

THE ANATOMY AND BOTANICAL POSITION OF MIRÉ.*

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Miré (pronounced Meé-ray), the plant whose structural characteristics and identity form the theme of the subject matter of this investigation, is the native aboriginal name of a shrub, parts of which members of the recent Mulford Biological Exploration party, under the direction of Dr. H. H. Rusby, brought back with them from Central Bolivia. Rusby (JOUR. A. PH. A., Vol. 13, p. 101) noticed that the Indians of that country employed the plant as a muscular paralytant and remedy for cutaneous parasites. Since it gave promise of being a valuable addition to the present list of the world's medicaments, Dr. Rusby, upon his return, sent

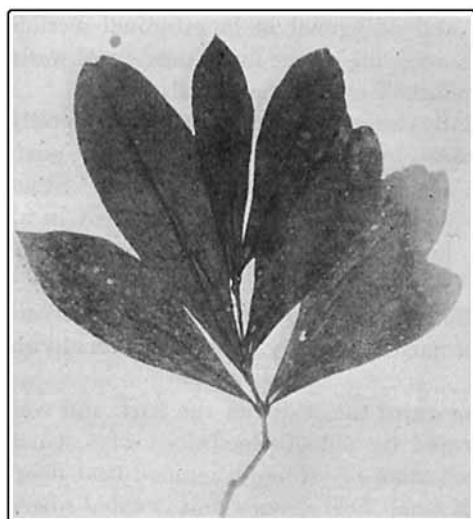


Fig. 1.—Leafy branch of Miré, a Central Bolivian shrub belonging to the genus *Brunfelsia* (Fam. *Solanaceæ.*) ($\times \frac{1}{2}$).

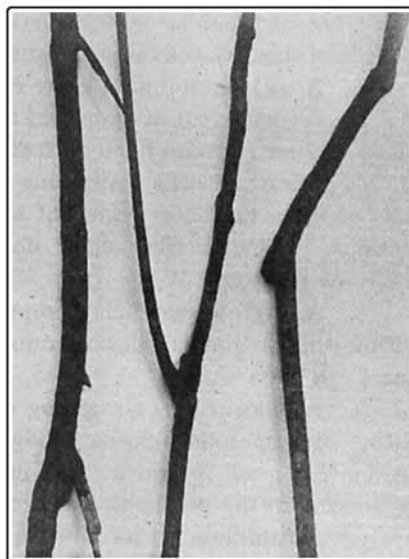


Fig. 2.—Aerial stems of Miré ($\times \frac{1}{2}$).

me some material with a view to determine its anatomical characteristics and, if possible, its botanical relationship.

The material received and described herein represented about 3 pounds of dried aerial stems and rhizomes with few rootlets, a specimen of rhizome with rootlets and a leafy aerial stem (Fig. 1), the latter collected August 10, 1921 by Dr. O. E. White in the vicinity of Huachi, Bolivia, at an altitude of 1800 feet.

DESCRIPTION OF RHIZOMES AND ROOTS.

Rhizomes of horizontal or oblique growth, occurring in cylindrical to sub-cylindrical segments, occasionally tortuous and furcately branched, up to 32 cm. in length and from 1.5 to 2 cm. in thickness. Externally, varying from light brown and longitudinally striate to reddish brown, longitudinally wrinkled and transversely fissured to reddish brown; warty, with abraded cork in very

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old portions, with oval to circular stem scars on upper or lateral surfaces of nodes and a few slender, filiform, wiry rootlets of brown color, or circular scars of these, on both lower and lateral surfaces; internally with very thin bark, broad, dense, yellowish brown wood and narrow, pale yellow pith; fracture of bark short-fibrous and of wood tough, uneven and splintery; odor very slightly aromatic upon burning, pop-corn like; taste sweetish, followed by a tingling sensation and, later, by a sensation of numbness.

HISTOLOGY OF RHIZOME.

The rhizome of *Miré* (Fig. 2) presents the following microscopic features passing from periphery toward the center:

1. A cork zone (*k*) composed of several rows of cork cells having lignified walls. These are rectangular in transverse view and polygonal in longitudinal section. Certain of the cork cells show most of their thickening on the inner tangential walls.

