

SCIENTIFIC SECTION

THE PHARMACOGNOSY, CHEMISTRY AND PHARMACOLOGY OF VIBURNUM.*

I. INTRODUCTION. HISTORY, BOTANY AND PHARMACOGNOSY OF VIBURNUM PRUNIFOLIUM L., VIBURNUM RUFIDULUM RAF., VIBURNUM CASSINOIDES L., AND VIBURNUM NUDUM L.

BY HEBER W. YOUNGKEN.

INTRODUCTION.

This investigation was prompted by the chaos existing in the literature relative to the value of *Viburnum* barks in the treatment of uterine disturbances and the uncertainty of the botanical sources of most of the barks used in the manufacture of preparations which were employed in animal tests.

In 1927, I presented an article upon *Viburnum cassinoides* (37). Work has been continued upon this and various other members of the *Viburnum* genus.

Working under a grant from the A. PH. A. Research Committee, authentic material has been collected by the author of the following: *Viburnum prunifolium* L., *Viburnum rufidulum* Raf., *V. cassinoides* L., *V. nudum* L., *V. Opulus* L. var. *americanum* (Miller) Aiton and *V. Lentago* L.

The plant materials collected were partly pressed in the field, partly preserved after collection in alcohol and in part dried by sun and by artificial heat.

A series of papers are now being prepared discussing the botanical, pharmacognostical, chemical and pharmacodynamic features of these species.

In the present communication the results of a preliminary study are given.

Pharmacognostic work was conducted only upon material which had been botanically authenticated, specimens of which have been permanently deposited in the herbarium of the Massachusetts College of Pharmacy, Boston.

HISTORICAL.

The genus *Viburnum* is described by Linnæus in his "Genera Plantarum" (1). Under this genus he includes the *Viburnum Tinus* and *Opulus* of Tournefort.

In his "Species Plantarum" (2), Linnæus groups the *Viburnums* under *Pentandria Trigynia*.

In his first edition of "Flora Virginica," Gronovius (3), describing plants which Clayton collected in Virginia, lists *Viburnum Prunifolium* under the title of "*Viburnum foliis subrotundis serratis glabris*" and describes it as "*Viburni species floribus albis umbellatim congestis, foliis Pruni, bacca molli atro-purpurea oblonga eduli, officulo duro compresso.*" His description is based upon Clayton's specimen No. 47. He gave it the synonym of Black Haw.

Linnæus (2) listed this plant in the first edition of his "Species Plantarum" and gave its habitat as Virginia and Canada. His description is based upon Gronovius' earlier account of this species. This species has been subsequently described by numerous authors including Gray, Sargent, Britton and Brown, Bailey, Small and Rehder.

Rehder (4) gives its distribution as from Connecticut to Florida west to Michigan and Texas and describes it as a "large shrub or small tree to 5 m. with rigid spreading branches; winter buds short-pointed, reddish pubescent; bracts glabrous; leaves broad-elliptic to ovate,

* This investigation was aided by a grant from the A. PH. A. Research Fund. Presented to the Scientific Section, A. PH. A., Rapid City meeting.

3-8 cm. long, acute or obtuse, rounded at base or broad-cuneate, serrulate, glabrous or nearly so; petiole not or narrowly winged, 8 to 16 mm. long; flowers pure white, in sessile cymes 5-10 cm. across; fruit short-ellipsoid to sub-globose, 8-12 mm. long, blue-black and bloomy."

Britton and Brown (5) give as its leading synonyms, "Black Haw," "Stag Bush" and "Sloe."

Rafinesque (6) in his "Alsographia Americana" first described *Viburnum rufidulum* as "*Viburnum L. rufidulum Raf. ramulis teretibus fuscatis, petioli marginatis rufo pubens ut nervis, fol. ovat. ellipt., obtusis, argente serratis, tenuis glabris; cymis sessilib. 3 fidis dilatatis rufo pubens—sent me from Alabama, leaves large, 3 inches long, cyme ample, nearest to V. Lentago; is it a variety of it?*"

Viburnum cassinoides is first described by Linnæus (7) as: "*Viburnum foliis ovatis crenatis glabris, petioli glandulatis carinatis. Folia infima obovata; proxima ovata, superiora lanceolata.*" He gives its habitat as North America.

The same author (2) was the first to describe *Viburnum Lentago*. His description of this species is based upon Kalm's specimen and is as follows: "*Viburnum foliis serrulatis ovatis acuminatis glabris, petioli glandulosis.*" He gave its habitat as Canada.

Viburnum nudum appears to have been first described by Grovoni (3) who based his account of it upon Clayton's specimen No. 64, now in the British Museum. He described it as "*Opulus aquatica foliis subrotundis frondibus albis in umbellas dispositis, baccis atro-purpureis, officulo compresso.*"

Linnæus (2) later described it under *Viburnum nudum* as: "*Foliis integerrima lanceolato-ovatis. Tinus foliis ovatis in petiolo terminatis integerrimus. Cymae in hac nuda.*" He gave its habitat as Virginia.

Britton and Brown (5) call it the Larger or Naked Withe Rod, Bilberry, Nanny-berry and Possum- or Shawnee-Haw, and describe it as "a shrub sometimes 15 ft. high with oval, oval-lanceolate or obovate, entire or obscurely crenulate leaves (sometimes 9' long) narrowed at the base, acute or obtuse at apex, more prominently veined than *V. cassinoides*, sometimes scurfy on the upper surface; peduncle equalling or exceeding the cyme."

Rehder (8) calls it the Smooth Withe Rod and gives its distribution as from Long Island to Florida, west to Kentucky and Louisiana.

Torrey and Gray (9) describe and list *Viburnum cassinoides* as *Viburnum nudum* var. *cassinoides*. This plant has likewise been described by Small, Gray, Britton and Brown, Rehder and other authors. Rehder (8) and Britton and Brown (10) call it the Withe Rod or Appalachian Tea. Rehder describes it as an "upright shrub to 2 m., occasionally to 4 m., similar to *V. nudum*: leaves elliptic or ovate to oblong, 3 to 10 cm. long, acute or bluntly acuminate, obscurely dentate or denticulate, dull green above, nearly glabrous, peduncle usually shorter than the cyme." He gives its distribution as from Newfoundland to Manitoba and Minnesota, south to North Carolina.

Viburnum Opulus is described by Linnæus (2) as "*Viburnum foliis lobatis; petioli glandulosis.*" He gave its habitat as Europe.

Miller (11) in his "Gardener's Dictionary" first calls attention to an American variety of *Viburnum Opulus* which he describes as: "*Viburnum (Americanum) foliis cordato-ovatis acuminatis serratis, petioli longissimus laevibus.* Wayfaring tree with heart-shaped, oval, acute-pointed, sawed leaves growing upon very smooth footstalks. American Guelder Rose with acute-pointed, sawed leaves and white flowers."

Miller in this same work also described *V. nudum*, *V. Opulus* and *V. cassinoides*. Aiton named this variety *Viburnum Opulus L. var. Americanum* Ait.

Marshall (12) describes a species corresponding to the *V. Opulus* of Linné and named it *Viburnum trilobum*.

Torrey and Gray (13) considered *Viburnum rufidulum* of Rafinesque a variety of *Viburnum prunifolium* and named it *Viburnum prunifolium* var. *ferrugineum*.

Small (14) again described this species in 1894 and gave it the name of *Viburnum ferrugineum*. In 1896 he assigned to it the name of *Viburnum tomentosum* (15).

Britton and Brown (16) and Rehder (4) have described and listed this species as *Viburnum rufidulum* Raf. or Southern Black Haw. Its distribution is given by Rehder as from Virginia to Florida, west to Illinois and Texas.

Sargent (18) describes this species in his "Manual of the Trees of North America" and calls attention to its greater abundance in Southern Arkansas, Western Louisiana and Eastern Texas.

In 1927, Rehder (19) readopted the name of *V. trilobum* Marsh. for the American variety of *Viburnum Opulus* and the synonym of Cranberry Bush. He describes it as "a shrub to 4 m. with gray branches; leaves broad-ovate, 5-12 cm. long, rounded or truncate at the base, lobes acuminate, coarsely dentate, sometimes the middle lobe elongated and entire, pilose on the veins beneath or nearly glabrous; petiole 1-3 cm. long with shallow groove and small, usually stalked glands; cyme 7-10 cm. across, on a stalk 1.5-3 cm. long; stamens about twice as long as corolla; fruit subglobose or short-ellipsoidal 8-10 mm. long, scarlet." He makes a separate species of *Viburnum Opulus* L. or the European Cranberry Bush (19).

Britton and Brown (20) make no distinction between *Viburnum Opulus* L. and *V. americanum* of Miller and other American authors, and give as the leading synonyms, Cranberry-tree, Wild Guelder-rose and High Bush Cranberry.

Viburnum Lentago has been more recently described by a number of authors including Gray, Britton and Brown, Bailey and Rehder. Rehder calls it Sheep-Berry and describes it (8) as "a shrub or small tree to 10 m. with slender branches; bracts slightly scurfy; winter buds gray, the terminal long pointed; leaves ovate to elliptic-obovate, 5-10 cm. long, acuminate, broad-cuneate to rounded at base, finely toothed, glabrous or scurfy on the veins beneath; petiole 1-2.5 cm. long, mostly winged with wavy margin; cymes 6-12 cm. broad, sessile; fruit ellipsoid, 1.2-1.5 cm. long, blue-black, bloomy." He gives its distribution as Hudson Bay to Manitoba south to Georgia and Mississippi. Britton and Brown (5) assign to it the synonyms of Nanny-berry, Sheep- or Sweet Berry and Sweet Viburnum and trace it as far west as Indiana, Kansas and Colorado.

RESEARCHES UPON MORPHOLOGY AND PHARMACOGNOSY OF VIBURNUMS.

Researches upon the morphology and pharmacognosy of the Viburnums have been fragmentary and scattered. Most of the investigations have been confined to the barks of medicinal members and in many there is no allusion to the authenticity of the material.

Sanio (21), in 1860, investigated the mode of formation of cork in *Viburnum Opulus* and showed that it developed beneath the epidermis. He also found stone cells in the bark of the different species of *Viburnum*.

Moeller (22), in 1876, described the wood of *Viburnum Opulus* and *Viburnum Lantana*.

Loebel, in 1882, observed the presence of arm-palisade parenchyma in *Viburnum Opulus* and Schwarz-Clements (23), in 1905, observed them in *V. pauciflorum*.

