SCIENTIFIC SECTION

THE PHARMACOGNOSY, CHEMISTRY AND PHARMACOLOGY OF VIBURNUM.*

II. HISTORY, BOTANY AND PHARMACOGNOSY OF VIBURNUM LENTAGO LINNÉ.

BY HEBER W. YOUNGKEN.

The first of the series of articles under the general title was presented by the author before the Scientific Section at its Rapid City meeting in 1929. Since that time he has continued his studies upon Viburnum and in this, the second paper of the series, presents the results of observations made upon *Viburnum Lentago*.

HISTORICAL.

In addition to the references made to this species in the previous article (1), the following may be stated: Linnæus, in his *Species Plantarum* (2) described *Viburnum Lentago* from material evidently collected by Kalm during his travels in Canada, as follows: "*Viburnum foliis serrulatis ovatis acuminatis glabris, petiolis glandulosis.* Habitat in Canada. Kalm. *Folio crasso Tini, glabra, denticulis minimis serrulata; petiolis longitudinaliter glandulosis.*"

It has since been described by many American authors including Gray (3), Sargent (4), Britton and Brown (5), Small (6) and Rehder (7).

In "Gray's New Manual of Botany," 7th edition, revised by Robinson and Fernald, page 760, it is placed in the section *Tinus* (Bork) Koehne, of the genus *Viburnum* which includes those Viburnums having winter buds with opposite scales, pinnately-veined leaves, with veins anastomosing near the margin and blue or black drupes whose stones are flat and even. This work assigns to this plant the synonyms of Sweet Viburnum, Sheepberry, Nannyberry and Wild Raisin and gives its distribution as from Quebec to Manitoba and southward.

Britton (8) gives preference to the synonym of Sweet Viburnum but states that it is also known as Sheepberry, Sweetberry, Nannyberry, Nanny Plum, Nancyberry, Wild Raisin, Blackthorn and Black Haw.

Sargent (4) gives an elaborate taxonomic description of this species and states its distribution to be from the Valley of the Riviere du Loup in the province of Quebec to the Saskatchewan, southward throughout the Northern States and along the Allegheny Mts. to Georgia and westward to So. Indiana, S.W. Missouri and Eastern Nebraska. He gives very brief macroscopic characteristics of its bark and wood.

Solereder (9) states that the phellogen is derived from the epidermis in this species.

Under the title of *Viburnum Prunifolium* or Black Haw, the U. S. P. VIII made official the barks of *V. prunifolium* L. or *V. Lentago* L. These continued to be the official botanical sources of the drug in the U. S. P. IX but the U. S. P. X did not admit the drug and it became official in the National Formulary V (1926). However, in the latter, *V. Lentago* was dropped as a botanical source of the official article, the root bark of *V. prunifolium* only being recognized.

MATERIALS AND METHODS.

The materials for this investigation consisted of stems, roots, stem and root barks, leaf and flowering branches and leaf and fruiting branches collected in the Arnold Arboretum by H. W. Youngken during the late spring, summer and early autumn of 1928, 1929 and 1930 and entire shrubs growing near Framingham, Mass. and collected by H. W. Youngken, May 20, 1929 and September 14 and 16, 1930.

* This investigation was aided by a grant from the AMERICAN PHARMACEUTICAL ASSOCIATION Research Fund. Presented in part to the Scientific Section, A. PH. A., Baltimore meeting.

Herbarium sheets were prepared of each lot and labeled as to location and date of collection.

Root and stem barks were studied on the living plants, then removed, some preserved in absolute and in 50% alcohol, the balance dried partly in the sun and partly by artificial heat and subsequently studied in the laboratory.

Representative portions of leaf and flowering and leaf and fruiting branches were partly preserved in 50% alcohol and partly in absolute alcohol.

The wood of many roots and stems was also studied and additional material

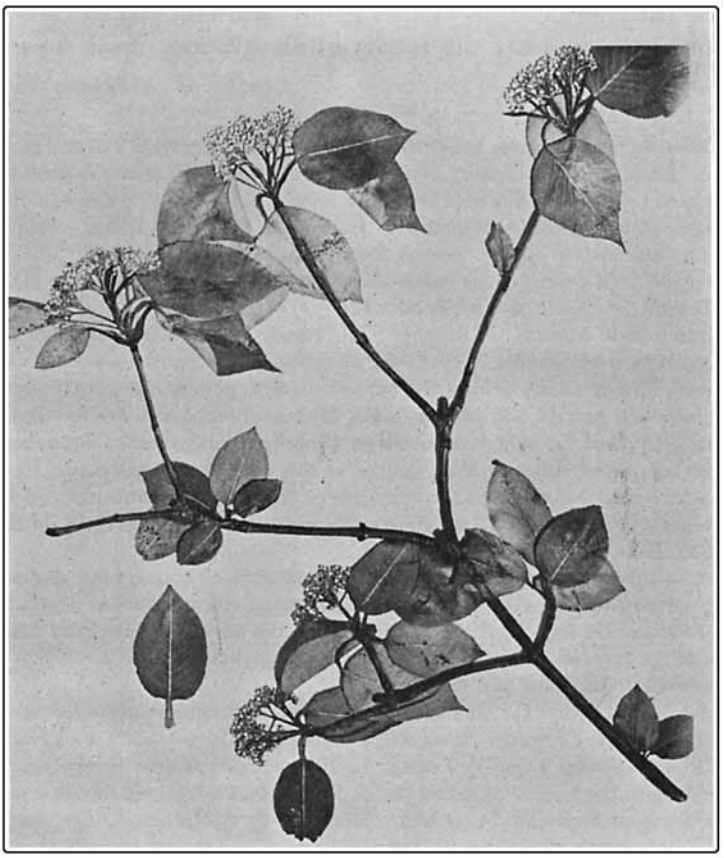

Fig. 1.—*Viburnum Lentago* L. leaf and flowering branch. To left, leaf with winged petiole (× 1/3).

preserved in the dried condition and in strong alcohol, for later chemical and pharmacodynamic studies.

