, phloem; F, innermost phloem, all $\times 200$, *e.m.r.*, end of medullary ray; *g.p.f.*, group of phloem fibres with narrow lumen; *g.p.f.l.*, group of phloem fibres with large lumen; *g.sc.*, group of sclereids; *lat.*, latex canal; *m.r.*, medullary ray, *ox.*, crystal of calcium oxalate; *p.*, cortical parenchyma; *p.f.*, isolated phloem fibre with narrow lumen; *p.p.*, phloem parenchyma; *s.*, starch; *s.p.*, sieve plate.

cortical parenchyma; the latex, which is granular in appearance, is stained yellow with iodine solution and pinkish-red with Millon's reagent. Towards the inner region of the cortex are groups of sclereids with, at times, a few small groups of thick-walled fibres or very occasional isolated fibres; no defined endodermis and pericycle were found.

Up to about 50 per cent of the thickness of the bark is of phloem, which consists of sclereids, sieve tissue, parenchyma, fibres and medullary rays. It can be sub-divided into three unequal zones, the largest of which contains abundant sclereid groups identical with those found in the cortex and phelloderm; also present are fibres with narrow lumen, usually in groups or very rarely isolated and at times embedded in the sclereid groups. In a narrow zone towards the inner region of the phloem, groups of fibres with narrow lumen are present but sclereid groups are absent. The innermost region of the phloem contains groups of fibres with narrow lumen and a few groups of fibres with large lumen; sclereids are absent. The sieve tubes have oblique, compound sieve plates on the end walls (Figs. 2, 3 and 4, *s.p*) and are less readily distinguished in the outer part of the phloem. Phloem parenchyma is of thin-walled cells, with a few intercellular spaces, some vertical walls are reticulately thickened and exhibit compound pits. Phloem fibres, R and T = 22 to 40 to 58 μ and H = 1290 to 1880 to 2670 μ , of two types: the greater number have a narrow lumen and occur in groups of two to fourteen fibres, scattered throughout the phloem (Fig. 1, 2 and 3, *g.p.f*); very rarely isolated fibres are found in the outer region of phloem only (Fig. 1, 2, 3 and 4, *p.f*): fibres with large lumen, occurring only in the innermost region of the phloem, are in a very few groups of four to fourteen fibres (Fig. 1 and 4, *g.f.l*, Fig. 2, *g.p.f.l*). Both types of fibres are spindle-shaped with bluntly pointed ends, walls thick, lignified, stratified, traversed by a few simple pits, along which splitting may have occurred; a crystal sheath surrounds the fibres or groups of fibres, except when these are embedded in the sclereid masses. The medullary rays are very wavy, are two to three cells in width but becoming up to five cells wide (Fig. 2, B, *e.m.r*) towards the periphery of the phloem, they are 15 to 25 cells in height; individual cells are straight or somewhat wavy in outline and contain starch granules.

Cells of the cortical and phloem parenchyma contain abundant simple or 2- to 4- compound starch granules; individual granules with eccentric hilum, spherical, ovoid or plano-convex and up to 36 μ in diameter (Figs. 1, 2, 3 and 4, *s*). Calcium oxalate, in square, rectangular or obliquely rectangular prisms or small cubes up to 30 μ , occurs in crystal sheaths around the fibres and also associated with the groups of sclereids (Fig. 1, 2, 3 and 4, *ox*).

Powdered bark. The powder is light brown in colour and exhibits the characters described above. These include the cork cells which are polygonal in surface view and reddish-brown in colour, with thin, unlignified or very slightly lignified walls (Fig. 4, B, *ck*). The sclereids occur in masses, the individual cells are of various shapes and sizes, measuring 22 to 52 to 80 μ in length and 18 to 32 to 54 μ in width; they are thick-walled and lignified, the lumen is either narrow or somewhat large (Fig. 4, B,

sc). The phloem fibres are usually broken during the powdering of the bark; fragments are either isolated or in groups of two to three fibres and are of two types; the greater number of fibres have a narrow lumen and are surrounded by a calcium oxalate crystal sheath except when they are associated with sclereid groups; fewer fibres with large lumen, and either with or without crystal sheath (Fig. 4, B, *f.p* and *f.s*). Calcium oxalate crystals (Fig. 4, B, *ox*) are also present in association with a few of the groups of sclereids. Phloem parenchyma (Fig. 4, B, *p.p*) associated with the cells of the medullary rays (Fig. 4, B, *m.r*), and cortical parenchyma (Fig. 4, B, *p*) of thin-walled and tangentially-elongated cells, all contain starch granules (Fig. 4, B, *s*).