2. A cork cambium of more or less collapsed meristematic cells.

3. A cortex (*co*) of somewhat tangentially elongated cortical parenchyma cells. Most of these cells are filled with starch grains, but scattered through many parts of this region are cells containing rosette aggregates of calcium oxalate. Stone cells occur in the outer region of this part of the bark but are not evident in all sections. They are frequently oblong in longitudinal sections and many occur singly or in groups.

4. A narrow pericycle composed mainly of starch-containing parenchyma within which region is a discontinuous arc of narrow, slightly lignified sclerenchyma fibers (*scl*²).

5. A phloem (*ph*) occupying up to one-third the width of the bark and consisting of numerous phloem patches separated by phloem medullary-rays which are mostly 1-cell in width. An interrupted zone of strongly lignified bast fibers (*bf*) occurs in the protophloem composed of small fiber groups and isolated fibers.

6. A cambium (*c*) forming an irregular wavy circle of collapsed meristematic cells which readily separate from the wood in sectioning.

7. A broad xylem composed of many narrow xylem wedges separated by lignified xylem medullary-rays (*mr*), the latter mostly 1-cell in width and containing abundant starch. The xylem wedges contain numerous thick-walled, greatly lignified wood fibers (*wf*) with oblique pits and relatively few porous and spiral tracheae, the latter most evident in the protoxylem region.

8. An inner cambium (*c*²) of meristematic cells.

9. A narrow internal phloem (*ip*) composed of soft bast patches separated by narrow medullary-rays with non-lignified walls. A few narrow sclerenchyma fibers (*scl*¹) accompany the soft bast on its inner face.

10. A central pith (*m*) of rounded to polygonal parenchyma cells, most of which are loaded with starch while some contain a rosette aggregate of calcium oxalate. Scattered about in this region are numerous stone cells with broad lignified and porous walls and narrow lumina. These appear irregularly-rounded to polygonal in transverse section and oblong to irregularly polygonal in longitudinal section. The starch grains (see Fig. 7) found in the parenchyma of the cortex pericycle and pith vary from simple, spheroidal or oval to 2-, 3-, or 4-compound, the larger single grains measuring from 6μ to 15.44μ in diameter or in length.

The hilum in many instances is circular but may be a triangular or linear cleft. Lamellæ are indistinct.

The rosette aggregates, found in the same regions, measured from 46μ to 115.8μ in diameter. The wood fibers are frequently irregularly wavy-walled and undulate, show oblique pits and short to long pointed or blunt ends. The tendency of these fibers to become curved toward the ends is common. Tracheae and tracheids with distinct and indistinct bordered pits occur in the xylem. The wood parenchyma is scantily developed.

DESCRIPTION OF AERIAL STEM.

In simple or furcately-branched cylindrical segments (Fig. 3) up to 30 cm. long and from 1 mm. to 15 mm. in thickness; externally light brown and covered here and there with grayish green foliaceous lichens having blackish apothecia, longitudinally striate in younger parts to irregularly longitudinally wrinkled with numerous transverse lenticels in older portions, with prominent nodes, many of which exhibit circular, depressed stem scars, others conical buds; fracture of bark short-fibrous, of wood tough, splintery-fibrous; externally—bark thin, brownish and readily separable from broad yellowish brown wood; pith narrow, pale yellowish to light brown; odor and taste similar to rhizome.

HISTOLOGY OF AERIAL STEM.

Sections through the aerial stem exhibit the following structural characteristics, passing from periphery toward the center:

1. A cork of several rows of cork cells similar in character to those noted in the rhizome.

2. A phellogen of collapsed meristematic cells.

3. A broad cortex of tangentially elongated cortical parenchyma cells, some of which are filled with starch grains while many others contain a rosette aggregate of calcium oxalate. Stone cells with greatly lignified walls occur in the outer and inner portions of many though not all of the sections through this region