Michael (24), in 1885, showed that scalariform vessels occurred in several *Viburnum* species.

Sayre, in 1895 (25), described the bark of the trunk of *Viburnum Opulus* and of the trunk, small branches and root of *Viburnum prunifolium*. His material was partly from commercial sources and his description and figures of the stem bark of *Viburnum Opulus* resemble that of *Acer spicatum*.

The same author (26), in 1896, discussed and figured some differences between the powdered barks of the trunk, twigs and root of *Viburnum prunifolium* and *Viburnum Opulus*, but the authenticity of at least some of the material with which he worked is doubtful.

In 1898 Denniston (27) made some studies on the comparative structure of the stem barks of *Viburnum Lentago*, *V. dentatum*, *V. nudum*, *V. cassinoides*, *V. lantanoides* and *V. Opulus* and the root and stem bark of *V. prunifolium*. He

distinguishes the bark of *Viburnum Opulus* from that of the other species by the presence of smaller cells in all of its tissues and states that it is the only one of the *Viburnum* barks in which compact groups of bast fibres occur so abundantly. He found no bast fibres in *V. prunifolium* bark but states that there are of common occurrence in all the other species of *Viburnum* examined. His material of *V. Opulus* was apparently *Acer spicatum* bark.

The same worker (28), in 1902, described the structure of the bark of *Viburnum ellipticum*.

In 1902, Miltacher (29) described the structure and constituents of Black Haw Bark (*V. prunifolium* L.). He called attention to the fact that stone cells, bearing considerable resemblance to bast fibres because of their axial elongation, are to be found in the cortex and bast ring. He also stated that primary bast fibres (pericyclic fibres) were to be found in young barks, but that these were eventually thrown off by the formation of secondary phellogen and that older barks are devoid of bast fibres. He also informs that the cells of the cortex and medullary rays contain a granular substance which is stained by alkanna and is converted by caustic potash into an emulsion containing yellow droplets of oil.

In 1905, Lloyd (30) writing under "Concerning Substitutes and Adulterations" in the *Pharmaceutical Review* stated:

"The bark of all species of Wild Haw native to this country that supplies the drug for the market, is collected by root diggers, and sold under the name of Black Haw."

In 1908, Farwell (32) reported that the official black haw bark was more difficult to obtain than formerly, that it was necessary to reject samples of several large lots of bark which according to his correspondent represented material which had been generally supplied the trade for some time but without complaint.

The same year Solereeder (31) called attention to the small peltate hairs occurring on the epidermis of *Viburnum Lentago* and *V. pyrifolium* which have a shield of 4-8 radially arranged cells, the basin-shaped nectarial glands on the petioles of *Viburnum Opulus* and on the lower laminar margin of *V. Tinus*. He referred to superficial cork formation in *V. Lantana* and *V. Lentago*, etc., in which the epidermis becomes the phellogen but states that in other species of *Viburnum*, *V. americanum* and *V. Opulus*, the phellogen is derived from the outermost cell layer of the primary cortex. He directed attention to the presence of bordered pits in the wood parenchyma of the genus *Viburnum* and to the petiole thickenings of the wall of the prosenchymatous cells of certain species.

Gunderson (39), in 1910, called attention to the pericyclic fibres forming almost a complete circle in *V. nudum*. He describes and figures glandular hairs in *V. Opulus* and non-glandular hairs in *Viburnum Opulus* and *V. Tinus*.

In 1913, Farwell (33) stated that as early as the 90's and until 1913 *Acer spicatum* bark was mistaken for true cramp bark or *Viburnum Opulus*. He gives the distinction between these barks.

In 1913, Farwell (33) described the structure of the leaves and histology of the bark of *Viburnum Opulus* grown in the United States. He considered it a variety of *V. Opulus* L. which he called *V. Opulus* L. var. *americanum* Aiton (17). He called attention to the fact that Mountain Maple bark (*Acer spicatum* L.) was being substituted for *Viburnum Opulus*.



Fig. 1.—*Viburnum prunifolium* Linné. Leaf and fruiting branch collected from shrub growing on outskirts of Asheville, N. C., June 1929.

excessive wood and one was spurious. The same authors point out some of the diagnostic differential features between *V. Opulus*, *Acer spicatum* and *V. prunifolium* barks and give a tannin and a valerianic acid test to distinguish *Viburnum Opulus* and *V. prunifolium* from *Acer spicatum* barks and preparations.

In some suggestions for pharmacopœial revision in 1920, J. M. Francis (36) called attention to the fact that black haw bark then obtainable from collectors consisted almost wholly of the bark of the trunk and stems with only a very small percentage of the bark of the root.

In 1927, Youngken (37) described the macroscopic and microscopic features of the root and stem barks of *Viburnum cassinoides*, and pointed out the chief differences between these and similar barks of *Viburnum prunifolium*. In the

In 1913, Holm (34) briefly described the internal structure of the vegetative organs of *Viburnum prunifolium*. He called attention to the presence of stereids in the leaf parenchyma of *V. prunifolium*, to a few isolated stereids in the pericycle of this species, to the diarch stele of the roots and to the presence of stellate and peltate hairs on the leaf, to the one pair of subsidiary cells parallel to the stomata which were very distinct for ordinary epidermal cells, each of which have prominent undulate walls.

In 1918, Viehoveer, Ewing and Clevenger (35) investigated a number of commercial *Viburnum* barks and preparations. They examined 50 samples of commercial *V. Opulus* and found 48 of them to consist of the bark of *Acer spicatum*. Of 7 samples of Black Haw examined by these workers, two contained

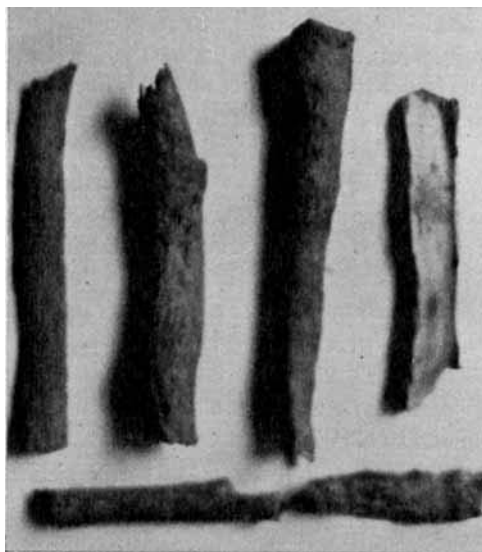


Fig. 2.—*Viburnum prunifolium*. Root bark.

same article he showed that 2 samples labeled "Shawnee Haw Bark" and 4 other samples labeled "Shonny Haw Bark" represented the barks of *Viburnum cassinoides*, rather than those of *Viburnum nudum*.

In 1929, while collecting authentic botanical material of a number of *Viburnums* in the Southern States, Youngken (38) came upon a number of trees of *Aronia melanocarpa* var. *grandifolia*, or Black Chokeberry, the bark of which had been collected by drug collectors as "Buck Shonny Haw" and offered to crude drug dealers as genuine Shonny Haw Bark. The distinguishing characters between this and genuine *V. cassinoides* or commercial Shonny Haw have been pointed out by this worker.

BOTANY AND PHARMACOGNOSY OF VIBURNUM SPECIES.

VIBURNUM PRUNIFOLIUM.

The material for investigation consisted of root and stem barks, roots, stems, leafy and fruiting branches of plants growing at Asheville, North Carolina, and collected by H. W. Youngken, June 12 to 17, 1929.

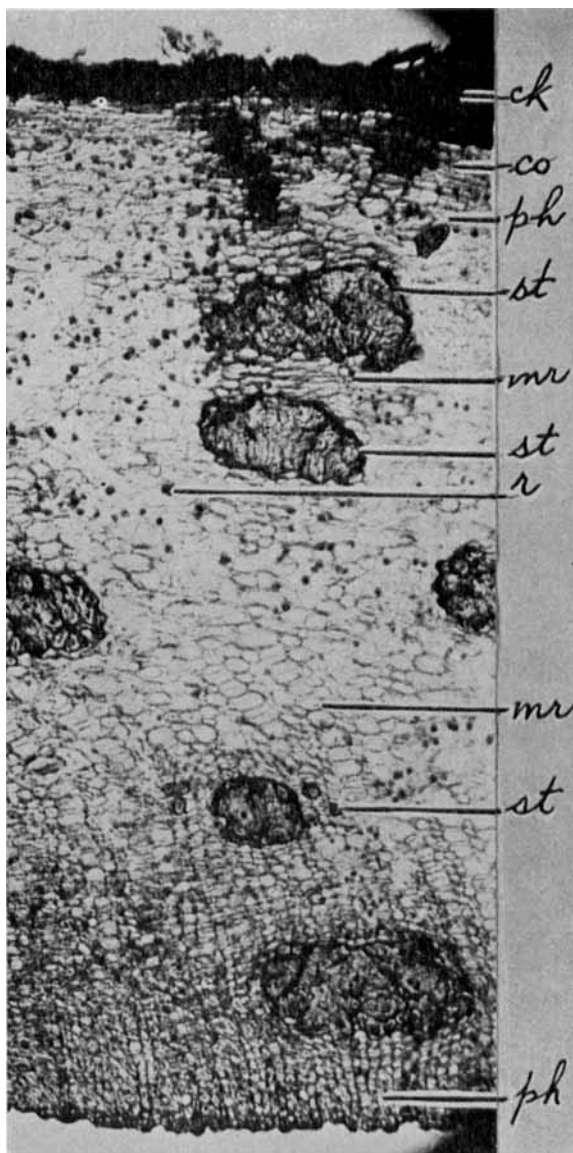


Fig. 3.—Photomicrograph of a cross section of *Viburnum prunifolium* root bark ($\times 50$), *ck*, cork; *co*, secondary cortex; *ph*, phloem; *st*, groups of stone cells; *r*, rosette crystal of calcium oxalate; *mr*, medullary ray.

DESCRIPTION OF VIBURNUM PRUNIFOLIUM L.

The plants from which the material was collected were large shrubs to small trees up to 15 feet in height with rigid spreading branches and dark bark. The leaves were broadly oval to ovate, 1 to 3 in. long, acute to obtuse at summit, rounded to broadly cuneate at base, serrulate along the margin and practically glabrous, the petioles being slender and up to 16 mm. in length. The fruits were oval, bluish black, glaucous drupes with a flattened stone and arranged upon sessile cymes.

DESCRIPTION OF ROOT BARK OF VIBURNUM PRUNIFOLIUM L.