DIAGNOSTIC CHARACTERS

The diagnostic characters of the bark of *A. oblongum* are:—

1. Cork cells, pale reddish brown in colour, rectangular to somewhat tangentially-elongated, thin-walled and unligified or very slightly lignified.
2. Phelloderm mainly lignified, of an irregular band of sclereids, eight to twenty layers in radial thickness.
3. Latex canals of cortex, very much tangentially elongated.
4. Sclereids present as groups of varying sizes in the cortex and phloem; individual cells with thick, stratified, lignified and pitted walls having narrow to somewhat large lumen.
5. Phloem fibres of two types, the majority with narrow lumen and either mostly in groups of two to fourteen fibres or very rarely isolated; fewer fibres with large lumen, always in small groups. Both types of fibres large, spindle-shaped, with thick, stratified and lignified walls, traversed by a few simple or branched pits.
6. Sieve tubes with compound sieve plates on the oblique end walls.
7. Medullary rays narrow and wavy; the cells with thin, somewhat wavy walls and containing starch granules.
8. Starch, abundantly present in cortical and phloem parenchyma, simple or 2- to 4- compound; individual grains with eccentric hilum, spherical, ovoid or plano-convex.
9. Prismatic calcium oxalate crystals in a parenchymatous sheath surrounding the fibres or groups of fibres, also at times in association with the sclereid groups.

GENERAL SUMMARY

(a) Entire Barks

In the present series of papers the barks of six *Aspidosperma* species have been described and illustrated, namely *A. ulei*¹, *A. excelsum*², *A. album*³, *A. megalocarpon*⁵, *A. quebracho-blanco*⁵ and *A. oblongum*, and these all show a common basic pattern of morphology and anatomy. They occur in thick and flat, curved or channelled pieces: the abundant cork is furrowed and fissured externally and bears epiphytic lichens or liverworts; the inner surface of each is longitudinally striated; the fracture is either short, granular and splintery in the outer part and fibrous in the inner part, or it is very hard. The odour of each bark is indistinct and the taste is bitter and aromatic.

