

DATURA SANGUINEA R. AND P., ITS STEM AND LEAVES

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Datura sanguinea R. and P., the Dark-red Datura, is a perennial species growing as a shrub or small tree in Peru and Ecuador. It has been grown in England and the chief alkaloid present is hyoscyne. The structure of the leaves and stem is described and compared with other medicinal species of *Datura*. The characters by which the dried drug may be recognised and distinguished from stramonium are given. The pollen grains are described as an additional means of differentiation.

Datura sanguinea R. and P. is a Peruvian species of *Datura* and is widely used in Peru for medicinal purposes. Some years ago plants were grown in the open from seed at the Wellcome Chemical Works, Dartford and the aerial parts of the plants were examined chemically by Drey and Foster (1953) for their content of solanaceous alkaloids. The total alkaloidal content of the leaves varied from 0.34 to 0.51 per cent, the content of hyoscyne being from 0.34 to 0.49 per cent. In view of these results the authors reported that "The aerial parts contain sufficient hyoscyne to make the plant a possible commercial source of the alkaloid".

Plants of this species were also grown from the seed by Dr. J. M. Rowson, both in the greenhouse attached to the Museum of the Pharmaceutical Society of Great Britain and also at the Experimental Ground at Birdsgrove House, Derbyshire. The identity of the plants was confirmed by Dr. Rowson, who compared them with the descriptions given by Ruiz and Pavon (1799), by Humboldt, Bonpland and Kunth (1818), by Lindley (1834) under the name *Brugmansia sanguinea*, and by de Candolle (1852). Dr. Rowson also compared the plants with specimens at the Herbarium of the Royal Botanic Gardens, Kew, Surrey.

DESCRIPTION OF THE PLANT

The following is a description of the leaves and stem of *Datura sanguinea* R. and P.; the Dark Red Datura. *Habitat* Colombia, Ecuador and Peru at an altitude of 1840 metres (6000 ft.).

Habit

The plant is a perennial and may develop as an undershrub or a small tree with a hemispherical, leafy top and grows to a height of about 1.75 to 9 metres (6 to 30 ft.). The main stem is thick, terete, much branched above and has an ash-coloured bark; the principal branches are terete and fragile, pubescent and leafy especially in the younger, distal parts; dwarf shoots arise in the axils of the leaves of the main branches; see Fig. 1.

Leaves

The leaves are bright green. The *larger* leaves, growing on the main branches have an alternate phyllotaxis; *petiole* about 4 to 7 cm. long,

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terete, channelled above and pubescent; *lamina* about 15 to 23 cm. long and 9 to 15 cm. broad, ovate with two to three broad triangular lobes on each side and shallow sinuses, softly pubescent on both surfaces; *venation* reticulate with 2 to 4 principal lateral veins on each side, ending in the apices of the lateral lobes; *apex*, acute to somewhat acuminate. Fig. 2A and Fig. 1. The *smaller* leaves of the dwarf shoots are in groups of three

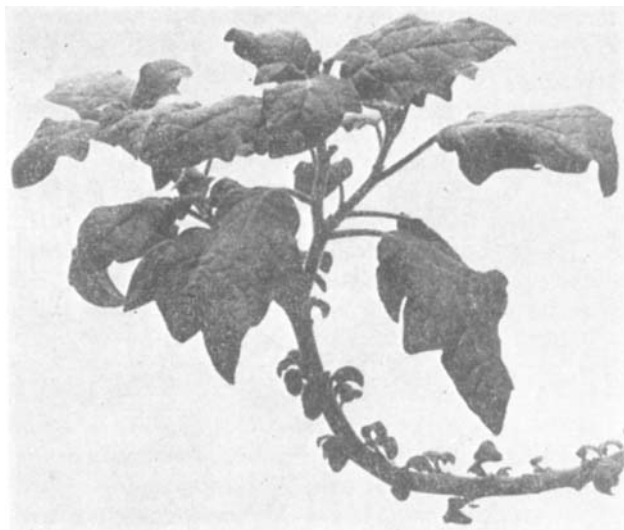


FIG. 1. *Datura sanguinea* R. and P. Branch of a shrub grown at Birdsgrove House, Derbyshire, showing the larger leaves and the dwarf, tufted shoots arising in their axils and bearing smaller leaves with entire margins. The larger principal leaves have fallen from the proximal portion of the stem shown in the photograph. 1/4 natural size.

to five; *petiole* about 0.5 to 2.0 cm. long; *lamina* about 5 to 12 cm. long and 1.5 to 4 cm. broad ovate, usually with an entire margin, occasionally somewhat wavy or having one or two broad triangular lobes; both *lamina* and *petiole* pubescent; *apex* acute; *venation* reticulate, lateral veins anastomosing near the margin; see Fig. 6A and Fig. 1.