Some of each kind of bark was deprived of all adhering wood and powdered by use of a drug mill previously freed of all adhering matter.

The plants and organs were studied in the field and in the laboratory as to habit and gross morphological features including organoleptic tests.

Microscopical studies were made of transverse, radial-longitudinal and tangential sections. A series of sections were cut through the roots and stems as

well as their bark regions at varying levels, some mounted temporarily in water, in phloroglucin and hydrochloric acid, in 1:100 ferrous sulphate solution, in chloral hydrate solution, in corallin soda and in potassium hydroxide T.S. Others which were stained with safranin and methyl green were permanently mounted in balsam. Others were heated to boiling in chloral hydrate solution and treated with a mixture of equal parts of tincture of alkanna and distilled water.

The inner surfaces of a number of pieces of barks were treated with a 1:1000 freshly prepared solution of ferrous sulphate and the color reactions recorded. Those of other pieces were tested with a 2% solution of ferric chloride and color reactions recorded.

The ground barks were boiled with distilled water, the decoction filtered and the filtrate treated with 2% solution of ferric chloride and the color and precipitate noted.

Another test for tannin was made by treating filtered decoctions of the barks with ammonium molybdate solution and noting the color reaction.

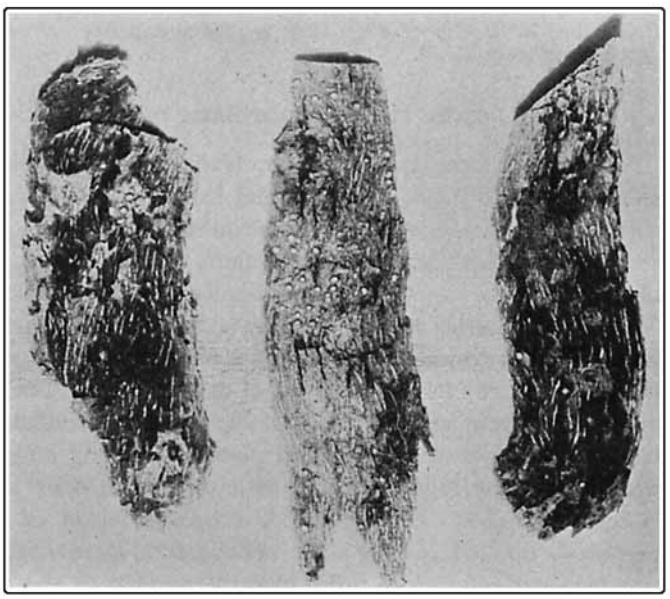

Fig. 2.—Root bark of *Viburnum Lentago* (× 7/10).

Microscopical examination was also made of the powdered barks completely deprived of wood and of scrapings from barks.

The powdered barks were studied in distilled water and in diluted iodine mounts for starch and in boiling distilled water, chloral hydrate solution, and in phloroglucin and hydrochloric acid for other elements. The materials were concentrated for further study of the elements in chloral hydrate solution.

Both root bark and stem bark were triturated in a mortar with syrupy phosphoric acid and the odor noted.

Samples of root and stem barks and also of wood were sent to Dr. J. C. Munch for pharmacodynamic studies and to Prof. F. J. Amrhein collaborating on the chemical studies of this and other Viburnum species.

Specimens of the materials used in this investigation have been permanently deposited in the herbarium of the Massachusetts College of Pharmacy.

DESCRIPTION OF VIBURNUM LENTAGO L.

Viburnum Lentago L. is a shrub or more frequently a bushy, round-topped tree attaining a height of about 30 feet and a trunk diameter of 10 inches with reddish brown bark and smooth,

grayish winter buds, the terminal buds being pointed. The leaves are petiolate, ovate to elliptic with the lamina usually acuminate at apex and broadly cuneate, rounded or sub-cordate at base, with serrulate margin, shining bronze-green when they first appear and covered on both surfaces with a rusty pubescence, becoming green to dark green as they develop and showing at maturity few hairs which are chiefly over the veins.

Of a large number of leaves examined the whole leaf including the petiole ranged up to 13.5 cm. in length and the lamina up to 5.4 cm. in breadth. While many of the petioles are winged and wavy-margined, there is a large number not showing the winged condition. The winged petiole of many of the leaves is an outstanding characteristic of this species.

The flower buds are globular and pale yellowish green, and appear in the axils of the leaves (upper). These burst open from April to June, expanding into short, flattened, scurfy, sessile cymes from 2 to 5 inches in breadth.

The flowers occur on slender pedicels, each being subtended by two short bracteoles. Each is about 1/4 inch across and possesses a green, ovoid calyx tube with 5 acute lobes, 5 epipetalous stamens with slender filaments and yellow anthers and a pistil consisting of a one-loculed, inferior ovary, thick, terminal style and a broad stigma.

The fruit is an edible, blue to black, oval to ellipsoidal, glaucous drupe with a sweet, succulent pericarp and containing a flattened stone within which is an albuminous seed. The fruits ripen in September when they are found dangling on slender, pendulous, red-stemmed stalks of the cyme.

DESCRIPTION OF ROOT BARK OF VIBURNUM LENTAGO L.