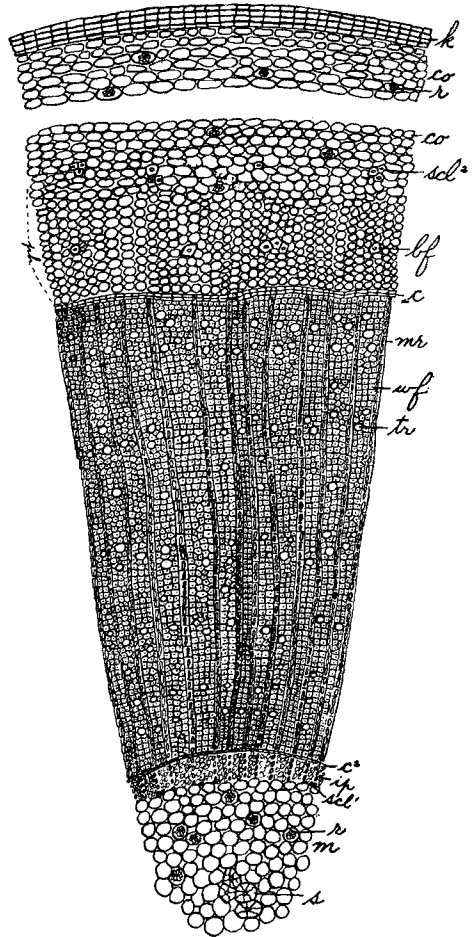


Fig. 3.—Transverse section through a representative portion of *Miris* rhizome showing cork (k), cortex (co), rosette aggregate crystals (r), sclerenchyma fibers (scl¹) in medullary sheath, in pericycle (scl²), phloem (ph), bast fibers in protophloem (bf), cambium (c), intraxylary phloem (ip), medullary-rays (mr); wood fibers (wf) and tracheae (tr) of xylem; medulla (m), and stone cells (s) (*highly magnified*).

examined. They occur singly or in small groups and are tangentially elongated, as viewed in transverse sections.

4. A pericycle containing an interrupted circle of narrow sclerenchyma fibers, arranged singly and in groups, whose walls vary in extent of lignification, in sections treated with phloroglucin and hydrochloric acid.

5. A narrow phloem composed of radially arranged soft bast arms separated by non-lignified medullary-rays 1 cell in width.

6. A cambium forming an irregular wavy circle of meristematic cells.

7. A broad radiate and porous xylem of many narrow xylem wedges, composed of strongly lignified wood fibers, interspersed with fewer tracheae and tracheids and very few wood parenchyma cells. The xylem medullary-rays separating the wood wedges have lignified porous walls and contain starch. The tracheal elements appear more abundant than in the rhizome of equal age, have chiefly distinct and indistinct bordered pits and oblique to transverse, porous septa.

8. An inner cambium of meristematic cells.

9. A narrow intraxylary phloem composed of soft bast. On the inner face of the soft bast, in what may be termed the medullary-sheath, occur narrow, highly lignified sclerenchyma fibers arranged singly or in small groups.

10. A broad central pith of rounded to slightly polygonal parenchyma cells most of which are filled with starch, while many contain a large rosette aggregate crystal. Polygonal to irregularly rounded-polygonal stone cells with greatly lignified walls and small lumen are scattered singly or in groups within this region.

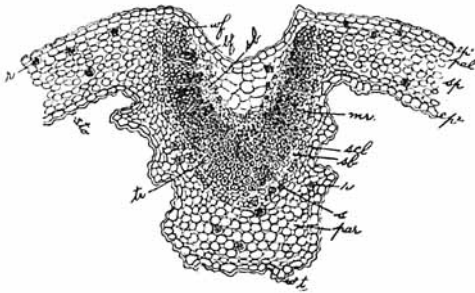


Fig. 4.—Transverse section of representative portion of Miré lamina including midrib, showing upper epidermis with striated cuticle (ep^1), palisade parenchyma (pal), spongy parenchyma (sp), lower epidermis (ep^2) with stomata (sto), rosette aggregates of calcium oxalate (r), group of sclerenchyma fibers (scl) and stone cell (s) in pericycle, parenchyma of midrib (par), stalk of glandular hair (t), medullary ray (mr), and wood fibers (wf), bast fibers (bf), tracheae (tr) and soft bast (sb) of bicollateral fibrovascular bundles (*magnified*).