HISTOLOGY OF THE LEAF

The leaves of *Datura sanguinea* R. and P. have a structure generally resembling that of the leaves of other important medicinal species of *Datura*, viz.: *D. stramonium* Linn., *D. tatula* Linn., *D. innoxia* Miller, *D. metel* Linn., as described by Timmerman (1927).

The larger leaves of the main branches, Fig. 2A, of *D. sanguinea* and the smaller leaves of the dwarf axillary shoots, Fig. 6A, have similar histological characters and the dimensions of the cells are slightly smaller for the smaller leaves (Fig. 5). The following description may be taken as applying to both the larger and the smaller leaves; unless otherwise stated, the measurements recorded refer to the larger leaves.

Petiole

The petiole of the larger leaves, measured at the middle point, is about 4 mm. thick; that of the smaller leaves of the dwarf shoots is about 1.5 to 2 mm. thick. A transverse section, Fig. 2B, is nearly circular in outline; on the upper side is a wide shallow groove, for the larger leaves about 1.5 mm. wide, flat or slightly convex at the bottom for a width of

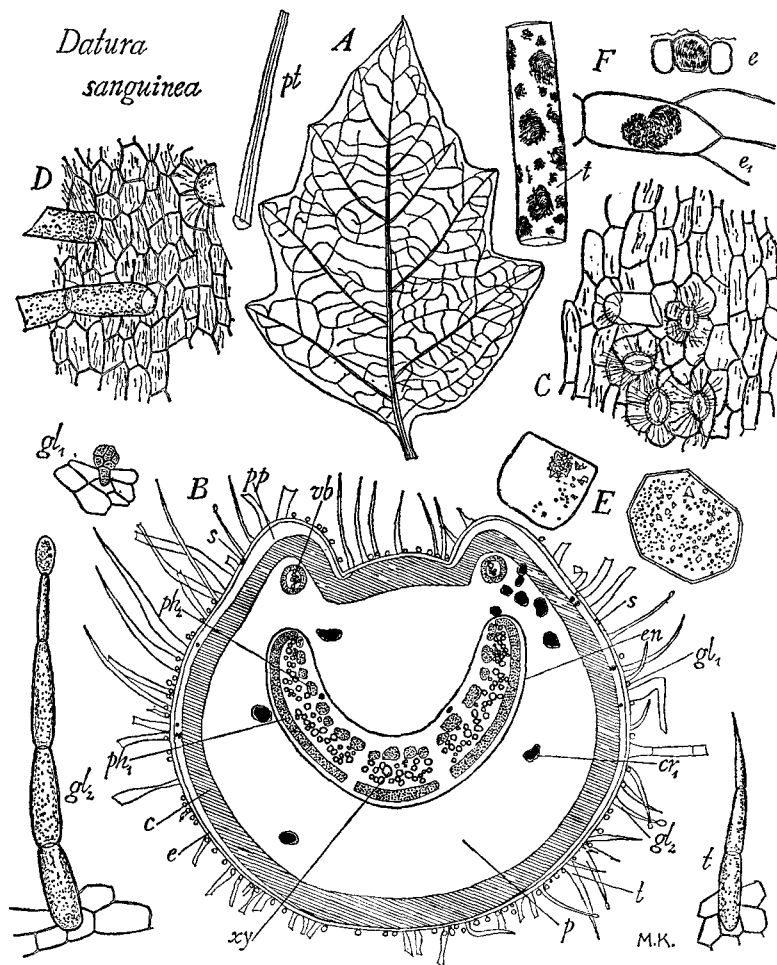


FIG. 2. *Datura sanguinea* R. and P. A, entire leaf, 1/3rd natural size, showing the undersurface and the separated petiole, *pt*, at one side. B, Petiole, T.S. $\times 16$, diagrammatic. C, lower and D upper epidermis of the petiole, both $\times 70$. E, cells from the parenchyma of the petiole, containing calcium oxalate crystals. F, Cells from the epidermis of the petiole, *e*, in T.S. and *e*₁, in surface view and a cell, *t* from a trichome, all showing groups of fine acicular crystals, $\times 130$. *c*, collenchyma; *cr*₁, microsphenoidal calcium oxalate; *e*, epidermis; *en*, endodermis; *gl*₁, clavate glandular trichome; *gl*₂, glandular trichome with uniseriate stalk, $\times 70$; *p*₁, parenchyma; *ph*₁, normal phloem; *ph*₂, perimedullary phloem; *p.p.*, photosynthetic parenchyma; *s*, stoma; *t*, covering trichome; *vb*, vascular bundle; *xy*, xylem.

1.0 mm., and having a rounded ridge, about 0.5 mm. high, on each side. In each of the ridges there is a small vasicentric vascular bundle. The meristele is gutter-shaped, about 2.25 mm. wide across the open side and 1.5 mm. deep; it is composed of a layer, about 0.5 mm. thick, of small vascular bundles, which have normal phloem on the abaxial surface and several small groups of perimedullary phloem on the adaxial surface, the whole group of bundles being surrounded by a starch sheath (endodermis) the cells of which contain a few small starch granules and some of them sphenoidal microcrystals of calcium oxalate. Cells filled with sphenoidal microcrystals also occur sparsely scattered throughout the cortical ground tissue of the petiole. The petiole is strengthened by a