The bark occurs in irregular, transversely curved or quilled pieces from 1.5 cm. to 9 cm. in length and from 0.5 mm. to 2 mm. in thickness. The outer surface is grayish brown or, where the outer cork has scaled off, brownish red, longitudinally wrinkled. The inner surface is pale yellowish to brownish red, longitudinally striate. The fracture is short and uneven, the fractured surface showing a grayish brown cork, a brownish to brownish red middle bark and a whitish inner bark in which a number of pale yellow groups of stone cells are discernible with the aid of a hand lens. The odor is strongly valeric acid-like, the taste bitter and astringent.

DESCRIPTION OF STEM BARK OF VIBURNUM PRUNIFOLIUM L.

In transversely curved, irregular or quilled pieces, 1.5 cm. to 15 cm. long and up to 3 mm. in thickness. Outer

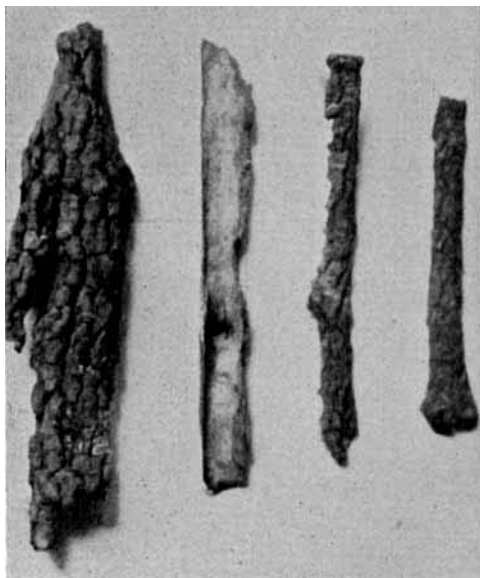


Fig. 4.—*Viburnum Prunifolium*. Stem bark.

surface silvery gray on young bark with raised, circular lenticels, grayish brown to blackish on older bark, the old bark showing a thick cork divided into a large number of irregular areas by numerous intersecting fissures. Inner surface pale yellowish to reddish brown or pale yellow with reddish brown blotches and streaks, longitudinally striate. Fracture short and uneven showing a grayish to blackish outer bark, a greenish brown to reddish brown middle bark and a light brown to whitish inner bark in which scattered groups of pale yellowish stone cells may be discerned with the aid of a hand lens. Odor faintly valeric acid-like becoming somewhat slightly more pronounced when triturated with phosphoric acid. Taste astringent and bitter.

HISTOLOGY OF ROOT BARK OF VIBURNUM PRUNIFOLIUM L.

The cork is of variable thickness and composed of somewhat lignified cork cells which are tangentially elongated in cross sections and polygonal in surface sections. The cork cells were up to 126 microns long and 54 microns broad as observed in cross sections, and many of them contained brownish contents. The phellogen exhibits tangentially-elongated cells with protoplasmic contents in cross sections.

The secondary cortex is a relatively narrow zone composed of tangentially-elongated parenchyma cells, some of which contain brownish amorphous masses, others either calcium oxalate in the form of rosette crystals or monoclinic prisms or tannin. Groups of stone cells with irregularly indented margins and isolated

stone cells are scattered through this region. Occasional rifts between parenchyma cells were noted in some of the sections.

The phloem is relatively broad and consists of a matrix of phloem parenchyma and sieve tubes separated into a number of oblong or curved phloem areas by medullary rays which, in cross sections run nearly straight or curve and converge in groups. Their passage outward is frequently interrupted by tangentially placed groups of stone cells.

The stone-cell groups are numerous in this region and frequently deeply notched. The groups measured up to $1360\mu \times 425\mu$, as observed in cross section. The individual stone cells are strongly lignified with prominent pore canals and rounded to irregular lumen, the latter frequently containing reddish to brownish contents. They measured up to 259.2μ in length and 90μ in width.

Rosette crystals of calcium oxalate, occurring in the cortex, phloem and medullary rays, were up to 54μ in diameter. The monoclinic prisms observed occurring in these same regions were considerably fewer than the rosette aggregates and up to 40μ in length. Numerous crystal fibres containing rosette crystals of calcium oxalate occur in phloem and cortex.

The medullary rays are 1 to 2 cells wide as observed in tangential-longitudinal sections and their cells contain either starch, tannin, brownish amorphous masses

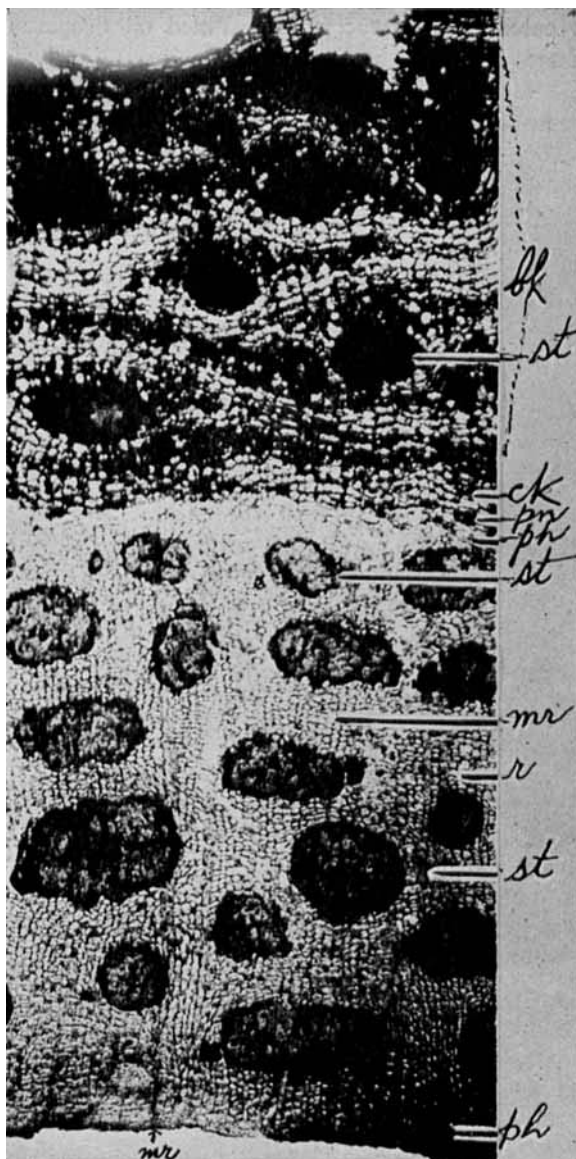


Fig. 5.—Photomicrograph of a cross section of older *Viburnum prunifolium* stem bark ($\times 41$), *bk*, borke; *ck*, cork; *pn*, secondary phellogen; *ph*, phloem; *st*, group of stone cells; *mr*, medullary ray; *r*, rosette aggregate of calcium oxalate. Note that secondary cork cambia (phellogens) have cut off a series of wavy cork layers in cortex, pericycle and outer phloem.

or calcium oxalate crystals. Fixed oil droplets separated from the amorphous masses in chloral mounts.

The starch grains observed in scrapings of the bark mounted in distilled water were simple to 2- to 3-compound, the individual grains being spheroidal to ovate, ovate-truncate, plano-convex and mostly up to 10μ , occasionally up to 18μ , in diameter or length.

No bast fibres were observed.



Fig. 6.—*Viburnum rufidulum* Raf. Leaf and fruiting branch. Collected in Arnold Arboretum, Jamaica Plain, Mass. Note fruit cluster at *f*.

Tannin giving a greenish color with 1:1000 solution of ferrous sulphate occurred in cells of the cortex, phloem and medullary rays.

HISTOLOGY OF THE STEM BARK OF *VIBURNUM PRUNIFOLIUM* L.

The cork varies in thickness and is composed of somewhat lignified cork cells which are tangentially elongated in cross sections and polygonal in surface view. Many contain brownish contents. The individual cork cells measured were frequently up to 129.6μ x 36μ , rarely up to 145.6μ x 41.6μ .

The cork cambium consists of tangentially-elongated meristematic cells.

The cortex and pericycle are of variable thickness and in old bark show wavy borke areas due to the origin of secondary cork cambia in these regions. Some of the corky areas show included masses of stone cells. The phloem is of variable width and exhibits numerous, nearly

straight to slightly curved medullary rays, 1 to 2 cells wide, traversing phloem parenchyma and sieve tubes. Irregularly rounded and tangentially-elongated groups of stone cells as well as a few isolated stone cells are scattered through this region. A few pericyclic fibres with irregular lumen and rounded or obtuse ends are present in young stem bark but are not seen in older bark. This verifies Mitlacher's observation (29).

The stone-cell groups were up to 2784μ x 340μ , as observed in radial longitudinal sections.

The parenchyma cells of the cortex and phloem and the medullary ray cells contained either starch, calcium oxalate in rosette aggregates or monoclinic prisms, brownish amorphous masses or tannin.

Numerous crystal fibres containing rosette crystals of calcium oxalate occur in the phloem. The rosette crystals were up to 57.6μ in diameter. As in the root bark, the monoclinic prisms of calcium oxalate were fewer. These were up to 40μ in length.

The starch grains are simple, spheroidal and 2- to 3-compound, the individual grains being up to 10μ .

Tannin giving a greenish color with 1:1000 solution of ferrous sulphate occurred in cells of the cortex, phloem and medullary rays. Some of the cortex and phloem cells also contained droplets of a fixed oil. This may be observed separating from the brownish amorphous masses in chloral mounts.

VIBURNUM RUFIDULUM RAF.

The material for investigation consisted of root, stems, leaves and fruits gathered by H. W. Youngken in the Arnold Arboretum, Boston, Sept. 10, 1928, of roots, stems, root bark and stem bark gathered Dec. 1 to 3, 1928, root bark and stem bark young plants and roots gathered March 1, 1929 and root bark and stem bark and leaves gathered April 25th to May 1st by E. J. Petry at Conway, Arkansas, where the plants grew in stony ground about 500 ft. above sea level, also of root and stem bark collected by W. W. Eggleston from plants growing on the bank of a ravine at Houston, Texas, May 8, 1929, and of plants, root and stem bark gathered in Clinton Co., Ky., by the S. B. Penick Co. All of these materials were verified by H. W. Youngken as authentic after a careful comparison with specimens in the Arnold Arboretum.

