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THE SEEDLING OF HAMAMELIS VIRGINIANA L.

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(Plates 206 and 207)

SEEDLINGS of trees and shrubs generally show a very uniform development, and the deviations depend mainly on the cotyledons being epigeic or hypogeic, and on the shape of the primary leaves, which sometimes differ from that of the mature tree or shrub. The internal structure, on the other hand, exhibits frequently several points of interest, and especially with regard to the early appearance of certain structural characters, which become more or less modified in the mature plant. The secondary increase in thickness of the primary root and the stem, including the hypocotyl, naturally involves several changes in the structure, beside that the tissues of the leaf are frequently subject to modification, when being exposed to change of environment, shade and light especially.

Seedlings of *Hamamelideae* are not mentioned by Lubbock;[1] he figures and describes *Bucklandia propulnea* R. Br., but this genus is a member of *Liquidambareae* according to Baillon. In *Hamamelis Virginiana* the first leaf of the seedling (FIG. 2) is large for the size of the plant, subcordate, acuminate, and distinctly crenate; the second leaf (FIG. 3) is much smaller, ovate and short-pointed; in the ultimate leaves (FIG. 1) the crenation is less pronounced, the base is oblique, and the apex varies from short-pointed to almost obtuse. The average size of the ultimate leaves aggregates about 9 cm. in length, and 6 cm. in width, but occasionally the inflorescences may be subtended by leaves measuring up to 13½ cm. in length, and 10 cm. in width. The

[1] Lubbock, John. A Contribution to our Knowledge of Seedlings. Vol. 1, London, 1892, p. 521.

vernation is not "involute" as stated by Sargent (Silva, V: 1893), but "plicate." When comparing the internal structure of the seedling, during the first season, with that of the mature tree (or tall shrub), the development of the various tissues may be described as follows.

The Root-system

In the primary root of the young seedling at the stage figured (fig. 2), collected early in May, increase in thickness has already taken place, but only within the stele; the peripheral tissues from the epidermis to endodermis incl. are still intact. The epidermis is very small-celled, destitute of hairs, and the cell-walls are of a deep brown color; there is a thin-walled exodermis, well marked by the lumen being somewhat wider than that of the adjoining cortex. The cortical parenchyma consists of eight compact strata of roundish cells with no contents of starch or crystals; the endodermis is well preserved, thin-walled and relatively large-celled, but contains no starch. At the expense of most of the pericambium the stele presents a dense mass of leptome and hadrome in deep rays with several strata of typical libriform, enclosing a narrow, slightly thick-walled pith. In the capillary, lateral roots of the same specimen the stele shows the original structure, which is diarch; the cortex presents a narrower zone, but otherwise the structure is as described above.

At the close of the first season the primary root has grown to a considerable length, and increased in thickness. The peripheral tissues from epidermis to endodermis, inclusive, have been replaced by many strata of homogeneous, thin-walled cork of the usual structure, and by a secondary thick-walled cortical parenchyma of only two layers, containing large deposits of starch, both tissues having originated from the pericambial meristem. The stele shows the same structure as described above, but the libriform is more thick-walled.

If we compare now the older roots of mature specimens, of the flowering shrub, for instance, we notice a somewhat modified structure. The cork and the secondary cortex represent broader zones, the latter containing starch in abundance, beside large, single rhombic crystals of calcium-oxalate. Moreover, we notice a number of isolated stereids and sclereids scattered throughout this parenchyma, beside some more definite strands of stereome outside the leptome. With regard to the medullary rays these contain large, single crystals and starch. The libriform shows a somewhat peculiar structure, the cells having an inner, quite thick, gelatinous layer, more or less separated from the lignified part of the cell-wall, thus representing the so-called "Gallert-schicht," described by De Bary;[1] it is a structure of somewhat irregular occurrence, being not exhibited by all the libriform-cells in many plants. As a matter of fact, De Bary calls attention to the occurrence of such cells together with normal libriform in the same annual ring of the trunk of certain trees, and a like variation exists also in roots. For in our *Hamamelis* we found such cells quite frequent in the innermost strata of the hadrome in the root, intermixed with normal libriform. Characteristic of the root structure is thus the early increase within the stele of the primary root of the seedling, while the peripheral tissues are still intact, succeeded during the first autumn by the replacement of these tissues by cork and a secondary cortical parenchyma. In roots of the mature tree stereids and sclereids appear in the secondary cortex, and part of the libriform shows the peculiar, gelatinous, inner layer, recorded by De Bary from the trunks of certain trees.