The bark occurs in irregular, transversely curved or quilled pieces usually from 1.5 cm. to 9 cm. in length and from 1.5 to 2 mm. in thickness. The outer surface is brown, irregularly longitudinally wrinkled, showing occasionally root scars or attached portions of rootlets. The inner surface is reddish brown to brownish red or whitish, longitudinally striate. The fracture is short and uneven, the fractured surface showing a brown outer bark and whitish middle and inner bark, in which are imbedded a number of pale yellow groups of stone cells that are discernible with the aid of a hand lens. The odor of the fresh bark is distinctly valeric acid-like, that of the dried bark indistinct or faintly valeric acid-like, becoming more pronounced upon moistening and strongly valeric acid-like upon triturating it in a mortar with syrupy phosphoric acid. The taste is very bitter and mildly astringent. A 1:1000 solution of ferrous sulphate (freshly prepared) applied to the inner surface of this bark gives a grayish blue color. A 2 per cent solution of ferric chloride applied to the inner surface of this bark gives a greenish black color.

When 2 Gm. of root bark were boiled with 40 cc. of distilled water and filtered, a nearly colorless filtrate was obtained. When a portion of this filtrate was treated with 4 drops of a 2% solution of ferric chloride, the filtrate was colored green and a greenish black precipitate formed which was collected on the filter paper. The second fraction of the filtrate was treated with 2 drops of a solution of ammonium molybdate when a yellow color resulted. This indicates the presence of a tannin.

HISTOLOGY OF THE ROOT OF VIBURNUM LENTAGO L.

A. Root of Primary Growth.

This growth is shown only for a comparatively short distance above the root cap in this species of *Viburnum*. Transverse sections examined microscopically exhibit the following structures, passing from periphery to the center:

1. Epidermis, a layer of epidermal cells with outer walls suberized and convex. Some of the cells show outgrowths in the form of papillæ and short root hairs.

2. Primary Cortex, 5 to 7 layers of thin-walled, polyhedral to spheroidal parenchyma cells and angular air spaces. Many of the parenchyma cells contain small starch grains and a few contain rosette aggregates of calcium oxalate although some of the sections do not show rosette aggregates of calcium oxalate.

The starch grains were mostly minute, simple and spheroidal and from 1 to 3.4μ in diameter, fewer were simple, spheroidal and subreniform to ovate and up to 10μ in diameter, but occasionally simple ovate or spheroidal grains are found up to 17μ in diameter, and a few 2–3 compound grains also occur.

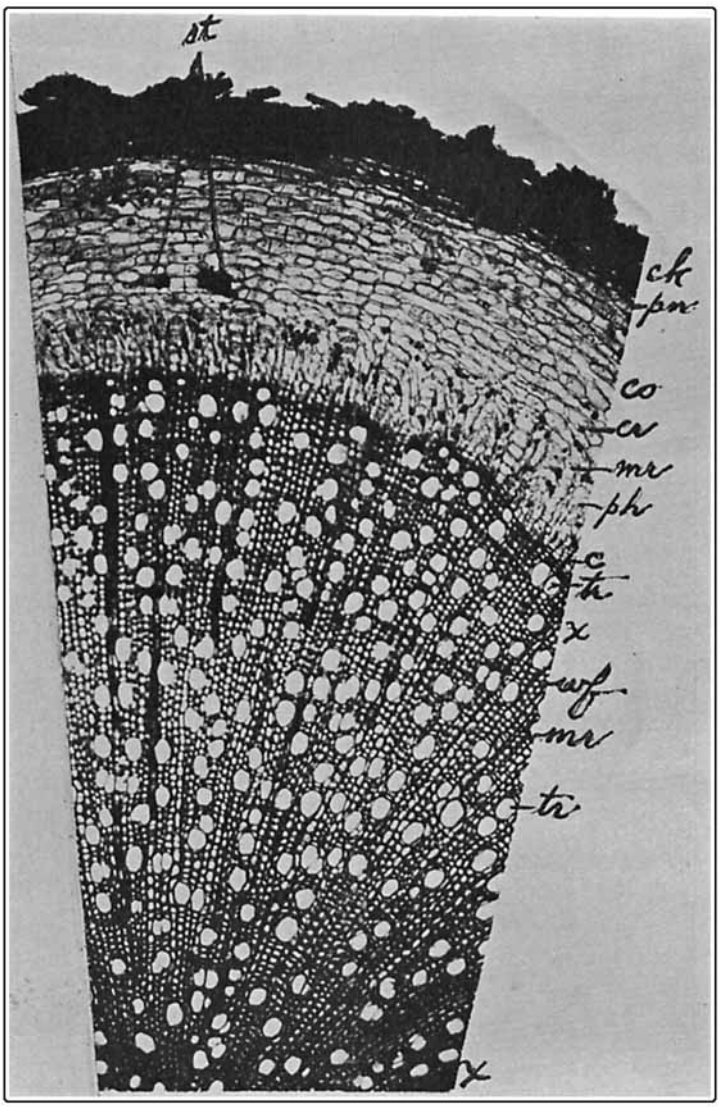

Fig. 3.—Photograph of a representative portion of a transverse section of middle-aged root of secondary growth of *Viburnum Lentago* (× 69). *ck*, cork; *pn*, phellogen; *co*, secondary cortex; *cr*, rosette aggregate crystal of calcium oxalate; *mr*, medullary ray; *ph*, phloem; *c*, cambium; *tr*, trachea in xylem; *x*, xylem; *st*, groups of stone cells.

3. Endodermis, of elliptic shape, consisting of slightly tangentially elongated endodermal cells with clear contents and slightly lenticularly thickened radial walls.

4. *Pericambium*, of a layer of meristematic cells.

5. *A Diarch to Triarch, Radial Vascular Bundle* of two to three xylem and two to three phloem strands.