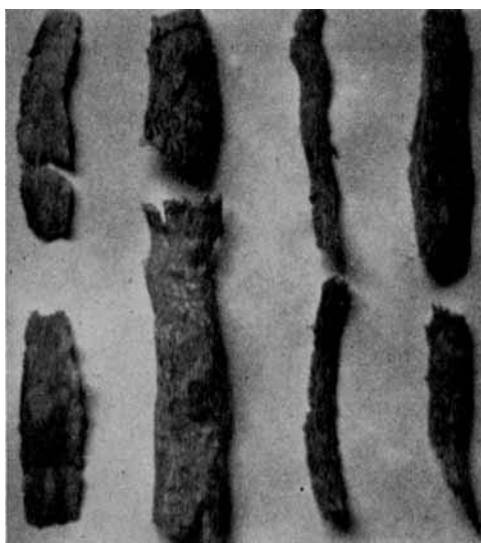


Fig. 7.—*Viburnum rufidulum*. Root bark.

DESCRIPTION OF VIBURNUM RUFIDULUM RAF.

Viburnum rufidulum Raf. or Southern Black Haw is a large shrub or small tree attaining a height of about 30 ft. with stout, rigid branches with obtuse, rusty hairy winter buds and elliptic to obovate, usually obtuse and serrulate leaves 2 to 4 in. long, which are glabrous, shining and dark green on the upper surface, rusty pubescent on the veins beneath, especially toward the base, and with usually narrowly winged, rusty pubescent petioles, up to $\frac{1}{2}$ in. in length. The flowers are white and arranged in sessile cymes. The fruits are dark blue, ellipsoidal, glaucous drupes with a flat stone. Rehder (4) and Bailey (40) both report its distribution from Virginia to Florida, west to Illinois and Texas.

This plant is hereby identified as the source of commercial Kentucky Black Haw Bark, which has been on the drug market for some time.

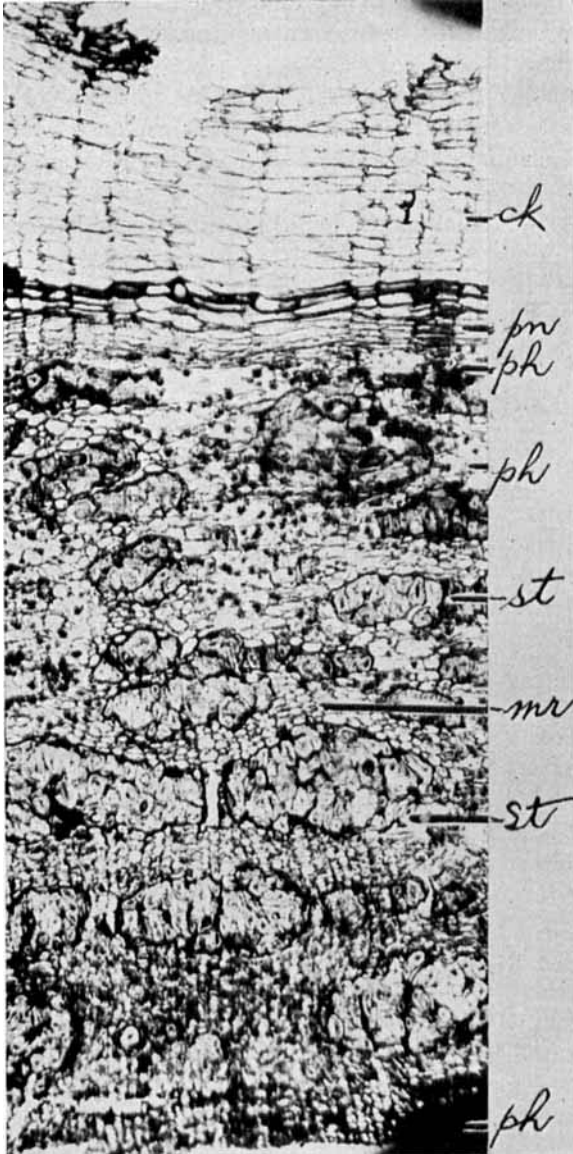


Fig. 8.—Photomicrograph of a cross section of *Viburnum rufidulum* root bark ($\times 50$), *ck*, cork; *pn*, secondary phellogen; *ph*, phloem; *st*, group of stone cells; *mr*, medullary ray; *cr*, crystal of calcium oxalate. The black objects in the parenchymatous cells are calcium oxalate crystals. Secondary phellogen is responsible for the cork tissue shown here. The original secondary and first formed cork have sluffed off.

Outer surface silvery gray on young bark with raised circular lenticels, grayish brown to blackish on older bark or reddish brown where cork has scaled off. The

DESCRIPTION OF VIBURNUM RUFIDULUM ROOT BARK.

In irregular or transversely curved pieces or quills from 1.5 to 10 cm. in length and from 0.5 to 3.5 mm. in thickness; outer surface varying from grayish brown, light brown, yellowish brown, light brown, irregularly longitudinally striated to wrinkled and furrowed, occasionally transversely fissured, and showing cork patches on old bark, reddish brown to purplish brown to purplish where cork is abraded; inner surface pale yellowish and frequently marked with irregular blotches or streaks of reddish brown, longitudinally striated; fracture brittle and uneven exhibiting a brown cork, a reddish brown cortex and whitish to reddish brown inner bark containing yellowish groups of stone cells, odor valeric acid-like, becoming very strongly so when treated with syrupy phosphoric acid, taste bitter and astringent. Upon treating the inner surface of this bark with 1:1000 solution of freshly prepared ferrous sulphate a greenish black color is evident.

DESCRIPTION OF THE STEM BARK OF VIBURNUM RUFIDULUM RAF.

In irregular, transversely curved or quilled pieces 1.5 cm. to 15 cm. in length and up to 6 mm. in thickness.

old bark shows thick cork with numerous irregular longitudinal, oblique and transverse fissures; inner surface pale yellowish to reddish brown or yellowish with reddish brown blotches and streaks, longitudinally striated. Fracture short and uneven, the fractured surface showing a grayish to blackish outer bark, a greenish brown to reddish brown middle bark and a light brown to whitish inner bark in which dull yellow stone-cell groups are visible under a hand lens. The odor is faintly valeric acid like, becoming only slightly more pronounced when treated

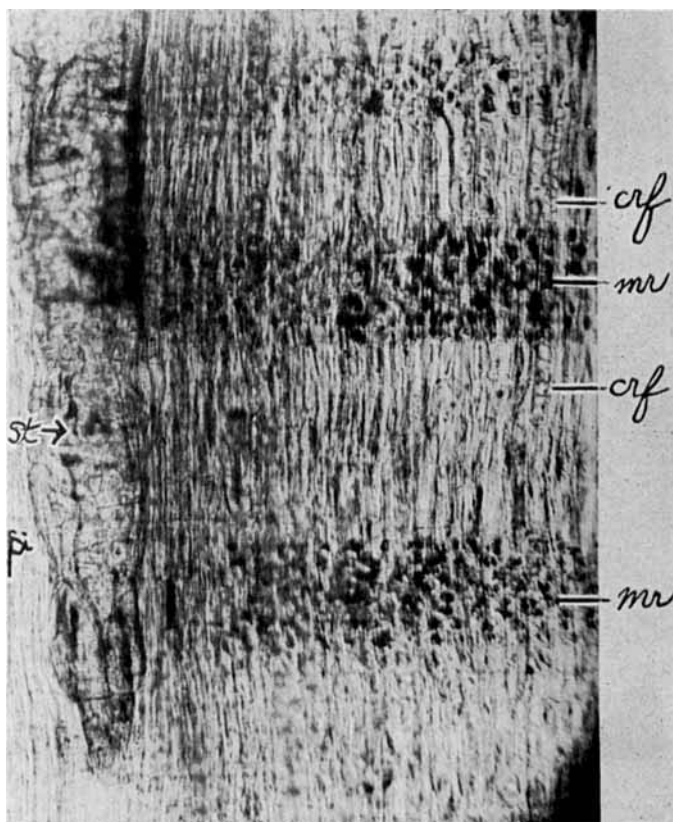


Fig. 9.—Photomicrograph of a radial-longitudinal section of the phloem region of the root bark of *Viburnum rufidulum* ($\times 102$). *st*, sieve tubes; *st*, group of stone cells; *mr*, medullary rays; *crf*, crystal fibres containing monoclinic prisms.

with syrupy phosphoric acid. The taste is astringent and bitter. The inner surface, when treated with a 1:1000 solution of ferrous sulphate, is colored greenish black.

HISTOLOGY OF VIBURNUM RUFIDULUM ROOT BARK.

The cork is up to 40 or more layers of cells in width which are tangentially elongated in cross sections. The largest of these cells are up to 154.8μ long and 72μ in radial diameter.

The phellogen is composed of a layer or more of tangentially-elongated, thin-walled, somewhat compressed cells.

The secondary cortex varies in diameter according to age. It is composed of pitted parenchyma cells which are tangentially elongated in cross section. Many of these contain rosette crystals of calcium oxalate while a number of them contain either starch, brownish red amorphous masses and tannin. Imbedded in this

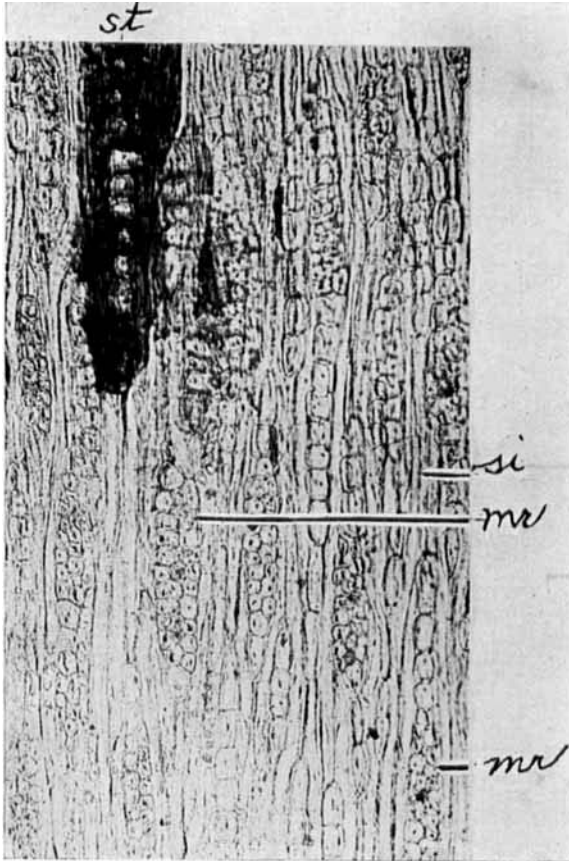


Fig. 10.—Photomicrograph of a tangential longitudinal section of the phloem region of the root bark of *Viburnum rufidulum* ($\times 102$). *si*, sieve tissue; *mr*, medullary rays; *st*, group of stone cells with a portion of an adherent crystal fibre containing monoclinic prisms of calcium oxalate.

region are numerous groups of stone cells and scattered stone cells. The stone-cell groups are either tangentially-elongated, irregularly circular to oval in outline with irregularly indented margins as viewed in transverse sections. An outstanding feature of the majority of the groups is their deeply indented irregular outline. The larger groups showed as many as 80 stone cells in cross sections, the groups measuring up to $1020\mu \times 510\mu$ in these sections. The individual stone cells are of a large variety of shapes and show varying degrees of lignification and pore canal branching. In radial-longitudinal sections and in preparations made by Schulze's method, they were up to 680μ in length.