The Stem

The hypocotyl of the young seedling is tall, cylindric, perfectly glabrous, but not smooth, the cuticle forming numerous, longitudinal ridges from base to apex. The epidermis is thick-walled (the outer wall), and a thin-walled cork of three strata has developed from hypodermal callenchyma (FIG. 4); the cork-cells show the general form, being stretched tangentially. The cortex is heterogeneous, consisting of two to three strata of collenchyma and of about six compact layers of thin-walled parenchyma, of which the three peripheral strata are rich in chlorophyll. There is a distinct, thin-walled endodermis, containing starch; the pericycle is composed of isolated strands of stereome in two to three layers interspersed with thin-walled parenchyma. The stele represents a compact cylinder of leptome, cambium and deep rays of hadrome with narrow, medullary rays (1–2 rows), and some libriform, slightly thick-walled. The pith is thin-walled, solid, rich in starch.

The epicotyl, the only internode of the young seedling, is obtusely triangular, and hairy with stellate hairs; the cuticle and the epidermis show the same structure as in the hypocotyl, but no cork is developed; the cortex is heterogeneous as described above, but several of the cells

[1] De Bary, A. Vergleichende Anatomie der Vegetations-organe der Phanerogamen und Farne. Leipzig, 1877, p. 497.

contain a brown substance, and large aggregated crystals of calcium-oxalate. The endodermis, pericycle and stele show the same structure as described above, but the outline of the stele is triangular, the three primordial mestome-strands being much thicker than the interfascicular.

At the close of the first season several (4–5) internodes have been developed, and in these the epidermis has become somewhat compressed, covering a broad zone of thin-walled cork, the cells of which are stretched radially as shown in FIGURE 6. The cortex consists of collenchyma and thick-walled parenchyma, both containing crystals, single in the former, but single and aggregated in the latter, besides deposits of starch. No endodermis could be distinguished, but a closed pericycle of stereome in about three layers. The stele shows the same structure as in the young seedling, but the libriform and the pith are thick-walled; the latter contains starch.

In passing to describe the structure of the branches of the mature shrub or tree, the long, slender internodes of a branch, about nine months old, show the epidermis still preserved, thick-walled and small-celled, covering four thin-walled layers of cork with the cells radially stretched (FIG. 6). The cortex is of five hypodermal strata of collenchyma surrounding three strata of moderately thickened parenchyma, of which several cells contain a brown, amorphous substance; while only single crystals were observed in the collenchyma, both single and aggregated were found in the parenchyma. No endodermis could be distinguished, but an almost continuous pericycle of three to four strata of stereome intermixed with sclereids; the stereids showed the inner cell-wall beginning to become gelatinous. Corresponding with the circular outline of the branch (in cross-section) the stele is almost round, but shows the three primary mestome-strands very plainly. The mestome is very compact, and libriform is especially well represented in the interfascicular tissue. A large, small-celled and thick-walled endoxyle covers the inner face of the three primary mestome-strands. With regard to the leptome this contains much thin-walled parenchyma forming rays between the strands of sieve-tubes, frequently containing a brown substance, but neither starch nor crystals; the hadrome contains much libriform, beginning to show the gelatinous structure of the inner cell-wall; the vessels are relatively narrow, polyedric rather than circular in cross-sections, and the medullary rays are of only one to two rows. The pith is thick-walled, and contains starch besides a brown substance, but no crystals. Viewed in longitudinal sections the cork-cells are high, but very narrow; the sclereids form long rows between the stereids, and the crystals are contained in cells, forming continuous rows, generally close to the stereome; the libriform shows bordered pits very distinctly.

This structure recurs in the older branches with the exception, that a secondary cortical parenchyma has developed on the inner face of the pericycle, and contains single crystals of calcium-oxalate. Moreover the pith shows the cells very thick-walled, porous, and stretched radially, containing several aggregated crystals, but no starch.

The three-flowered peduncle is at the time of the flowering densely hairy with numerous stellate hairs, and the cross-section is circular with a circular stele. The cortical parenchyma is homogeneous, collenchymatic, and of 12–14 layers, containing both types of crystals. The endodermis is fairly distinct, but destitute of starch, and no pericycle is developed.