ASPIDOSPERMA BARKS OF BRITISH GUIANA. PART VI

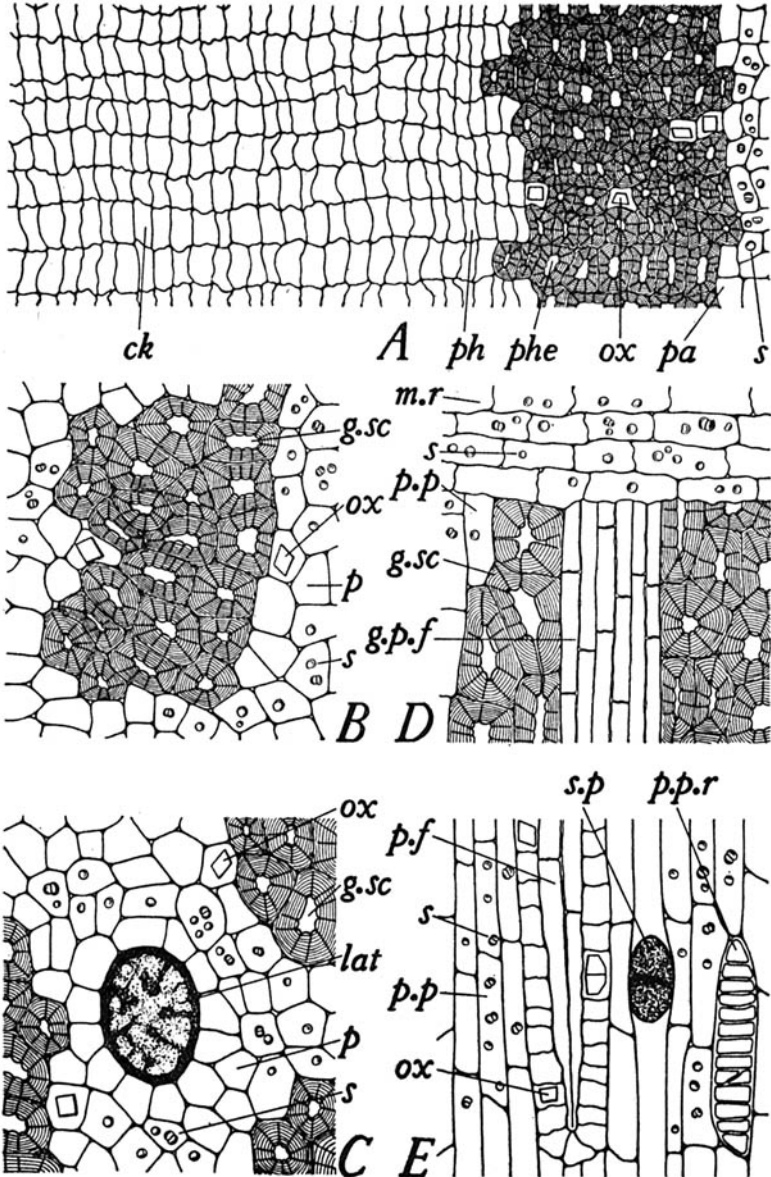


FIG. 3. *Aspidosperma oblongum* bark in L.S.:—A, cork; phellogen and phelloderm; B, and C, cortex; D and E, phloem; all $\times 200$; *ck*, cork; *g.p.f.*, group of phloem fibres with narrow lumen; *g.sc*, group of sclereids; *lat*, latex canal; *m.r.*, medullary ray; *ox*, crystal of calcium oxalate; *p*, cortical parenchyma; *pa*, cortical parenchyma found associated with phellodermic sclereids; *ph*, phellogen; *phe*, phellodermic sclereids; *p.f.*, isolated phloem fibre with narrow lumen; *p.p.*, phloem parenchyma; *p.p.r.*, phloem parenchyma with vertical walls reticulately thickened; *s*, starch; *s.p.*, sieve plate.