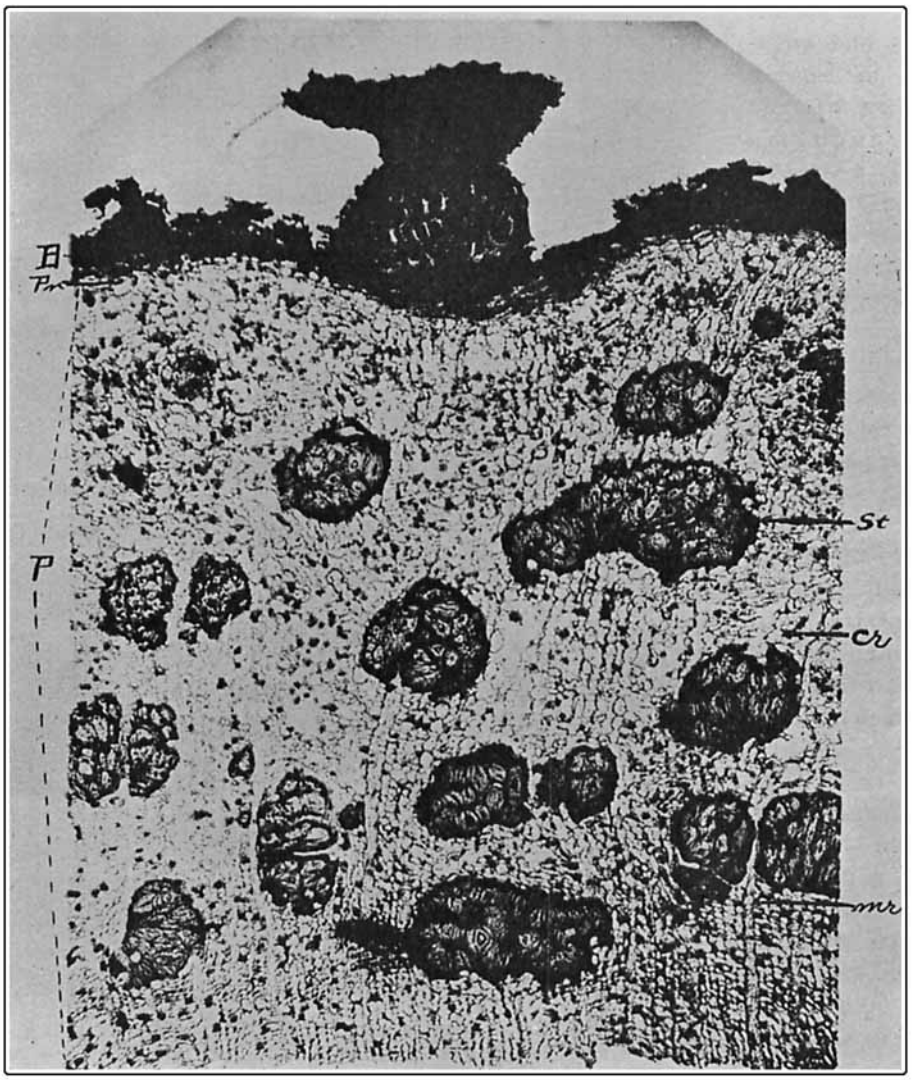

Fig. 4.—Photomicrograph of a representative portion of a transverse section of older root bark of *Viburnum Lentago* (× 46). Note that secondary phellogens have cut off a series of cork layers as far as the outer phloem with resultant exfoliation of outer tissues. *B*, borke with an included group of stone cells, surrounded by dead tissue; P_n, a secondary phellogen; *P*, phloem; *st*, group of stone cells; *mr*, medullary ray; *cr*, rosette aggregate of calcium oxalate.

6. *Pith*, a very narrow central core of few, small parenchyma cells and angular air spaces.

B. Root of Secondary Growth.

Transverse sections through a root of secondary growth in the early fall of its first year averaged 1.47 mm. in diameter. These exhibited shrunken epidermis and primary cortex in the process of peeling off, several layers of cork cells, a phellogen of clear meristematic cells in the process of division, a narrow secondary cortex of 3 or 4 layers of tangentially-elongated to rounded parenchyma cells and a phloem of 5 to 6 layers of cells becoming smaller in the inner region, an undulate cambium, and a porous, radiate wood cylinder 0.7 mm. in diameter.

The maximum thickness of the bark was 420μ. There is no sclerenchyma formed in the bark of this early secondary growth. Numerous rosette aggregates of calcium oxalate occurred in the cortex and phloem.

Transverse sections through the root of secondary growth of the fall of the second year's growth exhibited a broader secondary cortex, phloem and wood zones and measured about 2 mm. in diameter. The wood of this and older roots shows a greatly increased rate of growth over that shown by the cortical and phloem regions. No sclerenchyma was found in the bark of these sections. The thickness of the bark was approximately 570μ.

Transverse sections through a root of 3 years' growth were up to 6.25 mm. in diameter with a maximum bark thickness of 810μ and the wood having a diameter of about 5 mm.

The root of this age exhibits the following structure:

1. *Cork* of several layers of tangentially elongated and flattened cork cells which in cross sections were up to 61.4μ long and 34μ in width. Their walls are suberized.

2. *Phellogen* of tangentially-elongated meristematic cells appearing broader than the cork cells.

3. *Secondary Cortex* of 10 to 12 layers of oval to rounded to tangentially elongated starch- and crystal-parenchyma together with frequent rifts between groups of parenchyma cells. Some of these rifts were nearly filled with rosette aggregates of calcium oxalate.

4. *Phloem,* a broad region separated into numerous phloem patches by medullary rays which run straight or curved and at times are convergent in groups as viewed in cross sections. Many of the phloem cells contain rosette or stellate aggregates and others starch grains. Groups of thick-walled and strongly lignified stone cells and isolated stone cells of a variety of shapes occur in this region and these stone cells have branching pore canals and a narrow lumen.

5. *Cambium,* a wavy ring of more or less collapsed secondary meristem.

6. *Xylem,* a very broad central cylinder separated into numerous wood wedges by somewhat undulate xylem medullary rays. The medullary rays are mostly 1 cell wide in this region although a number of them are 1–2 cells wide and an occasional 1–3-celled medullary ray is discernible in a series of sections.