Among the structures characteristic of the stem, when examined from the seedling stage to the mature tree, the following may be mentioned. The cuticle forming longitudinal ridges on the hypocotyl and the epicotyl; the absence of hairs from the hypocotyl; the development of stellate hairs on the epicotyl and subsequent internodes; the development of cork beginning in the young hypocotyl; the cortex being heterogeneous, *i. e.* collenchymatic and parenchymatic in the hypocotyl and in all the suceeding internodes, except in the floral peduncle, where the cortex is collenchymatic all through; endodermis being distinct in the hypocotyl, epicotyl and in the floral peduncle, but absent from the other internodes; the pericycle being purely stereomatic in the seedling, but interspersed with sclereids in the young branches of the tree, and absent from the floral peduncle; the stereids and the libriform showing a gelatinous, inner wall in the branches of the tree; a well-developed endoxyle in the young branches of the tree; the cells of the pith being very thick-walled and stretched radially (in cross-sections) in old branches. The distribution of crystals of calcium-oxalate is very unequal: *viz.*, none in the hypocotyl; aggregated in the cortex and pith of the epicotyl; single crystals in the cortex of the apical internodes of the seedling during the autumn; single and aggregated in the lower internodes during autumn; aggregated and single in the primary parenchymatic cortex of young branches of the tree; single in the collenchymatic; aggregated in the pith and primary cortex of old branches of the tree; single in the secondary cortex of all branches; single and aggregated in the collenchymatic cortex of the floral peduncle.

The Leaves

The relatively large, epigeric cotyledons (fig. 2) have short petioles, which, at the characteristic point, *i. e.* just beneath the leaf-blade, are triangular in cross-section, and destitute of hairs. The cuticle is wrinkled on both faces, and the outer wall of epidermis is slightly thickened. The cortex consists of 15–20 strata of roundish cells rich in chlorophyll, and several cells contain a brown substance, but no crystals were observed; the hypodermal stratum of cortex is slightly collenchymatic on the dorsal face. The three mestome-strands are collateral and situated in a single band close to each other; a starch-bearing endodermis covers the leptome-side, and inside the endodermis are three arches of thin-walled stereome corresponding with the leptome. The blade of the cotyledon is also glabrous, and covered by a thin, smooth cuticle; the epidermis is thin-walled in the lateral parts of the blade, but slightly thick-walled (the outer cell-wall) above and beneath the midrib. Viewed in superficial sections the lateral cell-walls of epidermis are undulate on both faces of the blade, especially on the dorsal face; the stomata are confined to the dorsal face, with generally one rectangular subsidiary cell and four ordinary epidermis-cells. A few strata of collenchyma, hypodermal, are located beneath the midrib, passing into a small water-storage tissue of two to three strata. The chlorenchyma consists of one ventral stratum of very short and plump palisade-cells, some of which show the peculiar funnel-like shape, which recurs, but much more frequently, in the first green leaf succeeding the cotyledons; this stratum contains much more chlorophyll than the adjoining pneumatic tissue, which consists of about eight layers of oblong to roundish cells with wide intercellular spaces; the palisade-tissue passes uninterruptedly across the midrib. The midrib contains a single, arch-shaped, collateral mestome-strand, of which the leptome is supported by an arch of thin-walled stereome; no crystals of calcium-oxalate were observed in the cotyledon.

The primary leaf of the young seedling (fig. 2) has a short petiole, which is hemicylindric in cross-sections, the ventral face flat; it is hairy on both faces with stellate hairs. The cuticle is thin, nearly smooth, and the epidermis is slightly thick-walled. The cortex consists of five to six strata of thin-walled, roundish cells with chlorophyll, but no collenchyma was observed. The mestome-strands form a stele, almost circular in cross-section, and surrounded by a continuous sheath of stereome in three to four layers; a relatively broad, thin-walled pith occupies the center of the stele, containing a little starch, but no crystals. The leaf-blade of the primary leaf of same seedling shows a typical dorsiventral structure as to stomata and chlorenchyma. The cuticle is thin, smooth; the stomata are confined to the dorsal face; they are slightly raised, and have a wide air-chamber; they show three distinct structures: they are surrounded by five cells of which two are rectangular and parallel with the stoma, the others being ordinary epidermal cells with undulate lateral walls; or only one cell is rectangular, the other four being larger and with the lateral walls undulate; or there are only four cells, of which the two are much smaller than the others, but of irregular shape, and with the walls undulate. Viewed in superficial sections the lateral walls of epidermis are prominently undulate on both faces of the blade; in cross-section epidermis is thin-walled on both faces, with about the same lumen; stellate, and simple, unbranched hairs are frequent on both faces of the blade, the simple being unicellular, very long, and sharply pointed. There is one layer of palisade-tissue (FIG. 5), which is very open, and the cells are very short and much broader under the epidermis than where they touch the pneumatic tissue; the pneumatic tissue is of three to four layers of oblong to roundish cells with wide intercellular spaces; the chlorenchyma, especially the palisade-tissue, is rich in chlorophyll. The structure of this palisade-tissue is very different from the typical, because the cells are mostly of a funnel-like shape, as shown in the figure (FIG. 5). In describing the system of assimilation Haberlandt[1] calls special attention to this structure, the funnel-shaped cells, but according to this author, it is generally in the pneumatic tissue that this cell-form is represented in order to connect with a larger or smaller fascicle of true palisade cells so as to conduct the assimilated substances to the parenchyma sheaths of the mestome-strands. By Haberlandt these funnel-shaped cells are therefore called "Sammel- oder absorption-zellen," *i. e.* receiving cells; he cites several plants showing this structure of the uppermost stratum of the pneumatic tissue, for instance some ferns, but also several