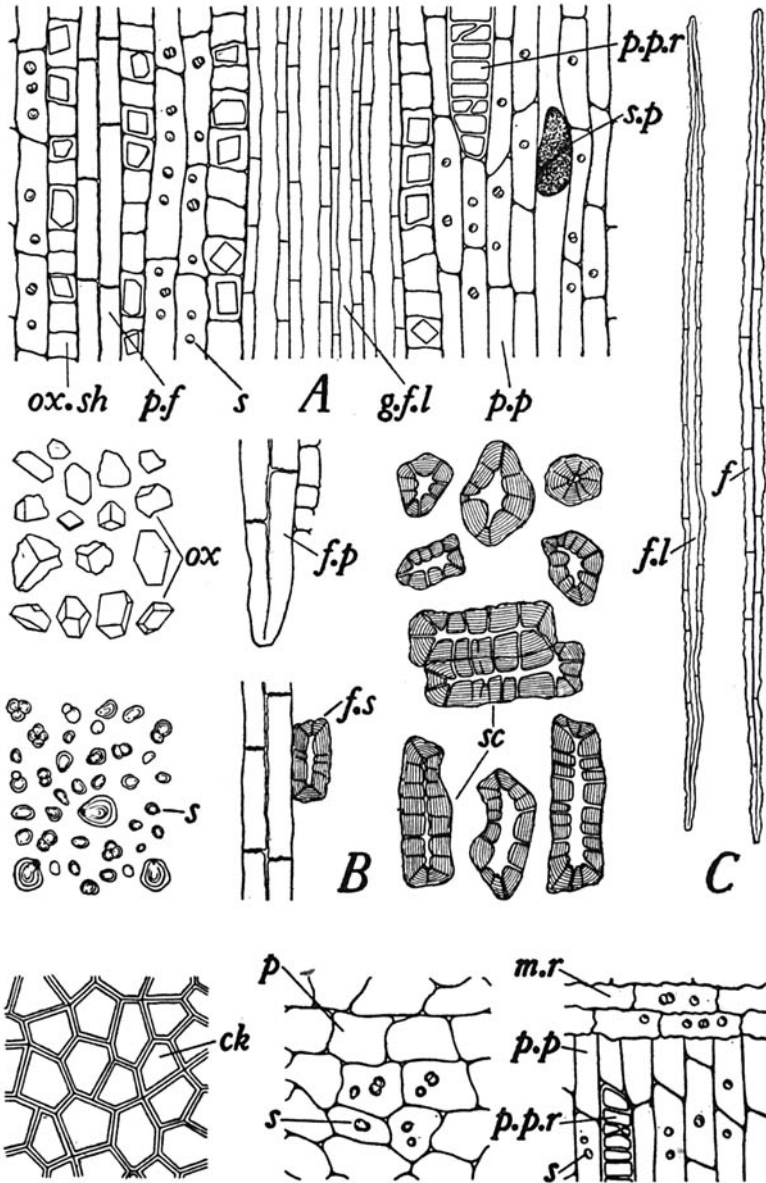


FIG. 4. *Aspidosperma oblongum* bark in L.S., powder and macerate:—A, innermost phloem $\times 200$; B, various components as seen in powder $\times 200$; C, fibres, isolated by maceration $\times 50$; *ck*, cork; *f*, phloem fibre with narrow lumen; *f.l*, phloem fibre with large lumen; *f.p*, phloem fibre with narrow lumen; *f.s*, sclereid cell attached to narrow lumened fibre; *g.f.l*, group of phloem fibres with large lumen; *m.r*, medullary ray; *ox*, crystal of calcium oxalate; *ox.sh*, calcium oxalate crystal sheath; *p*, cortical parenchyma; *p.f*, phloem fibre with narrow lumen; *p.p*, phloem parenchyma; *p.p.r*, phloem parenchyma with vertical walls reticulately-thickened; *s*, starch; *sc*, sclereids; *s.p*, sieve plate.

ASPIDOSPERMA BARKS OF BRITISH GUIANA. PART VI

Histologically, each of these six barks possesses a broad zone of cork consisting of lignified or unligified cells or both; the phelloderm and cortex contain abundant sclereids with thick, stratified and lignified walls, arranged in masses of varying sizes or in four to seven tangential bands. Latex canals are present in the cortex of four of the barks: in the other two barks these canals are absent but a small number of sclereids contain granular contents which stain in a similar manner to latex with Millon's reagent and with iodine solution. The phloem contains sieve tubes with compound sieve plates upon the oblique end walls; the medullary rays are narrow, the cells of which are either thin-walled or become sclerotic when passing through groups of sclereids. Many groups of sclereids are present in the outer part of the phloem, they are less abundant in *A. ulei* and are absent in *A. excelsum*. The scattered phloem fibres are mainly of large spindle-shaped cells with thick walls, traversed by simple or compound pits and with small lumen; some fibres with large lumen and narrow walls may also be present; each fibre or group of fibres is surrounded by a parenchymatous sheath of cells containing prismatic crystals of calcium oxalate, except when the fibres are embedded in groups of sclereids. Similar calcium oxalate crystals are associated with the sclereid groups. Starch granules, simple or 2-4 compound, are found in each of the six barks. The detailed characters by means of which these six barks may be distinguished from each other are set out in Table I.

Based on these characters the following analytical key for the identification of each bark has been drawn up.