In cross sections the tracheæ are characteristically polygonal, occur mostly singly surrounded by wood fibres, but there also occur a scattering of groups of two and a few groups of three tracheæ.

In radial longitudinal sections the cork cells are tangentially elongated, frequently up to 70–80μ in length and up to 28.32μ in breadth, occasionally up to

77.88μ x 35.4μ. The cortical parenchyma cells are tangentially elongated, rounded or ovate and numerous rifts occur between groups of these. The phloem in this kind of section shows numerous rows of phloem cells containing rosette aggregates and scattered groups of stone cells with thick walls, the groups being longitudinally elongate. The sieve tubes are numerous and exhibit prominent transverse to oblique sieve plates. Numerous crystal fibres containing rosette aggregates of calcium oxalate occur in the cortex and phloem.

The xylem contains tracheæ which show scalariform, pitted and bordered pore markings. The scalariform type shows oblique septa.

The medullary rays have porous lignified walls in the xylem. They contain either starch grains or calcium oxalate crystals. Numerous tracheids with straightened walls and two to several rows of circular to elliptic bordered pores are present. The wood fibres are lignified, elongated, taper ended and have bordered pits in their walls.

Tangential-longitudinal sections show the medullary rays to be up to 1–3 cells in width, most of them being 1 cell wide, many being from 1–2 cells in width. The cork cells are polygonal. The stone-cell groups appear considerably crenated and are frequently lobed and branched. These ranged up to 1700μ in length—up to 170μ in breadth in roots of this age. In an older root they were up to 2315.90μ in length and up to 433.16μ in breadth. Numerous crystal fibres containing rosette aggregates of calcium oxalate occur in both cortex and phloem.

Scrapings of the bark of this and older roots mounted in water show the starch grains to be simple or 2- to 3-compound. The simple grains are spheroidal, ovate, ovate-truncate to pyriform in outline, many with a distinct, 2–3 cleft hilum which is frequently alate. Most of the larger starch grains were up to 18μ in diameter or length, a few up to 20μ in diameter or length. The hilum in the elongated types is excentric. Numerous rosette aggregate or stellate crystals of calcium oxalate occur in cells of the cortex and phloem and, in addition, an occasional monoclinic prism. The rosette aggregate and stellate crystals were mostly up to 35μ in diameter, a few attaining the diameter of 49.64μ. The monoclinic prisms were up to 42.48μ in diameter.

DESCRIPTION OF THE STEM BARK OF VIBURNUM LENTAGO L.

In transversely curved, irregular or quilled pieces 1.5 cm. to 15 cm. long and usually up to 2.5 mm., more rarely up to 4 mm. in thickness (old bark); outer surface of young bark light reddish brown to dark brown and marked by an occasional dark orange colored, circular (on young bark), lenticular to ovate, raised lenticels, smooth with scattered scurfy areas; outer surface of old bark reddish brown to blackish brown, irregularly fissured and broken into small thick plates which frequently are broken on the surface into thin appressed scales, reddish brown to green where cork is abraded; cork frequently detached and scaly on middle aged and older stems; inner surface pale yellow to greenish yellow to pale yellow marked with irregular blotches of reddish brown to brownish red on old trunk bark; fracture short and irregular, exhibiting a fractured surface with reddish brown to blackish brown cork and greenish yellow to reddish brown middle and inner bark in which pale yellow masses of sclerenchyma are scattered; odor indistinct or faintly aromatic in dried barks, becoming aromatic upon moisten-

ing and mildy valeric acid-like upon triturating with syrupy phosphoric acid; taste bitter and astringent. A 1:1000 freshly prepared solution of ferrous sulphate imparts a grayish blue color when applied to the inner surface. A 2% solution of ferric chloride gives a greenish color when applied to the inner surface. This color changes later to greenish black.

If 1 Gm. of the ground bark is boiled with 20 cc. of distilled water and filtered and 4 drops of a 2% solution of ferric chloride is added to the filtrate, a greenish brown coloration and a greenish black precipitate result.

If 1 Gm. of ground bark is boiled with 20 cc. of distilled water and filtered and to the filtrate 2 drops of ammonium molybdate solution be added, a yellow color develops. These tests indicate the presence of tannin.

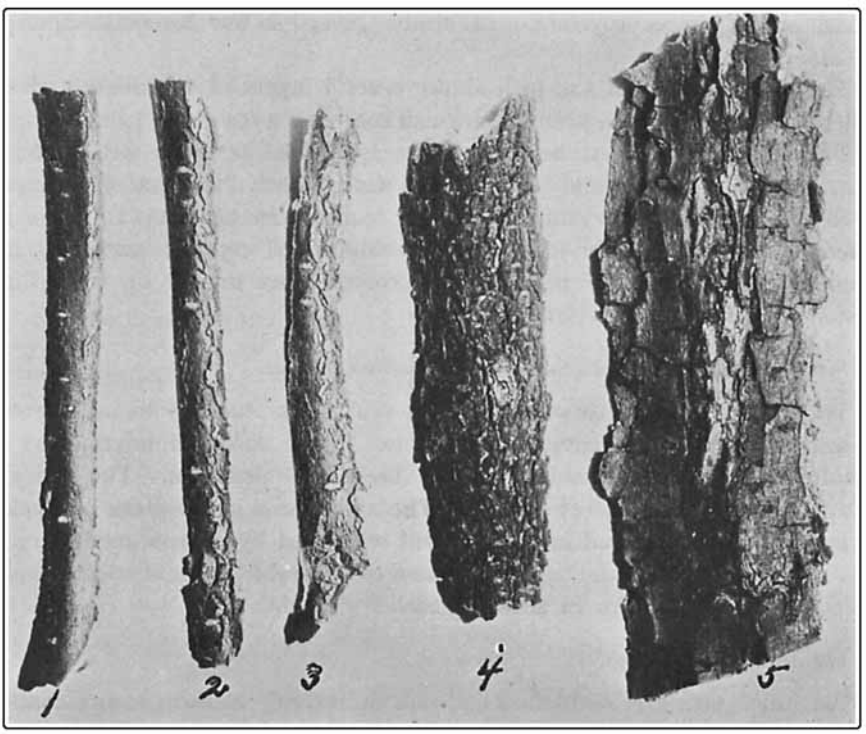

Fig. 5.—Stem bark of *Viburnum Lentago* taken from successive descending levels of the stem. Number 1 about 2 feet from tip. Number 5 from basal portion (nat. size).