[1] Haberlandt, G. Physiologische Pflanzenanatomie. Leipzig, 1896, p. 246 seq.

Dicotyledons: *Ficus, Juglans, Pulmonaria, Eranthis,* etc. But with regard to the typical palisade cells being replaced by funnel-shaped as in our *Hamamelis* (fig. 5) Haberlandt attributes this structure to sciaphilous plants especially, where the great width of the cells, directly beneath the ventral epidermis, favors an increased assimilation in the diffuse light of the shady environment. Several instances of this particular structure have been described and partly figured in our paper dealing with: Sciaphilous plant-types,[1] among these: *Orchis rotundifolia* Pursh, *Aster divaricatus* L., *Aristolochia Serpentaria* L., *Lepidagathis alopecuroides* R. Br., *Spiraea Aruncus* L., *Amphicarpaea monoica* (L.) Ell., *Stellaria pubera* Michx., etc. The very open structure of the pneumatic tissue in *Hamamelis* recurs in several sciaphilous plants, and by containing chlorophyll, even to a limited extent, it thus performs two functions: aerating and assimilating.

There is another peculiar structure to be observed in the chlorenchyma, namely the development of long, thick-walled sclereids (fig. 7), which, however, are more frequent in the leaves of the mature tree. Haberlandt (l. c. p. 141) describes the sclerenchyma and the various types of sclereids (a term proposed by Tschirch) which have been observed; he distinguishes between "brachy-, macro-, osteo- and astro-sclereids" in accordance with their shape. Of these forms the more or less isodiametric sclereids, the brachy-sclereids, are the most common, known especially from the pericycle of the stem of many herbaceous and woody plants, from the fruits of *Pomaceae,* and from the tuberous roots of *Dahlia, Paeonia* etc.; by Solereder[2] they are called "stone-cells." The sclereids in our *Hamamelis* represent the type "macro-sclereids," and are known from the leaves of many plants, more seldom from the stems (cortex and pith). Solereder calls this type "Spicular-zellen" (l. c. p. 919), and he enumerates the families in which they have been observed. The function of the sclereids is, according to Haberlandt, of a local, mechanical nature. This term proposed by Tschirch is more natural than that of some other authors, who under the category "idioblasts" include stone-cells, crystal-cells, oil-cells, resin-cells, etc., for instance Sachs,[3] Strassburger,[4] and others.

[1] Beihefte Bot. Centralbl. Vol. 44. Dresden, 1927.

[2] Solereder, Hans. Systematische Anatomie der Dicotyledonen. Stuttgart, 1899, p. 966.

[3] Sachs, Julius. Lehrbuch der Botanik, 4th ed. Leipzig, 1874, p. 85.

[4] Strassburger, E. Lehrbuch der Botanik. Jena, 1894, p. 71. (Strassburger, Noll, Schenck and Schimper).

The midrib forms an obtuse keel on the lower face of the leaf-blade, and contains a thin-walled water-storage-tissue of two to five strata, surrounding the single, arch-shaped mestome-strand. No endodermis was observed, but the leptome and the hadrome have a support of several layers of stereome forming two separate arches; the hadrome contains no libriform. A few single crystals were observed in the dorsal part of the water-storage-tissue. The lateral, thin veins are surrounded by green parenchyma-sheaths, inside of which some few stereids may be noticed on the leptome-side. The cells of the parenchyma-sheath border on the palisade- and the pneumatic-tissue.