DESCRIPTION OF LEAVES.

The leaves of Miré (see Fig. 1) are simple, alternate, petiolate, exstipulate, oblong-lanceolate to elliptic-oblong, glabrous on both surfaces, subcoriaceous, with pinnate-reticulate venation, entire or nearly entire margin, acute to acuminate apex and attenuate base. Their color when dried is grayish green on upper surface and brownish green on lower surface. The upper surface of the lamina is frequently spotted with emerald-green lichens, some possessing black apothecia. The leaves examined were up to 18 cm. in length and up to 5.8 cm. in width. The petioles were up to 8 mm. long. The midrib is concave on the upper and convex-crenate on the lower surface.

HISTOLOGY OF LEAF.

The lamina of the Miré leaf is dorsoventral in development. Transverse sections of (Fig. 4) this part outside of the midrib exhibit (1) an upper epidermis (ep^1)

devoid of stomata, the outer walls of which are wavy and possess a thick-striated cuticle, (2) a zone of one to two layers of tangentially elongated to irregularly cubical shaped, compactly arranged palisade cells (*pal*) some of which contain a rosette aggregate crystal, of calcium oxalate (*r*), (3) a broad zone of somewhat loosely arranged spongy parenchyma, many of the cells of which possess a rosette aggregate crystal, (4) a lower epidermis containing numerous stomata, and whose outer cell walls are wavy and with thick cuticle.

Surface sections of the upper epidermis (Fig. 5) show that the vertical walls of the upper epidermis cells are curvilinear except over the veins where they are rectilinear and the cells rectangular in shape. Surface sections of the lower epidermis (Fig. 6) show regular epidermal cells (*e*) with curvilinear vertical walls and numerous stomata (*s*), each of which is surrounded by a pair of subsidiary cells (*n*) of equal or unequal size and paralleled to the stomatal orifice.

Transverse sections through the midrib show that it is notched above and deeply convex below with several protuberances and sinuses. The epidermal cells over both surfaces exhibit a thick cuticle and wavy outer walls. Bi-collateral fibrovascular bundles occupy a crescentic area within the midrib, with ends of the crescent facing toward the upper epidermis. These show dense radiate xylem wedges separated by medullary-rays 1 cell in width. The upper soft bast zone is flanked on its outer face by a discontinuous arc of narrow, thick-walled sclerenchyma fibers while the lower soft bast zone is accompanied by an outer discontinuous arc of often densely arranged pericyclic fibers, with an occasional stone cell. Glandular hairs with a short, curved somewhat appressed stalk 2

to 4 cells in length and an ellipsoidal to saucer-shaped peltate head occur on the epidermis of the midrib. Parenchyma cells, some of which contain a rosette aggregate crystal of calcium oxalate, occur between the bundle zone and the epidermises. These crystals measured up to 54μ in diameter.

BOTANICAL POSITION OF MIRÉ.

The inability of the collectors of this plant to secure either flowers or fruits of this species, due to the season of the year when collected, obliged me to resort to pharmacognic methods in an attempt to establish its kinship. The presence in the axis and leaves of intraxylary soft bast accompanied on its inner face by sclerenchyma fibers, the scantily developed wood parenchyma, the presence of isolated groups of sclerenchyma fibers in the pericycle, tracheae with bordered pits, the absence of bast fibers in the secondary phloem, the narrow medullary-rays, and the absence of special internal secretory organs, all these together indicate that the plant is one of the *Solanaceæ*.

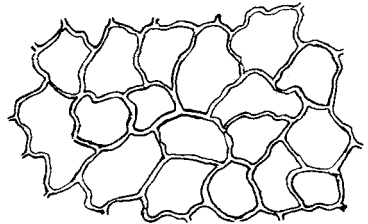


Fig. 5.—Upper epidermis of Miré in surface view greatly magnified.

