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Notes upon Uvularia, Oakesia, Diclytra and Krigia.

By Theodor Holm.

(Plates CXI–CXIII).

Uvularia perfoliata and Oakesia sessilifolia.—These two species have been hitherto united in the genus *Uvularia* of Linné, but have recently been separated by S. Watson,* on account of differences in the leaves, whether they are "perfoliate or sessile," the position of the flowers, whether they are "terminal or not," and the structure of the capsule, whether it is "three-lobed or three-winged." There are, however, other characters taken from the rhizome, which are not less important, although they may not even in connection with the above mentioned characters, be sufficient to distinguish them as representing two genera. The descriptions in systematic works of the rhizome of these two plants are generally defective.

A. Michaux † says of the genus *Uvularia* "Radix fibrosa, aphylla," but does not supply any special characters for the rhizomes of the different species. Barton ‡ describes *U. perfoliata*, as having "root white, palmate divisions cylindrical, garnished with a few yellowish-white radicles," while he in the second volume of the same work mentions the rhizome of *U. sessilifolia* "Root perennial, fleshy, whitish, resembling the root of *U. perfoliata.*" He gives a very good illustration of the species *perfoliata* and figures the anterior part of the rootstock, but without

* Proceedings American Acad. Vol. XIV.

† Flora Boreali-Americana, Vol. I, 1803, p. 199.

‡ Flora of North America, Vol. I and II, 1822.

showing stolons. John Torrey * describes *U. perfoliata* as having "root a tuft of fleshy fibres," and Kunth† says merely "Rhizoma repens" as a character for the whole genus, and we find the same in Darlington's‡ and Chapman's Manuals§. A more complete description has been given, however, in the sixth edition of Gray's Manual, where *Uvularia* has been characterized as having a "short rootstock with fleshy roots," while "a slender, creeping rootstock" has been attributed to the genus *Oakesia*.

But the fact that *Uvularia* possesses long, subterranean stolons, seems certainly hitherto to have been overlooked.

In *Uvularia perfoliata*, the main rhizome of the full-grown and flowering plant is hardly one line long, and is entirely concealed by the roots. These are whitish, fleshy and cylindrical, thickest at their upper extremity and then taper gradually towards the end; their length is from two to three inches on full-grown specimens, and they are but sparingly branched. Besides this part, the main rhizome, there are regularly two stolons to be observed, one on each side of the base of the flowering stem. Plate CXI, Fig. 1 illustrates the rhizome of an old plant, and we see here the two stolons each with its prophyllum at the very base. This prophyllum is about three lines long, triangular, but sheathing for half of its length. The stolons are covered with long, scale-like leaves, more than an inch in length, which form closed sheaths around the internodes. The apex of these leaves is free, triangular and a little curved. The stolons do not run in a straight line under the surface of the ground, but are slightly bent at each internode. The end of the stolons may strike root and the bud will then develop a new plant, while the other part is entirely destitute of roots and fades away early in the spring. At that time the young plant has been provided sufficiently with roots, similar to those described above, and does not need any longer to be in connection with the old individual from which it has been formed.

Oakesia sessilifolia. The rhizome of this plant is entirely different from that of the preceding. It is relatively long, about six

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* Flora of New York, Vol. II, 1843.

† Enumeratio Plantarum, Vol. IV, 1843, p. 200.

‡ Flora Cestrica, 1853, p. 328.

§ Flora of the Southern United States, 1883, p. 486.

inches or even more, and it shows a few stretched internodes. Plate CXI, Fig. 4 illustrates a rhizome of the full grown plant, and we see here that the roots have almost the same size and shape as those of *Uvularia*, but show, however, several ramifications. The leaves of the rhizome are scale-like and clasping, although not sheathing, and the internodes are cylindrical, almost straight. The anterior part of the rhizome carries two scale-like leaves, surrounding the flowering stem, at the base of which two branches are to be observed. The one (Br. 1) is long and has been formed this summer. It consists already of two internodes, and one root has been developed, similar to those of the older part of the rhizome. Another branch (Br. 2) has also been formed, but does not show yet more than one internode, and no roots have been developed. They are both secondary branches, and the main rhizome being a monopodium from its first development until terminated by the flowering stem, has now been changed to a sympodium, while the branches themselves will show a monopodial ramification, until again terminated by flowering stems. These branches of the rhizome will not be developed as stolons, even if it might look so, when we consider the whole rhizome; they show the same form and structure as the main rhizome and will not be separated from this, like the stolons of *Uvularia*.