complete hypodermal layer of collenchyma, about 0.25 mm. wide. On the sides of the petiole, between the epidermis and the collenchyma and over the ridges there is a narrow layer of photosynthetic parenchyma. All parts of the epidermis bear numerous covering and glandular trichomes, Fig. 2, *gl*₁, *gl*₂, and *t*, which resemble the trichomes of the lamina. Some of the epidermal cells contain a group of fine acicular crystals, the identity of which has not been established; some of the trichomes contain similar crystals, Fig. 2, *F* and Fig. 6 *cr*₂. The cuticle of the epidermis is striated longitudinally, Fig. 2, *D* and *C*.

Lamina

At a position about one third of the length of the leaf from its base, the *midrib* projects strongly (about 2.2 mm. in the larger leaves) on the lower surface and is rounded in outline; over the midrib on the upper side there is a ridge about 0.5 mm. high; see Fig. 3, *A*. Both the projecting lower surface and the upper ridge are supported by three or four layers of hypodermal collenchyma. These and other features closely resemble the structure of the midrib of *Datura stramonium* Linn. There are a few scattered idioblasts with sphenoidal microcrystals in the fundamental parenchyma, Fig. 3, *A cr*₁, and the meristele resembles that of the petiole; the starch sheath, however, is not clearly developed on the upper, adaxial side.

Both the upper and the lower epidermises of the leaf bear very numerous conical covering trichomes 2 to 4 to 5 cells long and about 30 to 95 to 160 μ wide at the base, their total length is about 58 to 690 to 1536 μ ; and the length of the basal cell is about 57 to 190 to 328 μ . Two kinds of glandular trichomes are present, a few clavate ones, Fig. 2, *gl*₁, with a one or two-celled stalk and a pluricellular pyriform head, similar to those of other solanaceous plants, and others with a long 2 to 4 to 5 to 6-celled uniseriate stalk and an ovoid or globular unicellular head, see Fig. 2, *gl*₂.

The *interneural lamina* is dorsiventral and resembles that of *D. stramonium* Linn. No stomata could be found on the upper epidermis, but they are very numerous in the lower, see Fig. 3, *C*, *D* and *E*. The palisade tissue consists of a single layer of cells and beneath it is a crystal layer, many of its cells each containing usually a cluster crystal of calcium oxalate, about 20 to 30 μ in diameter, occasionally a single prism is present in a cell. The anticlinal walls of the majority of the cells of the upper

epidermis are wavy and those of the lower epidermis very strongly wavy, see Fig. 3, *E* and *F*. The cells surrounding the bases of the trichomes have straight or nearly straight walls; those near the margin of the leaf also have straight walls, being rhomboid on the upper surface and elongated