The leaf of the full grown tree or large shrub shows the same structure of the the cuticle, epidermis and stomata as the primary leaf of the seedling; stellate hairs of two types, *viz.* four-armed with very thin cross-walls, and ten-armed, which are a little shorter and more thick-walled than the four-armed, and lack the cross-walls; of these types the former is the most frequent on the dorsal face, while the ten-armed occur on both faces of the blade. The chlorenchyma is developed as a typical palisade tissue of one layer (*P* in FIG. 7) of high cells rich in chlorophyll, and covering a relatively compact pneumatic tissue of about four to five strata with only a little chlorophyll; large macro-sclereids (FIG. 7) are frequent, extending from the ventral epidermis to the dorsal, and, sometimes, breaking through this; some few single crystals were observed in the palisade-tissue. The midrib (FIG. 8) forms a large, obtuse keel on the dorsal face of the leaf-blade, containing three strata of hypodermal collenchyma around the keel, and on the narrow, upper face, the chlorenchyma does not extend across the midrib, being interrupted by a large water-storage-tissue, surrounding a large stele, circular in cross-section, and an arch-shaped, collateral mestome-strand above this, and close to the ventral epidermis. A closed sheath of stereome in five to six layers surrounds the stele and the single mestome-strand; the leptome of the latter shows the normal, dorsal position; the center of the stele is occupied by a broad pith, containing many single, but only a few aggregated crystals of calcium-oxalate; similar crystals were also observed in the water-storage-tissue, besides macro-sclereids. This singular structure of the midrib recurs in the lateral veins, the secondaries, with the exception that there is a small opening on the ventral face of the stele, and that the ventral, arch-shaped mestome-strand above is wanting. In following the structure of the midrib towards the apex of the leaf-blade, the composition is very different, there being only an arch of mestome, surrounded by a large, thin-walled parenchyma, and a completely closed sheath of stereome; a narrow arch of pith is located between the hadrome and the ventral portion of the stereome.

The petiole of the mature leaf is almost cylindric, and very hairy near the base of the blade. The cuticle is smooth, and the epidermis is of small, thick-walled cells. Three to five hypodermal strata of collenchyma surround a thin-walled cortex of about eight layers, very compact, and containing chlorophyll and crystals, single as well as aggregated, the former being most abundant near the stereomatic pericycle, which surrounds a central stele, corresponding exactly with that of the midrib of the leaf-blade.

When comparing the structure of the cotyledons, the primary leaf of the seedling, and the leaf of the mature tree, we observe the following points of interest. The petiole of the cotyledon contains three collateral mestome-strands, located in one band, while a typical stele occurs in the petiole of the primary leaf and of the leaf of the tree. The chlorenchyma consists of one layer of short palisade cells with several funnel-shaped, and of eight strata of open, pneumatic tissue in the cotyledon; of one layer of short, funnel-shaped cells covering a pneumatic tissue of three to four layers with wide intercellular spaces in the primary leaf; and of one layer of typical, compact palisades covering a pneumatic tissue of four to five compact strata in the leaf of the tree. Macro-sclereids were observed in the chlorenchyma of the primary leaf and of the leaf of the tree, but not in the cotyledons. The midrib of the cotyledon consists of one arch-shaped, collateral mestome-strand with a dorsal water-storage-tissue; that of the primary leaf shows the same structure, while in the leaf of the tree the midrib represents a stele, circular in cross-section, with a ventral, collateral mestome-strand, and with a large, dorsal water-storage-tissue. The crystals of calcium-oxalate are distributed as follows. Aggregated as well as single, rhombic were found in the cortex of the petiole of the leaf of the tree; only single crystals were observed in the chlorenchyma of the leaf of the tree, and in the water-storage-tissue of the midrib in the primary leaf; many single and a few aggregated crystals were observed in the pith of the stele in the leaf of the tree, and in the dorsal water-storage-tissue of same. No crystals were found in the cotyledons, nor in the petiole of the primary leaf.