These two plants are therefore easily distinguished simply by their rhizomes, and we shall see farther that their internal structure also may furnish several good characters. We will then compare the structure of some of the corresponding organs and commence for instance with the roots. As mentioned above these are thick and fleshy in both plants, due to a considerable deposit of starch in the bark. The cells of the epidermis (Plate CXII, Fig. 12) are thin-walled in both species, and the bark, which occupies the greater part of the root, consists of relatively large, cylindrical cells, entirely filled with starch. In regard to these two tissues, the epidermis and the bark, our plants do not show any difference, but if we consider the innermost part of the root, we will see a somewhat different structure. The cells of the endodermis show very thin walls in *Oakesia* (Fig. 8) where also the spots called after Caspary are very distinct in contrast to *Uvularia* (Fig. 7) where the endodermis is thickened. The size of the cells of the

pericambium is also different; it is largest in *Uvularia*. Inside the pericambium we see the fibro-vascular bundles in a number of about twenty in *Oakesia*, but only about ten in *Uvularia*. The groups of phloëm are relatively larger in *Uvularia* and the xylem shows a stronger development in regard to thickness than in *Oakesia*. As regards the stem overground, we shall also here be able to find a few characters. It is solid in *Oakesia*, but hollow in *Uvularia*. The cells of epidermis do not show any difference; their exterior walls are rather thick in both, with a distinct cuticle. A quite strong sheath of mechanical tissue forms a ring around the fibro-vascular bundles, separated from the epidermis in *Oakesia* by only one stratum of bark-cells, while in *Uvularia* there are two distinct strata between the epidermis and the mechanical tissue. This last consists of about five layers in *Oakesia* and but two in *Uvularia*.

On turning to the structure of the leaves, the epidermis shows the following differences: The cells are relatively much larger in *Uvularia* on both faces, and if we consider simply the inferior face, where the stomata are present, the walls of the cells show a more distinct undulation in *Uvularia* than in *Oakesia*. The superior face is perfectly destitute of stomata in both plants. A transverse section of the leaves shows also that the cells surrounding the stomata are much broader in *Uvularia* (Plate CXI, Fig. 5). But otherwise in regard to the interior structure of the leaf, there was not to be observed any essential difference. Figs. 9 and 10, Plate CXII, illustrate a transverse section of the midrib, and we see here in both plants that the cells of the epidermis show rather thick walls with a distinct cuticle, and we find inside an almost collenchymatous tissue of about two strata (Fig. 11). The fibro-vascular bundles are relatively larger in *Oakesia*, and are not surrounded by any mechanical tissue neither in this nor in *Uvularia*.

The anatomical characters of these two plants are then:

THE ROOT.

The cell walls of endodermis are thickened in *Uvularia*.
The cell walls of endodermis are thin in *Oakesia*.
About ten fibro-vascular bundles in *Uvularia*.
About twenty fibro-vascular bundles in *Oakesia*.

The Stem.

Hollow in *Uvularia.*

Solid in *Oakesia.*

There are two strata of bark-cells between epidermis and the mechanical tissue in *Uvularia.*

Only one stratum in *Oakesia.*

The mechanical tissue consists of about two strata in *Uvularia.*

The mechanical tissue consists of five strata in *Oakesia.*

These two species show then quite a considerable difference in regard to their vegetative propagation and tendency to spread. The one, *Uvularia*, has a very short subterranean stem, but long stolons, which are soon able to develop new plants, therefore it occurs always abundantly where it grows. The other one, *Oakesia*, has a long, creeping rhizome without any formation of stolons; this manner of propagation is evidently not as important as the first one, where stolons were present. There is at least not to be observed so large a number of plants growing together as is the case of *Uvularia.*