The phloem varies in breadth but is averagely broader than the cortex. It is composed of phloem parenchyma containing either rosette aggregates or monoclinic prisms of calcium oxalate, starch grains, tannin or brown amorphous masses.

Through the outer and middle portions of the phloem numerous stone-cell groups and isolated stone cells are present which resemble those of the cortex. Coursing outward through the phloem in straight or curved fashion are many medullary rays which tend to converge in groups. Some of these are interrupted by the stone-cell groups while others bend around them. The medullary rays as observed in tangential sections are from 1 to 3 cells in width, the majority being 1 cell wide,

fewer 1 to 2 cells wide, fewest 1 to 3 cells wide. The cell contents resemble those of the parenchyma and of the cortex and phloem.

Crystal fibres containing rosette aggregates of calcium oxalate were abundant in cortex and phloem. The rosette aggregate crystals were up to 54μ in diameter while the monoclinic prisms studied ranged up to 32.4μ in length.

The starch grains were simple spheroidal to oval, the latter often with a beaked end, or 2- to 3-compound. Most of the individual grains were up to 4 or 5μ , a few up to 8μ , fewer up to 15μ .

HISTOLOGY OF VIBURNUM RUFIDULUM STEM BARK.

The cork zone is of variable width and composed of more or less isodiametric

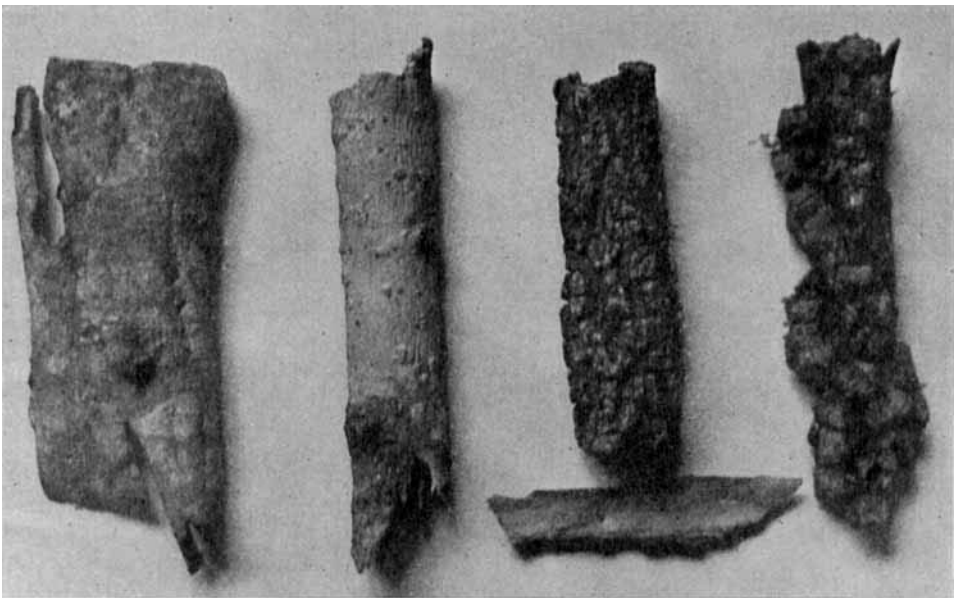


Fig. 11.—*Viburnum rufidulum*. Stem bark.

to tangentially-elongated cells in cross sections, polygonal to rounded polygonal in surface sections with suberized and lignified walls. The older cork cells are compressed and for the greater part tangentially elongated, with brownish contents. There is a tendency of the outer and inner walls to be thicker than the radial walls, but this is by no means constant. Frequently islets of stone cells are imbedded within the old cork or between it and the young cork. The young cork appears clear and open looking and is composed of radially and tangentially elongated cells with walls often wavy. The cork cells measured were up to 72μ long and 50.4μ wide.

The phellogen is composed of tangentially-elongated meristematic cells. The cortex and pericycle contain tangentially-elongated parenchyma with starch, tanning, fixed oil and brownish amorphous contents. Scattered through these

regions are many stone-cell groups and isolated stone cells. As the stem grows older, secondary cork cambia originate in the depths of the cortex and pericycle and outer phloem forming wavy cork layers in these zones containing groups of stone cells. In old stem bark sluffing of the outer layers occurs as far as the last secondary cork cambium and cork is formed in the outer phloem, so that in real old bark the medullary rays reach outward to the secondary cork cambium.

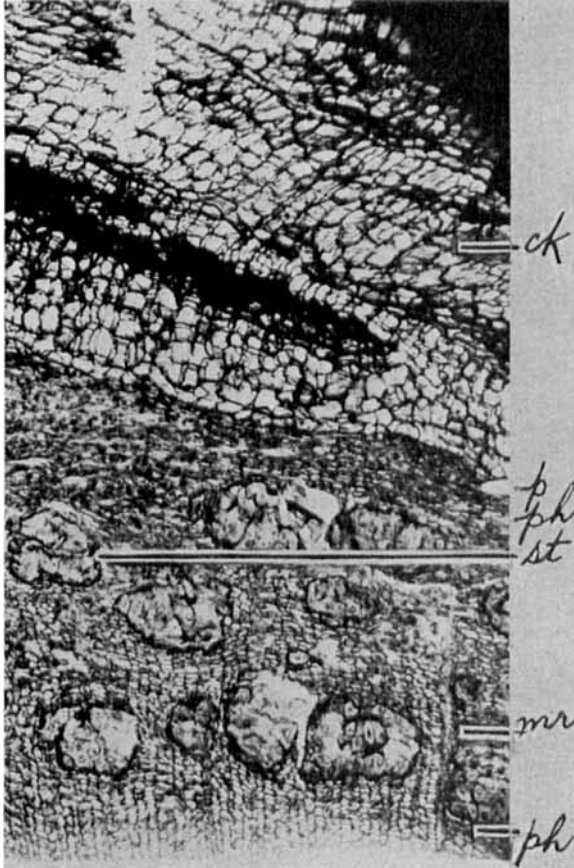


Fig. 12.—Photomicrograph of a cross section of *Viburnum rufidulum* stem bark ($\times 55$). Secondary cork cambia have cut off deep layers of cork as far as the phloem. *ck*, cork; *p*, a secondary cork cambium; *st*, group of stone cells; *ph*, phloem; *mr*, medullary ray.

While most of the medullary rays are 1 to 2 cells in width, there are quite a few 1 to 3 cells wide.

The phloem is a relatively broad zone consisting of sieve tubes and phloem parenchyma, the latter containing either starch, tannin, brownish amorphous masses or rosette aggregates, or monoclinic prisms of calcium oxalate. The medullary rays course through this region in straight to slightly curved or wavy fashion and contain elements similar in character to those found in the phloem parenchyma. Some of them are intercepted by groups of stone cells, which, along with isolated stone cells are abundant in the outer and middle phloem regions. The stone-cell groups appear close together in phloem, cortex and old cork. They are averagely smaller than in the root bark of this species. In radial longitudinal sections, one stone-cell group measured $850\mu \times 510\mu$. Many of the individual stone cells observed

in preparations made by Schulze's method are sinuate-toothed along the margin. They show a large variety of shapes and sizes.

The margins of the stone-cell groups were irregularly rounded, oval or oblong, crenate to toothed and indented. Numerous crystal fibres containing rosette aggregates and a number containing monoclinic prisms, as well as rosette aggregates and monoclinic prisms of calcium oxalate occurred in cortex, pericycle and phloem.

The rosette aggregates were up to 54μ in diameter while the monoclinic prisms were up to 25μ in length.

The starch grains are mostly simple, spheroidal and up to 4μ . A few are ovoid and beaked and up to 8μ , while 2- to 3-compound starch grains are occasional.

Numerous droplets of a fixed oil separated when sections of the bark were warmed in chloral hydrate solution.

The tannin cells took on a greenish coloration when sections were examined in 1:1000 solution of ferrous sulphate.

VIBURNUM CASSINOIDES.

The material for this investigation consisted of roots, stems, abundant root bark and stem bark and leaf and flowering branches collected near Pineola, N. C., in swampy woodlands, June 8 to 11, 1929, by H. W. Youngken.

DESCRIPTION OF VIBURNUM CASSINOIDES L.

Viburnum cassinoides L. (*V. nudum* var. *cassinoides* T. & G.) commonly known as Witherod and Appalachian Tea, is an upright shrub from 2 to 12 ft. in height occurring in swamps and wet thickets from Newfoundland to Manitoba and Minnesota, south into North Carolina. Its leaves are elliptic, ovate, oblong or ovate-lanceolate, from 1 to 3 in. in length, when mature, subcoriaceous, dull green above and nearly glabrous, paler green beneath, acute or bluntly acuminate at the apex and dentate to denticulate or obscurely so along the margin. Its inflorescences are compound cymes of white perfect flowers with peduncle usually shorter than the cyme. The fruits are bluish, ovoid drupes containing a flattened stone.

DESCRIPTION OF THE ROOT BARK OF VIBURNUM CASSINOIDES L.

In irregular, transversely curved or quilled pieces, 1.5 cm. to 16 cm. in length and 0.5 mm. to 2 mm. in thickness, rarely up to 2.5 mm. in thickness where cork



Fig. 13.—*Viburnum cassinoides* Linné. Leaf and flowering branch from shrub growing in swampy woodland near Pineola, N. C., June 1929.

is thick; outer surface grayish brown to dark brown or blackish brown, or, where the cork has been scraped off, brownish red, irregularly longitudinally striated and wrinkled on younger bark, becoming irregularly longitudinally wrinkled and somewhat irregularly fissured on old bark; inner surface varying from yellowish and streaked with lines and blotches of brown and red, yellowish brown to pinkish brown to reddish brown, longitudinally striated; fracture short and uneven, the fractured surface exhibiting a grayish to brownish, blackish or reddish brown cork. a whitish, brownish red or pale yellowish middle and inner bark in which dull yellowish oval or circular groups of stone cells may be seen with a hand lens: odor

strong, valeric acid-like: taste bitter and astringent. The inner surface of this bark, when treated with a freshly prepared 1:1000 solution of ferrous sulphate, becomes greenish black.