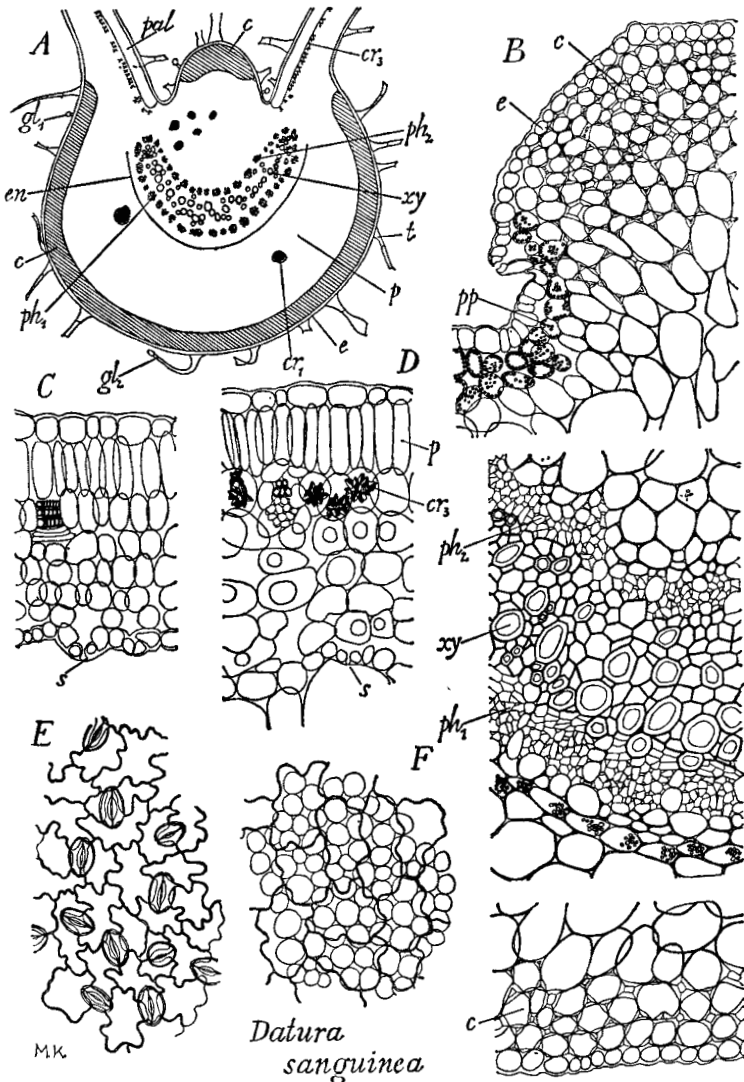


FIG. 3. *Datura sanguinea* R. and P. Lamina of larger leaf. *A*, diagrammatic T.S. of the midrib, $\times 16$; *B*, details of the midrib, T.S., $\times 100$; *C* and *D*, T.S.S. of the lamina, *C* near the apex, *D*, at the middle, $\times 130$. *E*, lower epidermis, $\times 130$; *F*, upper epidermis and palisade, $\times 130$. *c*, collenchyma; *cr*₁, microsphenoidal calcium oxalate; *cr*₂, cluster crystals of calcium oxalate; *e*, epidermis; *en*, endodermis; *gl*₁, clavate glandular trichome; *gl*₂, uniseriate glandular trichome; *p*, parenchyma; *pal*, palisade; *ph*₁, normal phloem; *ph*₂, perimedullary phloem; *pp*, photosynthetic parenchyma; *s*, stoma; *t*, covering trichome; *xy*, xylem.

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on the lower surface. The *stomata* are sometimes anisocytic (cruciferous) and vary somewhat in size in the apical quarter of the leaf from 27 by 20 μ to 42 by 31 μ ; in the central region from 40 by 27 μ to 70 by 40 μ ; near the margin and in the basal region from 23 by 20 μ to 42 by 27 μ . The *palisade ratio* varies from 5 to 7 to 8 and the stomatal index for the lower surface from 22 to 25 to 30. The vein-islets are very similar in shape and size to those of *D. stramonium*; the bounding lines tend to be somewhat more curved and the islets slightly larger, being on the average about 8 per sq. mm. against 11 for *D. stramonium*. They are of little use for differentiation, see Fig. 4.