Diclytra Cucullaria. "A cluster of grain-like tubers, crowded together in the form of a scaly bulb," is the only description which has been attributed to the rhizome of this plant in the sixth edition of Gray's Manual of Botany. It is rather astonishing that nothing more has been remarked upon this subject, the structure of these so-called "tubers" of a plant so common and well-known, as it is among the earliest-blooming of our flora. It does often happen, however, that these common species escape the attention of the botanists, thus they become at once well-known and not known at all; it seems at least to be the case with this plant. We shall see later that our plant does not possess any tubers at all, and that the rhizome shows a very interesting structure; in spite of that the author has been unable to trace the development of it from the very earliest stage of the germination. If we dig up the plant in the early spring, for instance in the month of March, when it is just commencing to bloom, we then see a rhizome, consisting of a number of light rose-colored tuber-like bodies, covered with dark crimson spots and clustered together so as to form a scaly bulb. We shall see farther that the size of these tuber-like bodies is different, there being always a few

which are much larger than the others, but there does not seem to be any regularity in regard to their position on the rhizome, only that there are often two or three of these larger ones situated closely together. We see farther that the vegetative and floral shoots at their base are surrounded by some scale-like, membranaceous leaves. By separating the "tubers" from the rhizome (Plate CXIII, Fig. 14) it is plainly seen to consist of a number of very short branches, some of which are terminated by an inflorescence or carry a few, (two or three,) normal leaves besides the scale-like ones. The roots are scarce, slender and proportionally weak. Now, in regard to the mentioned tuber-like bodies, these, the smaller ones, are almost conical, slightly flattened at their ventral face and shortly pointed, in contrast to the larger, which are distinctly triangular in outline with obtuse edges and show a scar at their apex, which proves that they have carried something. Still there is nothing yet to explain their origin, before we have removed the scale-like leaves. Inside these we shall find, (Plate CXIII, Fig. 15) in their axils, several clusters of minute "tubers," very much like those observed before, but these show at their summit a rudimentary toothed blade, and are nothing but leaves (Plate CXIII, Figs. 16–17) situated on a short axis. At the same time, during the removing of the scale-like leaves the base of the normal ones becomes free and shows nearly the same form as the larger tuber-like bodies, only with the exception that they are in connection with the long petiole and the large, finely divided blade. The large "tubers" represent then merely the base of now partly faded normal leaves.

There is, however, a shorter way to find out the origin of these tuber-like organs, if we will contemplate the plant at an earlier stage. Numerous minute, one-leafed specimens are always occurring around the mature plants, and these, illustrated in Figs. 18–20, are undoubtedly developed from the above mentioned smaller tuber-like leaves, which, as will be shown later, commonly support a very minute bud (Plate CXIII, Fig. 23). It was my first thought that they were developed from seeds and in a secondary stage, probably one year old, but it seems to be the only correct explanation to offer, that they were developed from the small tuber-like leaves. It is also to be pointed out that these drop easily

away from the main rhizome, enclosing at their base an axillary bud. Another reason is, that not a single germinating plantlet was to be found in spite of very careful search at different seasons of the year, and when I later collected the fruiting specimens, no seed was contained in the fruits. Plate CXIII, Fig. 18 shows then a young plant, consisting of an almost globular, tuber-like body, with the characteristic scar at its apex, and supporting a short axis, carrying a large scale-like leaf, inside of which a normal one has been developed. One short root is coming out below the scale-like leaf, while two are to be observed at the base of the older normal one. The number of scale-like leaves seems to vary; we see in Fig. 19 a specimen of the same age, where three are present. And if we will now examine the base of the young normal leaves, as well of the scale-like ones, we shall again find small clusters of tuber-shaped leaves with rudimentary toothed blades (Plate CXIII, Fig. 17). A few weeks later we will see that the young specimens have continued their growth so as to throw off the scale-like leaves, while the base of the normal leaf shows a considerable swelling, forming a tuber-like body, but with the other parts of the leaf still persisting (Fig. 20). Later in the summer, for instance in the month of August, the mature plant has dropped the inflorescences and the normal leaves, the rhizome being the only surviving part. It shows now the same aspect as that figured in Fig. 14, but with the exception that distinct, whitish buds are to be observed among the fleshy, tuber-like leaves. Plate CXIII, Fig. 22 shows a bud surrounded by several of these, of which three have been figured, the others having been removed, but of which the scars show their position upon exceedingly short branches. The bud itself carries four scale-like membranaceous leaves, inside of which there will be developed the following year some normal leaves and probably an inflorescence. And at the same time we will observe that the tuber-like leaves show a minute but distinct cavity at the base which contains a bud (Plate CXIII, Figs. 23 and 24) able to develop an independent plant as soon as it, together with the tuber-like leaf, has dropped from the rhizome.