Key to Differentiate the Six ASPIDOSPERMA Barks:

- | | |
|--|--------------------|
| 1. Latex canals—absent; medullary rays—sclerotic in association with the groups of sclereids | 2 |
| Latex canals—present; medullary rays—never sclerotic | 3 |
| 2. Cork cells—lignified; cortical sclereids—arranged in 4-7 tangential bands: | |
| <i>A. megalocarpon</i> | |
| Cork cells—unlignified; cortical sclereids—arranged in groups of varying sizes: | |
| <i>A. quebracho-blanco</i> | |
| 3. Cork cells—lignified; phloem fibres—always isolated: | |
| <i>A. excelsum</i> | |
| Cork cells—unlignified; phloem fibres—isolated and in groups | 4 |
| 4. Unlignified fibres—present in the pericyclic region; phloem fibres with large lumen—absent: | <i>A. ulei</i> |
| Unlignified fibres—absent; phloem fibres with large lumen—present | 5 |
| 5. Latex canals—axially elongated: | <i>A. album</i> |
| Latex canals—somewhat isodiametric or tangentially elongated: | <i>A. oblongum</i> |

(b) *Powdered Barks*

The colour of the powdered barks is fawn to brown, or yellow (*A. ulei*) or somewhat pink (*A. quebracho-blanco*). Diagnostic structures present

TABLE I
DIFFERENTIAL CHARACTERS OF BARKS OF SIX *Aspidosperma* SPECIES

	<i>A. album</i>	<i>A. oblongum</i>	<i>A. ulei</i>	<i>A. excelsum</i>	<i>A. megalocarpon</i>	<i>A. quebracho-bianco</i>
Colour of Inner Surface	Yellowish brown to almost black	As <i>A. album</i>	Characteristic yellow	As <i>A. album</i>	As <i>A. album</i>	Yellow to reddish-brown
Fracture	Short, granular, splintery in outer part, fibrous in inner part	As <i>A. album</i>	Very hard	As <i>A. album</i>	As <i>A. album</i>	As <i>A. album</i>
Cork	Cells thin-walled, unilignified or only slightly lignified	As <i>A. album</i>	As <i>A. album</i> ; cells much collapsed	Most cells with inner and outer walls thickened and lignified—a few cells thin-walled or unilignified or slightly lignified	Cells with inner and outer walls thickened and lignified. A few included groups of sclereids present	As <i>A. album</i>
Phellodermic Sclereids	One more or less continuous band of isodiametric cells	As <i>A. album</i>	As <i>A. album</i> ; One to several layers of tangentially-elongated cells also present	Isodiametric cells arranged in groups of varying sizes	As <i>A. excelsum</i>	As <i>A. album</i>
Cortex:	One band in outer cortex otherwise in scattered groups	In groups of varying sizes	As <i>A. oblongum</i>	In four to seven bands. A few sclereids with large lumen present in inner cortex	As <i>A. excelsum</i>	As <i>A. oblongum</i>
Latex canals	Axially elongated	Somewhat tangentially-elongated	Isodiametric or somewhat tangentially-elongated	Tangentially elongated	Absent	Absent
Sclereids with granular content	Absent	Absent	Absent	Absent	Present	Present
Fibres	Absent	Absent	Unlignified or slightly lignified; embedded in sclereid groups	Absent	Absent	Absent
Phloem:	Never sclerotic	As <i>A. album</i>	As <i>A. album</i>	As <i>A. album</i>	Sclerotic when in association with sclereid groups	As <i>A. megalocarpon</i>
Medullary Rays	In groups, except in the innermost region	As <i>A. album</i>	As <i>A. album</i> but less abundant	Absent	As <i>A. album</i>	As <i>A. album</i>
Sclereids	Isolated or in small groups	In small groups or very rarely isolated	Isolated or very rarely in groups of 2 fibres	Always isolated	Isolated or very rarely in groups of 2 fibres	As <i>A. album</i>
Fibres (a) with narrow lumen	Present in the innermost region in groups	As <i>A. album</i>	Absent	Present in the innermost region, isolated	Isolated, scattered throughout the phloem	As <i>A. ulei</i>
Fibres (b) with wide lumen	25–32–40 μ	22–40–58 μ	55–65–80 μ	36–50–62 μ	28–80–134 μ	25–46–62 μ
(c) Sizes diameter length	800–1750–2600 μ	1200–1880–2670 μ	2500–3650–5370 μ	1550–2210–2800 μ	600–1140–1650 μ	500–850–1200 μ