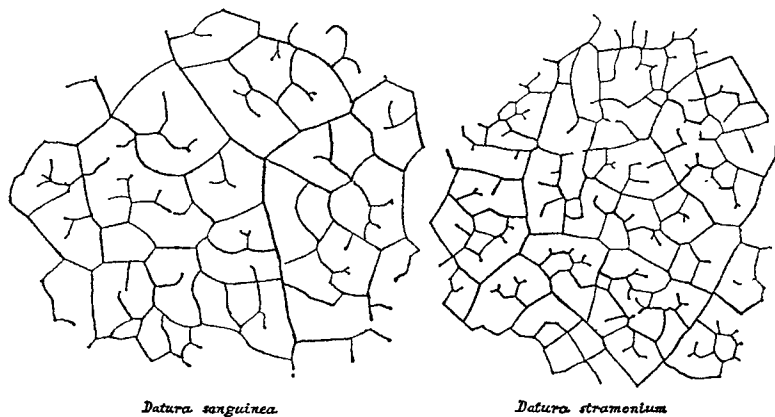


FIG. 4. *Datura sanguinea* R. and P. and *Datura stramonium* Linn., vein-islets, $\times 14$.

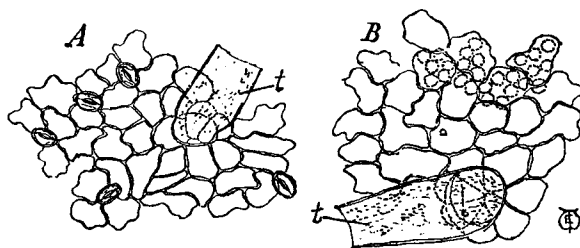


FIG. 5. *Datura sanguinea* R. and P. Smaller leaf. *A*, lower epidermis; *B*, upper epidermis; *t*, base of trichome, $\times 130$.

HISTOLOGY OF THE STEM

The structure of the stem shows a general resemblance to that of *D. stramonium* Linn. (Timmerman 1927); the cells of the epidermis are about 40 to 75 μ in diameter and occasional ones contain sphenoidal micro-crystals of calcium oxalate, while others may sometimes contain groups of small unidentified acicular crystals similar to those found in the epidermis of the petiole, see Fig. 6, *D*. The young stem, Fig. 6, *B* and *C*, up to a diameter of about 1.0 cm., is densely covered with uniseriate glandular trichomes consisting of 4 to 5 to 8 cells and up to 2 mm. long; their basal