DESCRIPTION OF THE STEM
BARK OF VIBURNUM CASSI-
NOIDES L.

In irregular, transversely curved or quilled pieces from 1.5 cm. to 17 cm. in length and 0.5 mm. to 2 mm. in thickness and possessing a purplish brown aspect when examined in quantity. Outer surface smooth and polished with scattered, raised circular to oval lenticels on young bark to irregularly longitudinally wrinkled and irregularly fissured on older bark, the latter sometimes showing greenish or grayish lichens, or outer surface purplish red where cork is abraded. In-

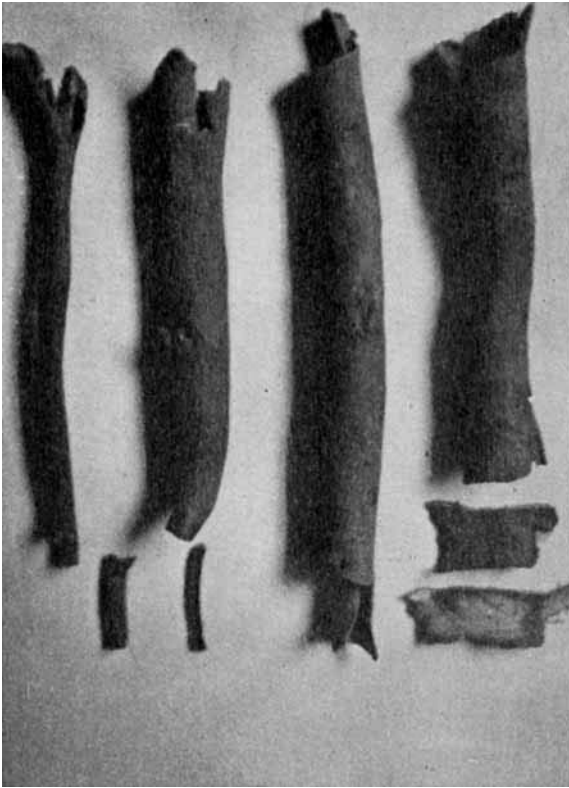


Fig. 14.—*Viburnum cassinoides*. Root bark.

ner surface pale yellow to yellow streaked with brownish red or orange brown or inner surface brownish red, longitudinally striate. Fracture short and uneven exhibiting a grayish to brown or black cork, a greenish phelloderm on young bark, and a yellowish white to pinkish white or reddish brown middle and inner bark in which scattered dull yellowish, oval to circular groups of stone cells may be seen with a hand lens. Taste distinctly bitter and somewhat astringent. Odor aromatic, valeric acid-like, becoming strongly valeric acid-like upon triturating bark with syrupy phosphoric acid.

HISTOLOGY OF THE ROOT BARK OF VIBURNUM CASSINOIDES L.

The cork is composed of a variable number of layers of suberized cells which are tangentially elongated in cross sections.

The phellogen is composed of tangentially-elongated meristematic cells.

The secondary cortex is composed of several layers of tangentially-elongated cells with occasional rifts between the parenchyma. Imbedded in this region are groups of stone cells and some isolated stone cells.

The phloem is relatively the broadest region and consists of a matrix of sieve tubes and phloem parenchyma traversed by medullary rays, the latter being 1, 1 to 2 and 1 to 3 cells wide as observed in tangential section. Scattered through this matrix are a number of irregularly circular, ovate or oblong groups of stone cells, similar in character to those noted in the secondary cortex with somewhat scalloped and crenated to toothed margins.

The individual stone cells examined varied in size and shape, had lignified walls, branching pore canals and circular, oval or slit-like lumina. The walls of the largest of these were up to 90μ in thickness.

The parenchyma of the cortex and phloem and medullary ray cells contained either starch grains, brownish amorphous masses, tannin or rosette crystals of calcium oxalate.

Droplets of a fixed oil separated from cells of these regions when mounts were examined in chloral solution. The starch grains are mostly simple spheroidal, ovate to top shaped, some beaked and up to 14.4μ . A few 2- to 3-compound starch grains also occur as well as their plano-convex or angular-rounded parts.

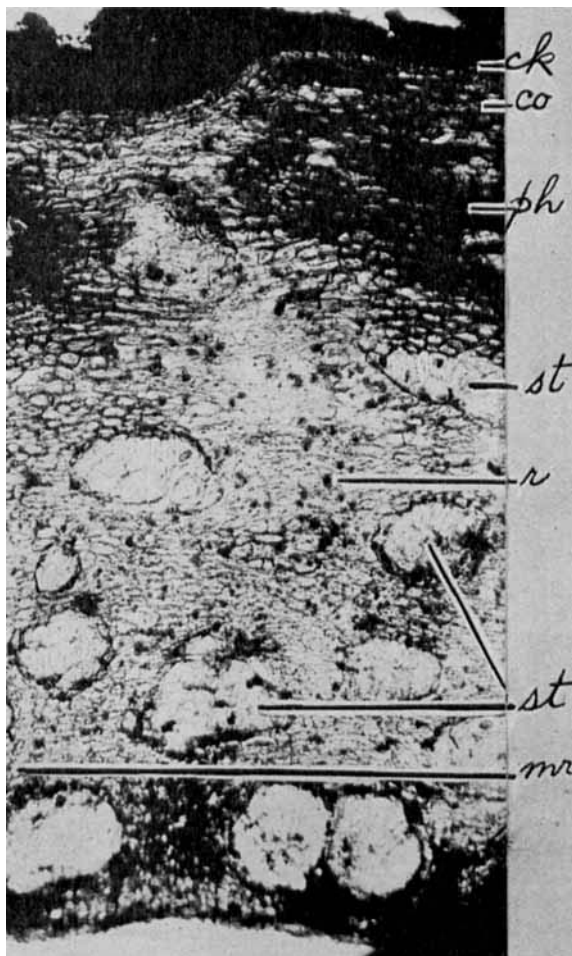


Fig. 15.—Photomicrograph of a transverse section of the root bark of *Viburnum cassinoides* ($\times 52$). *ck*, cork; *co*, secondary cortex; *ph*, phloem; *st*, stone cell groups; *r*, rosette aggregate of calcium oxalate; *st*, groups of stone cells; *mr*, medullary ray.

The rosette crystals of calcium oxalate are mostly under 40μ , a few up to 54μ . Numerous crystal fibres containing rosette aggregates of calcium oxalate occur in the phloem and cortex. The cells containing tannin took on a greenish coloration when mounts were examined in 1:1000 of a freshly prepared solution of ferrous sulphate.

HISTOLOGY OF THE STEM BARK OF VIBURNUM CASSINOIDES L.

The cork is of variable thickness and consists of cells which are tangentially elongated and suberized to somewhat lignified.

The phellogen is composed of tangentially-elongated meristematic cells.

The secondary cortex is composed of tangentially-elongated parenchyma some of the cells of which contain chloroplastids and small starch grains. A few scattered groups of stone cells occur in this region.

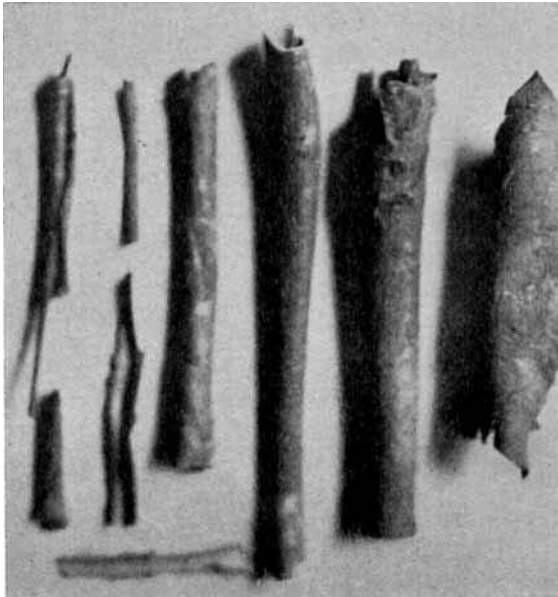


Fig. 16.—*Viburnum cassinoides*. Stem bark.

The primary cortex is composed of pitted parenchyma containing either rosette crystals of calcium oxalate, starch grains, tannin or brownish amorphous masses. Scattered through this region are irregularly circular to oval or oblong groups of stone cells with crenated margins and a few isolated stone cells.

The phloem is a relatively broad zone of sieve and phloem parenchyma which is traversed by medullary rays which in cross sections, are seen to run a straight to somewhat wavy or slightly curved course and tend to converge in

groups. Numerous stone-cell groups and some isolated stone cells are scattered through the phloem. The stone-cell groups were up to $2856\mu \times 214.2\mu$. The individual stone cells are of a variety of shapes and sizes and show thick, lignified walls, up to 36μ in thickness, branching pore canals and circular to irregular lumina.

Many of the parenchyma cells of the cortex, pericycle and phloem contain rosette aggregates of calcium oxalate which were up to 36μ in diameter. Others contain starch, tannin and some brownish amorphous contents. Mounts made in chloral hydrate showed a separation of fixed oil droplets. The tannin gave a greenish color with 1:1000 solution of ferrous sulphate.

Tangential-longitudinal sections exhibited numerous crystal fibres in phloem, cortex and pericycle containing rosette aggregates of calcium oxalate. In these

sections the medullary rays were mostly 1 to 2 cells wide, a few 1 to 3 cells in width. They contained elements similar to those noted in the parenchyma cells of the bark.

The starch grains are mostly simple, spheroidal and up to 10.8μ .

VIBURNUM NUDUM.

The material for this investigation consisted of root bark, stem bark, roots, stems and leaf and flowering branches collected at Mud Creek Flats between Flat Rock and Hendersonville, N. C., by H. W. Youngken and of stem bark and leaf and flowering branches collected at Biltmore, N. C., by H. W. Youngken on June 12, 1929.

DESCRIPTION OF VIBURNUM NUDUM L.