HISTOLOGY OF THE STEM OF VIBURNUM LENTAGO L.

A. Just below Terminal Bud.

Transverse sections cut just beneath the terminal bud show an quadrangular to hexagonal outline with rounded angles and exhibit the following internal structure:

1. Epidermus of tangentially-elongated epidermal cells with a well-developed cuticle.

2. Exocortex of about three layers of parenchyma cells with brownish walls, some containing starch, many containing chloroplasts.

3. *Mediocortex* of several layers of collenchyma cells and showing rifts between groups of cells. Some of the rifts are partially filled with rosette aggregate or stellate crystals of calcium oxalate.

4. *Endocortex* and 5, *Pericycle* of parenchymatous cells with starch or crystal contents and also showing rifts containing rosette or stellate crystals of calcium oxalate. An occasional pericyclic fibre has already made its appearance in the pericycle.

6. *Fibrovascular bundles* of the open collateral type arranged in an hexagonal form and separated by narrow medullary rays. There are six larger primary bundles and between these a number of narrower secondary bundles.

7. *Medulla,* a broad central zone of polygonal, pitted parenchyma cells and angular air spaces. Many of the cells contain rosette aggregates of calcium oxalate, others simple to compound starch grains, a few brownish amorphous contents.

The outer margin of the pith shows several layers of conjunctive tissue of smaller cells some of which possess brownish contents, a few rhombohedral crystals.

The starch grains were mostly simple, spheroidal or ovate with a 2-curved hilum. A few 2–3-compound starch grains were observed in some of the sections. The rosette and stellate crystals of calcium oxalate measured up to 35.4μ in diameter. A relatively fewer number of rhombohedral crystals, occurring in the conjunctive tissue, phloem, pericycle and cortex, were mostly up to 17.7μ, but occasionally up to 39μ in length.

B. First Year's Growth, 8 Inches below Terminal Bud.

Transverse sections through the first-year stem made 8 inches below the terminal bud are nearly circular in outline. These show an interrupted circle of small islets of fibres and isolated single fibres in the pericycle. The bark region had a maximum thickness of 416.5μ. The xylem was up to 500μ in thickness. The bundles were arranged in a circle and separated by narrow medullary rays. There were fewer rifts in the bark region and considerably fewer crystals of calcium oxalate were present than in those of earlier growth.

C. Third-Year Stem.

The third year's growth shows phellogen activity in the exocortex and the beginning of formation of strata of cork in this region. The bark region has been augmented but slightly while that of the wood has greatly increased.

D. Fourth-Year Stem.

Cross sections of the stem in the summer of the fourth season of growth show a maximum bark thickness of 583.1μ. The cork has begun to exfoliate and evidences of increased secondary phellogen activity is seen. Small islets of stone cells and isolated stone cells have arisen in the cortex and phloem. A few narrow pericyclic fibres are observed. Large and small rifts are seen in the mediocortex and small rifts in the phloem, some containing rosette aggregates or stellate crystals of calcium oxalate.

The cortex and phloem parenchyma is rich in these types of crystals and a smaller number of rhombohedra of calcium oxalate are also to be observed.

The cortical parenchyma cells have become more tangentially elongated. The medullary rays in the phloem pursue a straight to slightly curved path and are rich in starch content.

The xylem is porous and radiate being divided into a large number of elongated wood wedges by many narrow medullary rays. Each wood wedge shows numerous thick walled, lignified, wood fibres and many tracheæ, the latter mostly arranged singly and in groups of two. The conjunctive tissue around the protoxylem is also lignified.

The pith averaged about 1034μ in diameter and was composed of polygonal pitted parenchyma, some of the cells containing starch, others rosette or stellate crystals of calcium oxalate and a few brownish amorphous contents. The stellate crystals in the sections measured up to 53.1μ in diameter but were mostly under 40μ. The rhombohedra were up to 39μ in length.

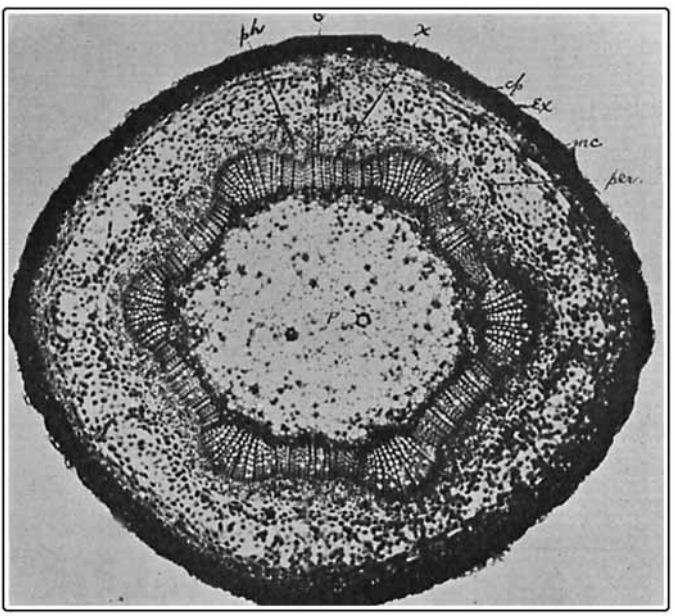

Fig. 6.—Photomicrograph of a transverse section of the stem of *Viburnum Lentago* cut just beneath a terminal bud (× 23). *ep*, epidermis; *ex*, exocortex; *mc*, medicocortex; *per*, pericycle; *ph*, phloem; *c*, cambium; *x*, xylem; *p*, pith.