TABLE II
 DIFFERENTIAL CHARACTERS OF POWDERED BARKS OF SIX *Aspidosperma* SPECIES

	<i>A. album</i>	<i>A. oblongum</i>	<i>A. ulei</i>	<i>A. excelsum</i>	<i>A. megalocarpon</i>	<i>A. quebracho-blanco</i>
Colour	Fawn to light brown	As <i>A. album</i>	Yellow	As <i>A. album</i>	As <i>A. album</i>	Orange to reddish-brown
Sclereids with small lumen	Present in groups	As <i>A. album</i>	As <i>A. album</i>	As <i>A. album</i>	As <i>A. album</i>	As <i>A. album</i>
Sclereids with large lumen	Absent	Absent	Absent	Present	Absent	Absent
Sclereids with granular contents	Absent	Absent	Absent	Absent	Present	Present
Latex canals	None visible, due to powdering	As <i>A. album</i>	As <i>A. album</i>	Broken pieces visible	Absent	Absent
Fibres with narrow lumen	Lignified, present, see Table I	As <i>A. album</i>	As <i>A. album</i> , a few unignified fibres also present	As <i>A. album</i>	As <i>A. album</i>	As <i>A. album</i>
Fibres with large lumen	Present	Present	Absent	Present	Present and at times associated with groups of sclereids	Present
Sclereid/Fibre Ratio	128	802	319	1008	293	105

Note: For details of cork cells and dimensions of fibres see Table I.

are fragments of cork tissue, groups of sclereids, fibres which are usually broken and either isolated or in small groups, starch grains and calcium oxalate crystals as described above for the entire barks. Latex cells are frequently much destroyed during powdering.

Certain specific differences, which depend upon tissue arrangement in the entire barks, are also destroyed by powdering. To ensure differentiation of the powdered barks of certain of these species a ratio value has been developed^{4,6}. This is the number of sclereids present in unit mass of powdered bark divided by the number of fibres present in the same weight of bark. This S/F value has been found to be constant within a species and differential between barks of the six *Aspidosperma* species examined.

The differential diagnostic characters for these six barks in powder form are set out in Table II.

The following analytical key based on these characters may be used for the identification of any one of these six barks.

Key to differentiate the six powdered ASPIDOSPERMA Barks:

- | | |
|--|--------------------|
| 1. Cork cells—all, or the majority lignified | 2 |
| Cork cells—unlignified or only slightly lignified | 3 |
| 2. A few cork cells—unlignified, S/F ratio = 1008 | |
| <i>A. excelsum</i> | |
| Cork cells—all lignified, S/F ratio = 293 | |
| <i>A. megalocarpon</i> | |
| 3. Granular material—present in a few sclereids, S/F ratio = 105 | |
| <i>A. quebracho-blanco</i> | |
| Granular material—absent from all sclereids | 4 |
| 4. Large lumened fibres—absent, S/F ratio = 319 | |
| <i>A. ulei</i> | |
| Large lumened fibres—present | 5 |
| 5. S/F ratio = 128 | <i>A. album</i> |
| S/F ratio = 802 | <i>A. oblongum</i> |

Woodson⁷ has investigated the classification of the genus *Aspidosperma* and has arranged the 52 species in nine different series by means of their floral characters. The six barks which we have investigated in these researches belong to four of the Woodson series as follows: Series 3 *A. ulei*; Series 6 *A. oblongum*, *A. excelsum*; Series 8 *A. quebracho-blanco*; Series 9, *A. album*, *A. megalocarpon*. There is no clear parallelism between the distinguishing anatomical characters recorded in Tables I and II for these six barks, and their position in the Woodson classification.

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