Viburnum nudum L., commonly known as Smooth Witherod, Shawnee Haw and Shonny Haw is an upright shrub growing to the height of 15 ft. Its leaves are ovate to elliptic, ovate-lanceolate to elliptic-lanceolate, acute or obtuse usually entire and somewhat revolute but also frequently obscurely crenulate to denticulate and undulate, petiolate, broadly cuneate at base, from 2 to $4\frac{3}{4}$ in. in length, scurfy on both sides when young, dark green and shining on the upper surface at length. The flowers are white or yellowish white and arranged in compound cymes, the peduncle of which is as long or frequently longer than the cyme. The fruits are subglobose drupes, pink at first, changing to bluish black.

According to Bailey (40), this shrub is found from Long Island to Florida, west to Kentucky and Louisiana.

A number of shrubs intermediate between typical *V. nudum* and *V. cassinoides* in leaf and peduncle characters were observed near Pineola and near Statesville, N. C.

DESCRIPTION OF VIBURNUM NUDUM ROOT BARK.

In irregular, transversely curved or quilled pieces, 1.5 to 7 cm. in length and from 0.5 to 2 mm. in thickness: outer surface grayish brown or, where cork has

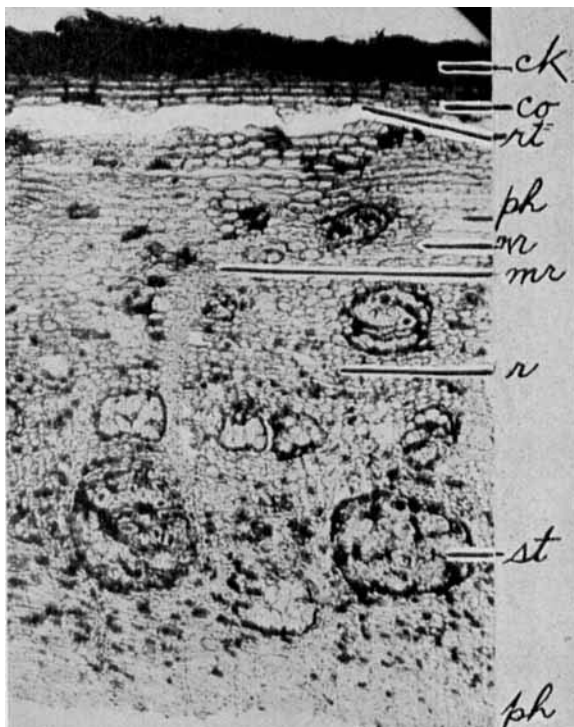


Fig. 17.—Photomicrograph of a transverse section of *Viburnum cassinoides* stem bark ($\times 58$). *ck*, cork; *co*, cortex; *rt*, rift between parenchyma cells of cortex; *ph*, phloem; *mr*, medullary ray; *st*, group of stone cells; *r*, rosette aggregate of calcium oxalate.

scaled off, brownish red, irregularly longitudinally wrinkled; inner surface brownish red, frequently with pale yellow blotches and streaks, longitudinally striated; fracture short and uneven, showing in bark which is young or of medium thickness a grayish to dark brown cork, a brownish red middle bark and a whitish inner bark with numerous scattered oval to rounded, dull yellow groups of stone cells: odor strong, valeric acid-like; taste distinctly bitter and somewhat astringent.

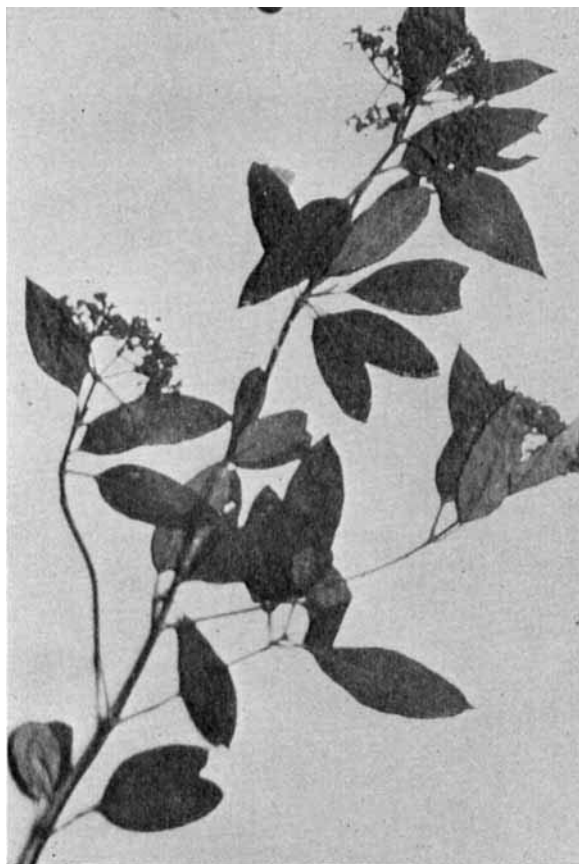


Fig. 18.—*Viburnum nudum* Linné. Leaf and flowering branch. Collected in low swamp at Mud Creek Flats near Flat Rock, N. C., June 1929.

DESCRIPTION OF VIBURNUM NUDUM STEM BARK.

In strips, transversely curved pieces or quills from 1.5 cm. to 16 cm. in length and from 0.5 to 2 mm. occasionally 3 mm. in thickness: outer surface varying from dark brown to blackish brown, showing purplish blotches in some pieces, irregularly longitudinally wrinkled and showing numerous circular to oval lenticels, smooth in young bark becoming longitudinally wrinkled, irregularly wrinkled and at length fissured in old bark: inner surface pale yellowish, streaked and blotched in some pieces with orange brown and red; fracture short but uneven, showing in bark which is young or of medium thickness a brown cork, a greenish yellow to brown middle bark, and a pale yellowish to reddish brown inner bark, the latter showing oval to rounded groups of dull yellow stone cells under the hand lens:

odor aromatic, valeric acid-like, becoming pronounced valeric acid-like upon trituration with phosphoric acid; taste distinctly bitter and somewhat astringent.

This bark tends to be darker than the stem bark of *V. cassinoides*. The purple areas noted are less extensive than on the outer surface of the stem bark of *V. cassinoides*.

A greenish black color is developed when the inner surface of this bark is treated with 1:1000 solution of ferrous sulphate.

HISTOLOGY OF THE ROOT BARK OF VIBURNUM NUDUM L.

The cork is of variable width and composed of tangentially-elongated cells with suberized to slightly lignified walls, as observed in cross sections.

The phellogen is made up of tangentially-elongated meristematic cells. The secondary cortex is narrow and shows tangentially-elongated to rounded parenchyma cells with pitted walls and starch, tannin, calcium oxalate or brownish amorphous contents. In young root bark a continuous zone of stone cells is laid down in the inner part of this region, just outside of the phloem. This becomes broken up into smaller masses as growth proceeds.

The phloem is a comparatively broad region composed of phloem parenchyma containing starch, tannin, calcium oxalate crystals and brown amorphous masses and separated into numerous phloem patches by medullary rays 1 to 2 cells wide which run either straight or curved and tend to converge in groups. Numerous stone-cell groups of irregularly rounded, ovate or oblong shape and with crenated margins as well as a number of isolated stone cells occur in this region. The individual stone cells are of a large number of shapes and sizes, are lignified with branching pore canals and have circular to oval to triangular or slit like lumina. Many of them contain reddish coloring matter. Their walls were up to 44μ in thickness.

Numerous rosette crystals and crystal fibres containing this form of calcium oxalate occurred in the phloem and cortex. The rosette crystals were up to 43μ in diameter.

The starch grains were simple, spheroidal and 2- to 3-compound, the individual grains up to 12μ . The simple grains are frequently beaked.

The tannin gave a greenish coloration with 1:1000 freshly prepared solution of ferrous sulphate.

HISTOLOGY OF THE STEM BARK OF VIBURNUM NUDUM L.

The cork is composed of tangentially-elongated, suberized cells which are

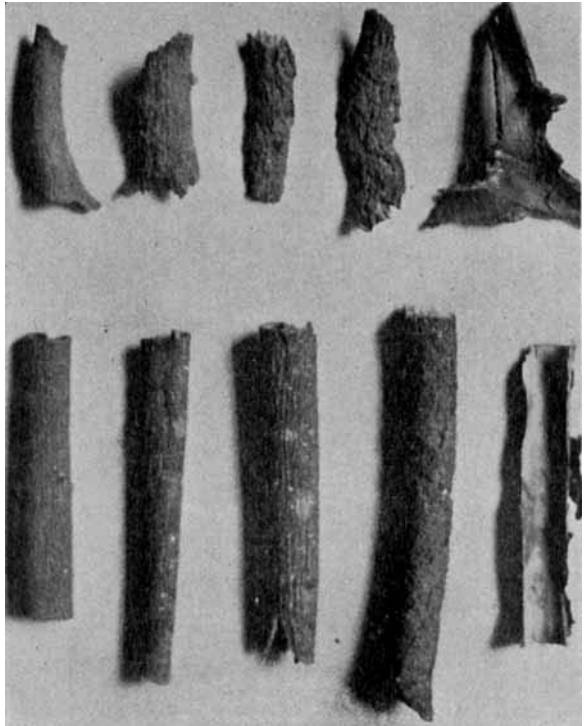


Fig. 19.—*Viburnum nudum*. Root bark above. Stem bark below.

polygonal to rounded polygonal in surface sections. In the older bark stone-cell groups are imbedded in this region. The dimensions of the cork cells were up to $136\mu \times 102\mu$.

The phellogen consists of tangentially-elongated meristematic cells.

The cortex is comparatively narrow and shows rifts. Its outer portion is collenchymatic and in young bark contains chloroplasts, its inner portion parenchymatous with pitted parenchyma cells containing brownish amorphous masses, rosette crystals of calcium oxalate, starch and tannin. Stone-cell groups averagely smaller than in root bark and isolated stone cells occur in this region. Rifts occur between parenchyma cells in cortex and phloem.

The pericycle contained elements similar to the cortex.

The phloem is relatively broad and composed of phloem parenchyma and sieve tubes traversed by medullary rays 1 to 2 cells in width which run straight or slightly curved and tend to converge in groups, as observed in cross sections. Imbedded in this region are a large number of circular, oval, oblong or ellipsoidal groups of stone cells and a number of isolated stone cells with lignified walls, branching pore canals and irregularly circular to ovate to slit-like lumina. The wall of the stone cells was up to 46.6μ thick.