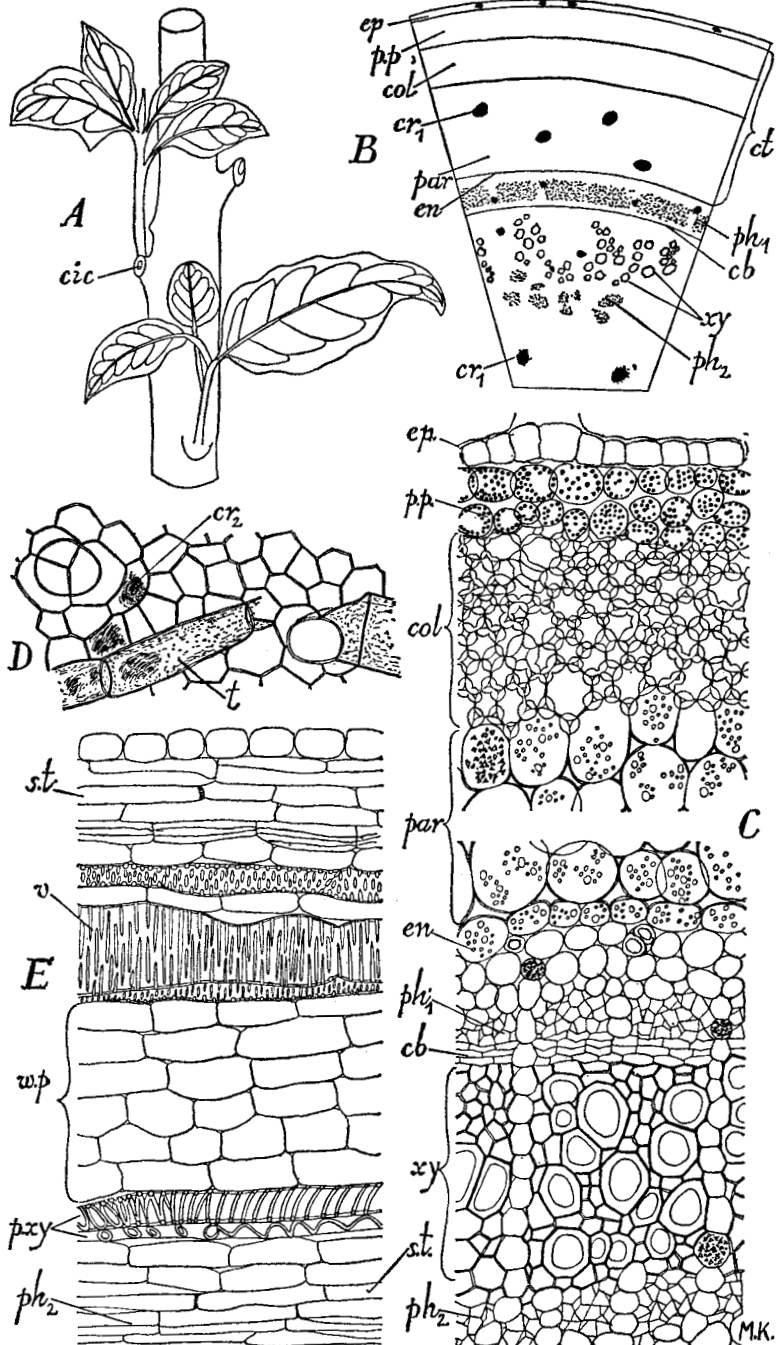


FIG. 6. *Datura sanguinea* R. and P. Stem. *A*, habit sketch showing scars, *cic*, of the larger leaves and two dwarf axillary shoots with small leaves, $\times 1/3$; *B*, diagrammatic T.S. $\times 16$; *C*, details of T.S. $\times 70$; *D*, epidermis in surface view, $\times 70$; *E*, L.S. through the outer part of the stele, $\times 70$; *cb*, cambium; *cic*, cicatrix; *col*, collenchyma; *cr*₁, microsphenoidal calcium oxalate; *cr*₂, fine acicular crystals; *ct*, cortex; *ep*, epidermis; *en*, endodermis; *par*, parenchyma; *ph*₁, normal phloem; *ph*₂, perimedullary phloem; *p.p.*, photosynthetic parenchyma; *p.xy*, primary xylem; *s.t.*, sieve tissue; *t*, trichome; *v*, vessel; *w.p.*, xylem parenchyma; *xy*, xylem.

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cell is slightly tapered towards the base, which is about 70 to 90 μ wide and midway up the diameter is up to 150 μ ; the glandular unicellular head is about 35 to 40 μ in diameter. Non-glandular trichomes appear to be absent from the stem. The older stems are covered externally with a layer of cork derived from a phellogen which arises in the epidermis, Fig. 7, *A*. Beneath the epidermis are two to four rows of photosynthetic parenchyma containing chlorophyll granules; within this is a ring of collenchyma about 0.3 mm. wide consisting of 6 or 7 rows of cells; the remainder of the cortex, about 0.5 mm. wide, consists of round-celled, thin-walled parenchyma containing small starch granules about 3.5 to 7.5 μ in diameter, the cells being about 95 to 155 μ in diameter, a few scattered cells are filled with sphenoidal microcrystals of calcium oxalate.

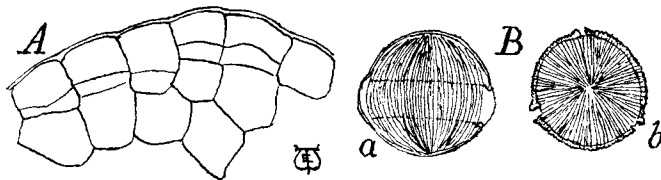


FIG. 7. *Datura sanguinea* R. and P. *A*, Origin of phellogen in the epidermis of the stem $\times 180$; *B*, pollen grains; *a*, equatorial view; *b*, polar view $\times 300$.