We have thus in the seedling of *Hamamelis Virginiana* an illustration of the early appearance of some of the more important structures, noticeable in the root, stem and foliage. We have seen the development of cork and a secondary cortex in the root at the close of the first season, while stereids and brachy-sclereids do not appear in the secondary cortex before the roots are several years old. The development of stellate hairs begins on the epicotyl, while the cork, and the differentiation of the cortex into collenchyma and ordinary parenchyma already begins in the hypocotyl. The pericycle being purely stereomatic in the seedling, but interspersed with brachy-sclereids in the branches of the tree. The appearance of aggregated crystals in the epicotyl, and of single in the apical internodes of the seedling. With regard to the foliage we have seen that the cotyledons and the primary leaf lack a typical palisade-tissue, while such is well represented by the leaves of the tree; moreover the appearance of macrosclereids in the chlorenchyma of the primary leaf, recurring more frequently in the foliage of the tree; the singular structure of the midrib of the leaf of the tree representing a stele, while that of the cotyledons and the primary leaf contains only a single, arch-shaped mestome-strand; finally the occurrence of single crystals in the water-storage-tissue of the primary leaf, but of both single and aggregated in the various tissues of the leaves of the tree.

If we compare the structure of *Hamamelis* with that of *Liquidambar*, the total absence of secretory ducts from the former, and their presence in the latter constitutes an anatomical character of importance, and more so than the development of sclereids in the leaves of *Hamamelis*. It was principally upon the basis of the system of secretory ducts in *Liquidambar* and *Altingia* that Van Tieghem[1] segregated these genera from *Hamamelideae* (*Hamamelis*, *Rhodoleia*) as a small, very distinct group of very doubtful affinity; for even if the structure of the stem and leaf resembles that of *Dipterocarpeae* and *Simarubeae*, the root-structure does not agree with these. When combining these anatomical characteristics with the floral structure as represented by *Liquidambar* on the one side, and by *Hamamelis* on the other the segregation appears a very natural one. But considered by itself alone the anatomical structure, in this case the presence of ducts, would hardly be sufficient for warranting such segregation, because the development of secretory cells as well as secretory ducts may characterize all the members of certain families, or only

[1] Van Tieghem, Ph. Second mémoire sur les canaux sécréteurs des plantes. Ann. d. sc. nat. Bot. Série 7, Vol. 1. Paris, 1885, p. 86.

some of the genera or species. For instance, in the *Compositae* endodermal ducts occur in many of the *Tubuliflorae*, in several of the *Labiatiflorae*, but only in a few *Cichoriaceae;* in the *Cornaceae* ducts are only known from *Mastixia*, in the *Caesalpinieae* from *Eperna* and *Copaifera*, etc.

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Explanation of Plates 206 and 207.

(All the figures are of *Hamamelis Virginiana* L.)

Plate 206. Fig. 1, leaf of the tree; two-thirds of the natural size. Fig. 2, the seedling; natural size. Fig. 3, second proper leaf of a seedling; natural size. Fig. 4, cross-section of the hypocotyl of a seedling; Ep = epidermis, Co = cork, Coll. = collenchyma; × 480. Fig. 5, cross-section of the primary leaf of a seedling; Ep. = ventral, Ep* = dorsal epidermis, P = ventral chlorenchyma, P* = pneumatic tissue; × 480.

Plate 207. Fig. 6, cross-section of a branch in its first year, letters as in fig. 4; × 480. Fig. 7, cross-section of a leaf of the tree, showing a macrosclereid; letters as in fig. 5; × 480. Fig. 8, cross-section of the midrib of a leaf of the tree, Ep = ventral, Ep* = dorsal epidermis. The large, obtuse keel contains a stele of mestome surrounded by a sheath of stereome, bordering on the leptome, and outside this is a large-celled water-storage-tissue, surrounded by strata of peripheral collenchyma. Above the stele, close to the ventral epidermis, is a small, collateral mestome-strand; × 60.

PECULIAR ASPECTS OF THE NEW ENGLAND DISTRIBUTION OF ARCEUTHOBIUM PUSILLUM

R. J. Eaton

There is a diminutive roadside bog in Concord, Massachusetts, where Thoreau first discovered *Ledum groenlandicum* Oeder seventy-five years ago. Typical associates are also present, such as *Picea mariana* (Mill.) BSP., *Andromeda glaucophylla* Link, *Kalmia polifolia* Wang. and the like.

During a brief stop at this place last summer, Ludlow Griscom called my attention to the diseased appearance of one of the half dozen young specimens of *Picea mariana* which have survived sundry wood cutting and draining operations. On close examination, the disease proved to be a heavy infection of *Arceuthobium pusillum* Peck. Strangely enough we could find no infection on any other spruce despite the fact that the branches of the nearest neighbor were actually interlocked with those of the diseased tree. Thus does the survival of the dwarf mistletoe in this bog, to say nothing of the entire Concord region, hang by a very slender thread!