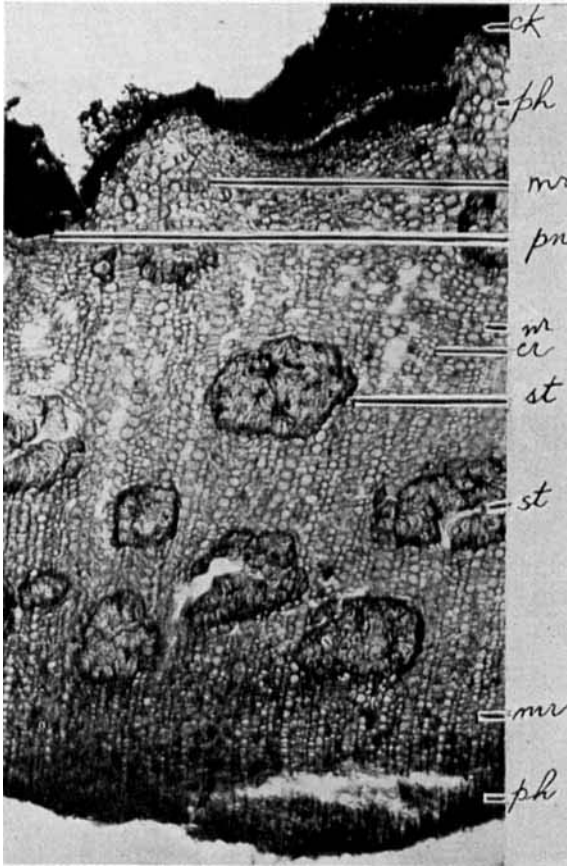


Fig. 20.—Photomicrograph of a cross section of *Viburnum nudum* root bark (about $\times 40$). Secondary phellogens have cut off cork causing exfoliation of secondary cortex and original outer bark as far as the phloem. *ck*, cork; *pn*, secondary meristem; *ph*, phloem, *mr*, medullary rays; *st*, groups of stone cells; *cr*, rosette aggregate of calcium oxalate.

The stone-cell groups measured up to $2856\mu \times 357\mu$ in radial-longitudinal sections.

Crystal fibres containing rosette aggregates occurred in cortex, phloem and pericycle. The phloem parenchyma and medullary rays contained either starch, tannin, brown amorphous masses, or granular contents or rosette aggregates of calcium oxalate up to 54μ in diameter.

Some of the stone cells exhibited a wavy-toothed margin in mounts made of material which had been prepared by Schulze's method. They measured up to $180\mu \times 72\mu$.

The tannin took on a greenish coloration when treated with 1:1000 freshly prepared solution of ferrous sulphate.

Scrapings of the bark mounted in distilled water showed the starch grains to be chiefly simple, spheroidal and up to 15μ . A number of 2- to 3-compound starch grains also occur. Many of the simple grains were beaked and showed a central cleft hilum.

REFERENCES.

(1) Carl von Linné, "Genera Plantarum," page 332, 1737.

(2) Carl von Linné, "Species Plantarum," 1st Edition, page 268, 1753.

(3) D. J. F. Grovonio, "Flora Virginica," 1st Edition, Leyden, page 53, 1739.

(4) A. Rehder, "Manual of Cultivated Trees and Shrubs," page 805, 1927.

(5) N. L. Britton and A. Brown, "Illus. Fl. U. S., Can. and Br. Poss.," 2nd Edition, 3 (1913), 273.

(6) C. S. Rafinesque, "Alsographia Americana," page 56, Phil., 1838.

(7) Carl von Linné, "Species Plantarum," 2nd Edition, page 234, 1762.

(8) A. Rehder, "Manual of Cultivated Trees and Shrubs," page 804, 1927.

(9) J. Torrey and A. Gray, "Flora N. A.," 2 (1841), 14.

(10) N. L. Britton and A. Brown, "Illus. Fl. U. S., Can. and Br. Poss.," 2nd Edition, 3 (1913), 272.

(11) P. Miller, "The Gardner's Dictionary," 8th Edition, London, 1768.

(12) H. Marshall, "Arb. Am.," page 162, 1785.

(13) J. Torrey and A. Gray, "Flora N. A.," 2 (1841), 15.

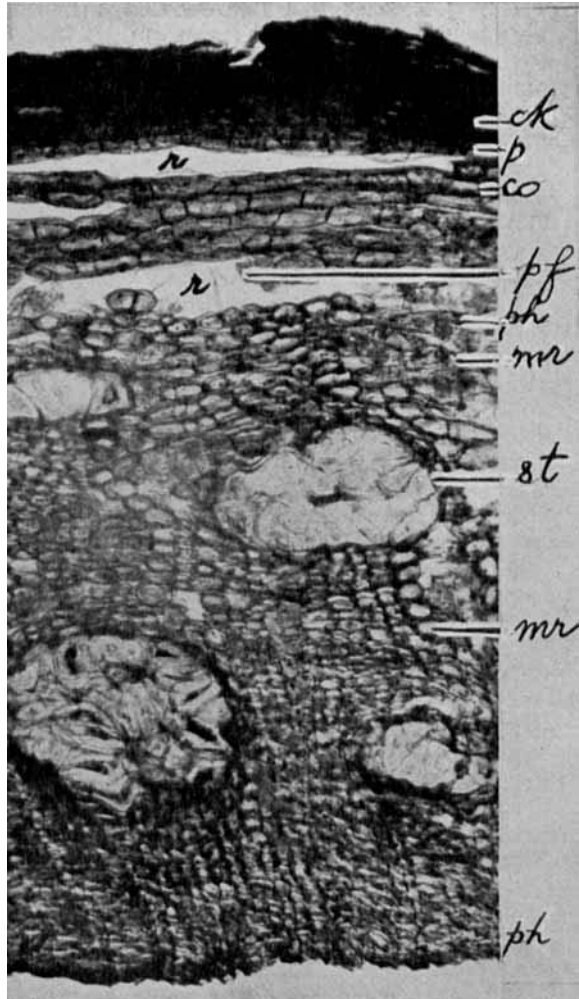


Fig. 21.—Photomicrograph of a cross section of *Viburnum nudum* stem bark ($\times 110$). *ck*, cork; *p*, phellogen; *co*, cortex; *pf*, pericyclic fibers in pericycle; *r*, rifts, occurring between groups of parenchyma cells in cortex and pericycle; *ph*, phloem; *st*, group of stone cells; *mr*, medullary rays which are often interrupted in this and some other *Viburnum* barks by interposed groups of stone cells. The black objects in the parenchyma cells are calcium oxalate crystals.

- (14) J. K. Small, *Bull. Torr. Bot. Club*, 4 (1894), 123.
 (15) J. K. Small, *Ibid.*, 23 (1896), 410.
 (16) N. L. Britton and A. Brown, "Illus. Fl. U. S., Can. and Br. Poss.," 2nd Edition, 3 (1913), 274.
 (17) W. Aiton, "Hortus Kewensis," 1 (1789), 373.
 (18) C. S. Sargent, "Manual of the Trees of No. America," pages 890-891, 1922.
 (19) A. Rehder, "Manual of Cultivated Trees and Shrubs," page 810, 1927.
 (20) N. L. Britton and A. Brown, "Illus. Fl. U. S., Can. and Br. Poss.," 2nd Edition, 3 (1913), 270.
 (21) Sanio, *Struct. et div. du liege*, "Jahr. für wiss Bot.," 1860.
 (22) J. Moeller, "Denkschr. Wiener Akad.," 47-50 (1876), 343.
 (23) Schwarz-Clements, "Relation of Leaf Structure to Physical Factors," *Trans. Amer. Micros. Soc.*, page 63, 1905.
 (24) Michael, "Bau d. Holzes der Compositen, Caprifoliaceen u. Rubiaceen," *Diss.*, Leipzig, 1885.
 (25) L. E. Sayre, "Viburnum Prunifolium and Viburnum Opulus. Characters of Distinction," *A. J. P.*, 28 (Aug. 1895), 387-394.
 (26) L. E. Sayre, "Viburnum Barks, Microscopical Distinction of the Powders," *A. J. P.*, 29 (May 1896), 225-232.
 (27) R. H. Denniston, "The Comparative Structure of the Barks of Certain American Viburnums," *Pharm Arch.*, 1 (1898), 137-148.
 (28) R. H. Denniston, "Viburnum Ellipticum Hook. Structures of the Bark, etc.," *Pharm. Arch.*, (April 1902), 61-65.
 (29) W. Mitlacher, *Pharm. Post.*, 35 (1902), 773.
 (30) J. U. Lloyd, *Pharm. Rev.*, 23 (1905), 333.
 (31) H. Solereder, "Systematic Anat. of the Dicotyledons," Engl. translation, 1 (1908), 439-444.
 (32) O. A. Farwell, *Merck's Rept.*, 17 (1908), 35.
 (33) O. A. Farwell, *Bull. Pharm.*, 27 (1913), 65.
 (34) Theo. Holm, *Merck's Rept.*, 22 (1913), 35-37.
 (35) A. Viehover, J. F. Clevenger and C. O. Ewing, "Commercial Viburnum Barks and Preparations," *Jour. A. Ph. A.*, 17 (1928), 944-952.
 (36) J. M. Francis, "Viburnum Prunifolium," *Jour. A. Ph. A.*, 9 (1920), 417.
 (37) H. W. Youngken, "Viburnum Cassinoides, a Recent Substitute for Viburnum Prunifolium," *Jour. A. Ph. A.*, 17 (1928), 330-335.
 (38) H. W. Youngken, "Black Chokeberry Bark as a Substitute for Viburnum Cassinoides," *Jour. A. Ph. A.*, 18 (1929), 1225-1228.
 (39) A. L. Gunderson, "Recherches Anatomiques sur les Caprifoliacées," page 21, Paris, 1910.
 (40) L. H. Bailey, "Standard Cyclopedia of Horticulture" (1922), 3459.

Reports on other parts of this investigation are to be published as they are completed by the collaborators, who are James C. Munch and Florin J. Amrhein, with the author of this paper.

MASSACHUSETTS COLLEGE OF
 PHARMACY, BOSTON.

The Canadian Pharmaceutical Journal, of which our esteemed fellow-member, Dr. R. J. B. Stanbury is the editor, gave an interesting account of the Baltimore meeting of the AMERICAN PHARMACEUTICAL ASSOCIATION, devoting quite a large part of the issue to the proceedings. Both Editor Stanbury and President MacFarlane attended. An address by the latter will be found in the May issue of the JOURNAL in the minutes of the General Sessions. (See page 571, May issue of the JOURNAL.)