The endodermis is formed of rather smaller cells, about 60 to 80 μ in diameter, containing starch granules, Fig. 6, *C*. The pericycle consists of parenchyma in which, immediately within the endodermis, at intervals, there are fibres either singly or in groups of 2 to 4, they are about 33 to 48 to 55 μ in diameter. These fibres are unligified and are very evident in the older stem, but are not so clearly visible in the younger parts of the stem. The phloem forms a band about 0.3 mm. wide. The xylem is a region about 0.5 mm. wide; it is rather parenchymatous and is traversed by medullary rays. On the inner side of the xylem, in the periphery of the pith, are numerous groups of perimedullary phloem. The pith consists of large-celled parenchyma with scattered idioblasts filled with sphenoidal microcrystals of calcium oxalate; similar idioblasts occur in the parenchyma of the medullary rays and of the xylem and phloem. The cells of the medullary rays and pith, other than the idioblasts, contain small starch granules similar to those in the cortex.

POLLEN GRAINS

Leaves, especially densely pubescent ones, collected from plants which are in flower, as is usual for stramonium, will often have pollen grains adhering to the surface. The characters of the pollen are therefore a useful additional means of identification. The pollen grains of *D. sanguinea* differ markedly from those of *D. stramonium* and are therefore described as affording a useful diagnostic character; they do, however, closely resemble the pollen of *D. innoxia* (Wallis and Rohatgi, 1952).

The pollen grains of *Datura sanguinea* are sub-spherical having a polar diameter slightly smaller than the equatorial diameter. When examined

TABLE I
MEDICINAL SPECIES OF *DATURA*

	<i>D. stramonium</i>	<i>D. tatula</i>	<i>D. innoxia</i>
<i>Covering trichomes</i>			
Length	130 to 275 to 550 μ	130 to 390 to 650 μ	120 to 325 to 450 μ
Width at base	35 to 61 to 95 μ	50 to 110 μ	35 to 50 μ
Length of basal cell	75 up to 120 μ or more	75 up to 240 μ or more	Often over 50 μ
Number of cells	1 to 3 to 4	3 to 4 to 8	1 to 3 to 4
<i>Stomatal index</i>			
Upper epidermis	16 to 18 to 20	16 to 20 to 22	12.7 to 17.5 to 20
Lower epidermis	24 to 25 to 26	28 to 30 to 31	21 to 22 to 24
<i>Palisade ratio</i>	4 to 7 not less than 4	4 to 6 approx.	4 to 5 approx.
<i>Glandular trichomes</i>	Clavate, 1 to 2-celled stalk 30 to 50 μ long by 12 μ wide, 2 to 7 celled pyriform head (40 to 47 μ) \times 45 μ .	As <i>D. stramonium</i>	Many 2 to 4-celled, uni- seriate, 75 to 600 μ long, with a unicellular rounded head. A few clavate similar to <i>D. stramonium</i> .
<i>Pollen grains</i>	Sub-spherical 56 to 80 μ diameter, 3 pores 24 to 28 μ ; very slight furrows; exine irregu- larly warty.	As <i>D. stramonium</i>	Sub-spherical 69 to 84 μ diameter, 3 pores 12 to 24 μ ; small germinal furrows, exine with striae radiating from the poles.

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in a 70 per cent w/v solution of chloral hydrate in water, the polar diameter measures about 45 to 47 μ and the equatorial diameter measures about 50 to 54 μ ; when mounted in lactophenol the dimensions are slightly smaller. The surface of the exine is striated with slight ridges radiating from the poles to the equator where about 100 can be counted. There are three pores, but no germinal furrows are visible. When viewed equatorially many grains show a faintly outlined band, about 15 μ wide, passing round the equator, see Fig. 7, B.

CONCLUSION

The structure of the leaves of *D. sanguinea* closely resembles that of *D. stramonium* and other medicinal species of *Datura*. The most distinguishing features are:

(1) The abundance of trichomes upon, and the absence of stomata from, the upper epidermis.

(2) The dimensions of the basal cell of the trichomes, which is about 57 to 190 to 328 μ long and 38 to 94 to 160 μ wide at the base.

(3) The abundant uniseriate glandular trichomes up to about 0.8 to 2.0 mm. long, with a unicellular rounded head.

(4) Pollen grains which differ markedly from those of *D. stramonium*, but have much resemblance to those of *D. innoxia*.

Note. In a powder of the leaves, trichomes are much broken hence their length and the number of cells are of little value as characters of the powdered leaf.

Table I summarises the important characters of five well-known medicinal species of *Datura*.

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