Longitudinal radial sections showed numerous rosette and stellate crystals of calcium oxalate in the cells of the cortex and pericycle, a few non-lignified pericyclic fibres, longitudinally-elongated groups of stone cells in cortex and phloem, numerous crystal fibres in the phloem, the latter containing rosette and stellate crystals and in some instances a mixture of these types with rhombohedra.

Tangential sections showed the medullary rays to have a range of 1 to 2 cells in width.

HISTOLOGY OF THE STEM BARK OF VIBURNUM LENTAGO L.

A. Young Stem Bark.

The microscopical features of the bark regions of the stem sections described in the foregoing paragraphs are those typical of young *Viburnum Lentago* stem barks as found in commerce in the past. Since the run of commercial bark material usually has pieces with adherent wood present and occasionally segments of the

stems of the plants from which the bark was gathered, the entire stem histology should aid the pharmacognosist in tracing the botanical source of the samples.

B. Old Stem Bark.

The sections studied were those obtained from a piece of bark cut from the

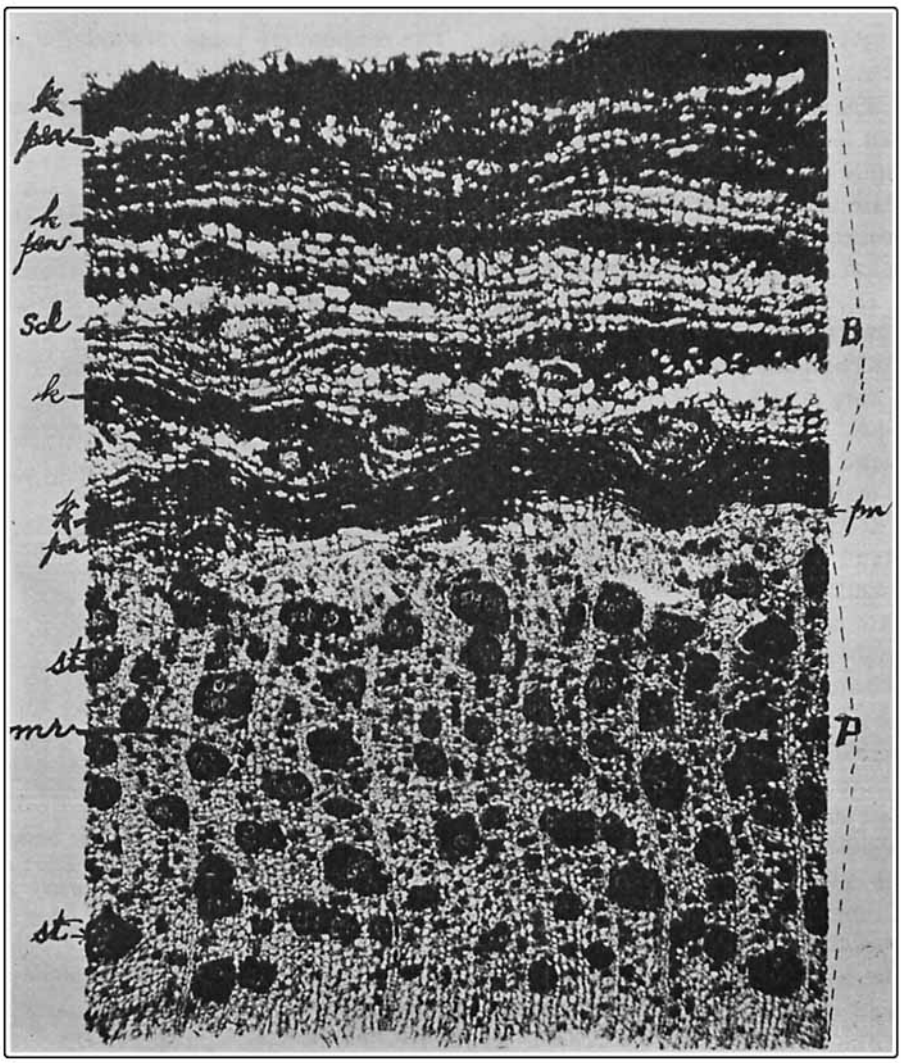

Fig. 7.—Photomicrograph of a representative portion of a transverse section of the old stem bark of *Viburnum Lentago* showing secondary phellogen activity as far as the outer phloem region (×50). *B*, borke; *pn*, a secondary phellogen; *P*, phloem; *K*, *k*, cork; *scl*, group of sclerenchyma fibres in the pericycle; *p*, outer dead phloem; *pn*, a secondary phellogen; *st*, groups of stone cells; *mr*, medullary ray.

base of the old thick stem of a *Viburnum Lentago* tree about 15 feet in height in the Arnold Arboretum. This bark was collected in the summer of 1929. This bark had a thickness of 3 mm. nearly half of which consisted of borke.

In cross sections it exhibited (1) an outer, broad borke region comprising nearly half of the thickness of the section. In this were to be noted a series of secondary phellogens extending as far as into the outer portion of the phloem. Each of these had laid down cork tissue on its outer face.