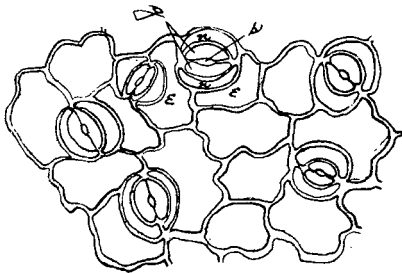


Fig. 6.—Lower epidermis of Miré in surface view. Note the stomata with neighboring cells (*n*) parallel to stomatal orifice (*s*); guard cells (*g*) and ordinary epidermal cells (*e*) (greatly magnified).

The presence in the axis and leaves of intraxylary soft bast accompanied on its inner face by sclerenchyma fibers, the scantily developed wood parenchyma, the presence of isolated groups of sclerenchyma fibers in the pericycle, tracheae with bordered pits, the absence of bast fibers in the secondary phloem, the narrow medullary-rays, and the absence of special internal secretory organs, all these together indicate that the plant is one of the *Solanaceæ*.

The occurrence of an occasional stone cell among the pericyclic fibers (as first noted by the writer in the midrib) the presence among certain of the cork cells of thickened inner tangential walls, and the occurrence of scattered stone cells in the pith are anatomically characteristic of several species of *Brunfelsia* as pointed out by Fedde (*Verg. Anat. d. S., Diss. Breslau, 1896*). These very structures, present in the Miré material examined, together with the other Solanaceous features heretofore indicated places Miré in the genus *Brunfelsia*.

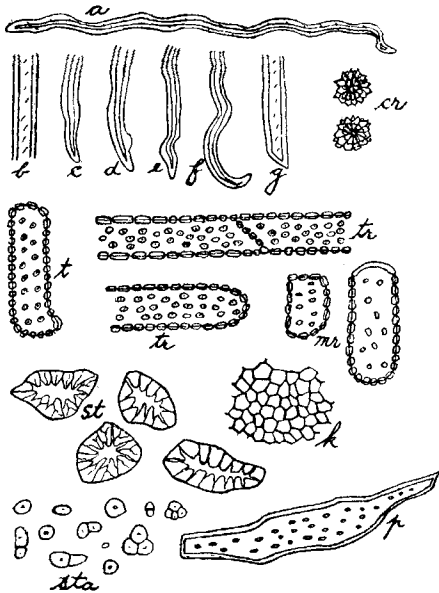


Fig. 7.—Histological elements found in the axis of Miré. Sclerenchyma fiber (a); median portion of sclerenchyma fiber (b); ends of sclerenchyma fibers (c, d, e, f, g); tracheid with bordered pores (t); tracheae (tr); medullary-ray-cells (mr); stone cells from pith (st); cork tissue (k); pitted vessel (p) and starch grains (sta) (*highly magnified*).

While comparing the Miré material with various mounted species of *Brunfelsia* in the gray Herbarium of Harvard University, I came upon a mounted herbarium specimen labeled "*Brunfelsia hydrangaeformis* (Pohl) Benth"¹ which was collected at Uchimachi, Coroico, Bolivia, July 20, 1894 by Miguel Bang and distributed by Drs. Britton and Rusby. This specimen agreed in every respect macroscopically with the plant which Pohl figured and described in his *Plantarum Brasillae*, plate 7, 1827 and which de Candolle also described in *Prodromus*, part X, 1846. The leaves and stem of this plant appeared so strikingly like similar parts of Miré that I decided to make a microscopic comparison. Through the kindness of Dr. Hirschy of the Gray herbarium, I obtained for this purpose a fragment of a leaf and short segment of a stem. These, when compared histologically with Miré, showed many close resemblances. Later, through the kindness of Dr. Rusby, I obtained an entire leaf and piece of the stem from another herbarium sheet in the New York Botanical Garden which was labeled "*Brunfelsia hydrangaeformis* Pohl. collected by Weddell, in Brazil, in 1847." After a careful microscopic comparison of this material with the same parts of Miré, I find both exhibit a striking similarity of structure.

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¹ Dr. H. H. Rusby has accepted the author's determination of the botanical origin of Miré as *Brunfelsia hydrangaeformis* (Pohl) after a comparison of it with a series of specimens collected by himself and others.