Passing from the outer surface inward, we note numerous layers of dead fissured cork, black in color and in the process of sloughing off. Next, a series of wavy phellogens extending tangentially across the cortex, pericycle and outer phloem regions. These had cut off reddish brown to black, flattened, irregular shaped cork cells on their outer faces. Between these wavy phellogen and cork strata lay irregular shaped areas of cortex, pericycle and outer phloem regions, all of which showed varying evidences of necrosis. Many of these areas contained groups of stone cells lying amidst crystal and starch parenchyma and in addition the pericyclic areas often showed slightly lignified pericyclic fibres. The inner secondary phellogens lie in the outer phloem region and have cut off larger cork cells with reddish brown walls and protoplasmic contents. Between these areas leptome tissue, some containing islets of stone cells were found.

The cork cells were usually up to 35.4μ in length and up to 17.70μ in width but attained a maximum length of 53.1μ and a width of 33μ.

The stone-cell groups appeared to be more numerous than those of old stem barks of the other Viburnum species studied.

Radial longitudinal sections exhibit numerous crystal fibres in the phloem. These contain rosette and stellate crystals and in some instances rhombohedral crystals of calcium oxalate. The large number of these is very striking. The stone-cell groups are elongated longitudinally and attain a length of 2000μ and a width of 166.6μ. In nearly every group, thick walled, elongate to spindle shaped forms were seen lying amidst shorter, irregularly shaped forms of a large variety of sizes. The cork cells appear very similar to those seen in cross sections.

Tangential-longitudinal sections show the cork cells to be irregularly polygonal to tangentially elongated. The medullary rays appear spindle shaped and 1 cell to 1 to 2 cells in width, their cells being somewhat larger than surrounding parenchyma cells. The stone-cell groups frequently appear branched and show a great variety of marginal indentations and irregularly dentate, crenate, slightly lobed to deeply lobed or knobbed margins. Some of the larger stone-cell groups were up to 2666μ in length and 166.6μ in width.

The individual stone cells varied from isodiametric to circular, ovate, lenticular, conical and oblong. Some had truncate to rounded to knobbed or hooked ends. Their margins varied even at times with the same cell. The various forms of margins noted included the dentate, crenate, undulate and rectilinear types. Their walls were highly lignified and showed numerous branching pore canals.

When sections were gently boiled in chloral hydrate solution, oily globules separated. After draining off the chloral solution and treating the sections with tincture of alkanna diluted with water (equal parts), the oily globules took on a red color.

POWDERED VIBURNUM LENTAGO ROOT BARK.

Grayish brown. Numerous fragments of starch- and crystal-parenchyma with occasional parenchyma cells showing brownish contents; starch grains mostly simple but also 2–5 compound, frequently 3-compound, the simple grains and parts of the compound grains being spher-

oidal, ovate, plano-convex to angularly rounded, from 2 to 24μ in diameter or length with a typically 2-cleft hilum resembling the wings of a bird in flight and showing a distinct polarization cross; numerous fragments of suberous tissue, the cork cells being quadrangular to irregularly polygonal or irregularly brick shaped, their walls being suberized and usually up to 61.4μ occasionally up to 70.8μ in length, their lumina with granular contents; numerous crystals of calcium oxalate of rosette, stellate with pointed rays and rhombohedral shape, frequently up to 35.4μ but occasionally up to 49.46μ (stellate types) or 42.48μ (rhombohedral type); numerous lignified stone cells being of triangular, conical, oblong, circular or fusiform general outline, a number showing varying degrees of crenation, undulation and lobing, their walls being frequently unevenly thickened and lignified and usually up to 43μ in thickness; few sclerenchyma fibres.

POWDERED VIBURNUM LENTAGO STEM BARK.

Grayish brown. Numerous fragments of sclerenchyma fibres or bundles of these, the individual fibres mostly with lignified walls from 3.54μ to 10.62μ thick, the walls being usually of variable width even in the same fibre and often irregularly crenate or dentate on the lumen side, the lumina very irregular and closed in some places in many of the fibres, a number of the fibres showing many transverse septa; numerous stone cells and fragments of groups of these of colorless or pale yellow aspect with walls showing variable degrees of lignification and frequently uneven thickening and with branching pore canals, the individual stone cells of oblong, polygonal, circular, triangular, cuneate, lenticular, ovate or irregular outline with frequently irregularly crenated, toothed or lobed margins; numerous fragments of parenchyma with crystal or starch contents; starch grains considerably fewer than in the root bark collected at the same time from the same plant, simple or 2- to 3-compound, the individual grains spheroidal, ovate, plano-convex to rounded angular in outline, usually about 18μ in diameter or length with a centric (excentric in ovate grains) 2-cleft hilum resembling the wings of a bird in flight and showing a distinct polarization cross under the petrographic microscope; calcium oxalate crystals in rosette aggregates and rhombohedra mostly from 15μ to 35μ in diameter or length; numerous fragments of cork tissue with brownish, polygonal to brick shaped cells with or without adherent parenchyma.

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Reports upon additional chemical studies and upon the pharmacodynamics of this species are to be published as they are completed by the collaborators, who are F. J. Amrhein and J. C. Munch with the author of this paper.

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THE GERMICIDAL POWERS OF CONSTITUENTS OF ESSENTIAL OILS.

In continuation of work carried out in 1928, investigations have been made to determine the Rideal-Walker coefficients of certain pure constituents of essential oils. Soap emulsions were again employed, and the following are the results obtained: Eugenol, 8.6; thymol (nat.), 20; borneol and santalol, less than 0.1; linalol, 5; geraniol, 7.1; menthol (synth.), 0.9; menthol (nat.), 0.4; citronellal, 3.8; cinnamic aldehyde, 3; citral, 5.2; menthone, 2.25; carvone, 1.5; cineole, 2.2; terpineole, 4; anethole, 0.4; and safrol, 0.3.—E. K. Rideal, A. Sciver, N. E. G. Richardson (*Perf. Record*, 21 (1930), 341-344).—*Jour. & Pharm.*, 72 (1931), 283.