The true origin of the "tuber-like organs" has then been proved to be rudimentary leaves or the swollen bases of the normal ones.

Our plant shows then a very peculiar structure of rhizome, it being short, densely covered with tuber-like leaves, supporting and partly enclosing axillary buds, able to produce new individuals, and these are therefore very important in the propagation of the species. Three different kinds of leaves are present—tuber-like, scale-like and normal ones. The function of these thickened leaf-bases is undoubtedly the same as the fleshy scales of the monocotyledonous "leek" of *Lilium* for instance, containing large deposits of starch, besides that they by dropping from the rhizome are able to raise new individuals. In regard to the germination, this does not seem to be known, and it would be highly desirable to obtain some seeds so as to study the very first stage of this interesting species. If we might conclude something from the mature plant and reduce the figure of this to the germinating plantlet itself, might we then not suggest a germination with but one cotyledon, like in some species of the closely allied genus *Corydalis*, and that the base of this leaf-like cotyledon would show the same swollen form as that of a normal leaf, and partly enclosing the plumule?

Krigia Dandelion. There are a few interesting circumstances to be observed in the rhizome of this species, which do not seem to have been perfectly known before, and it may not, therefore, be superfluous to describe them a little more concisely. At least in the sixth edition of Gray's Manual of Botany the specific diagnosis does not give any clear explanation of the rhizome, but indicates merely the roots as being "slender and tuberiferous." "Tuberous" roots occur frequently in several families, but "tuberiferous" i. e. by tubers giving rise to new individuals, can not exist, if we will take the expression "tuber" in its proper sense. Roots, forming true bulbs, are on the contrary known and have been mentioned by Warming* as occurring in *Scilla Hughii.* It gave me, however, the impulse to examine the case myself, and the following note is the result of my examination. Several specimens were collected in the vicinity of Washington, where it grows abundantly in shady woods, and all my specimens showed the presence of several true tubers. These tubers, as it will

* Eug. Warming: Smaa biologiske og morphologiske Bidrag. Botanisk Tidsskrift, Vol. II, Series III, 1877–'79, pag. 61.

be shown, do not belong, however, to the roots, but to subterranean stems. Plate CXIII, Fig. 25 shows then the complete rhizome and the leaves of a mature specimen; we see here that the plant has been developed from a large tuber, and that three stolons proceed from the leaf-bearing axis, all of which terminate in tubers.* The tuber has then been formed by the end of a stolon, a manner of propagation which is not uncommon, as for instance in *Cyperus esculentus* and others. The stolons are rather thin, with long internodes, of which the leaves are scale-like and pointed. The direction of the stolons is almost horizontal, and they do not run very deeply under the surface of the ground. The tubers themselves consist simply of but two internodes, the leaves of which are a little larger than those of the stolons, but show, however, the same form. In regard to the shape of the tubers, these are almost globular at a younger stage, but later they are of a nearly oblong shape with the apex acute, formed by a few pointed scale-like leaves. Now, when the tuber is going to germinate, the stolon dies away, and one or two relatively long internodes will be developed from the apex of the tuber, terminated by the flowering scape with a rosette of normal leaves. This is to be seen in Fig. 25, where the plant distinctly shows its offspring from a large tuber, and we see also one long vertical internode between the leafy rosette and the tuber itself. All the roots are confined to this internode, and it looks, certainly, as if it were a tuberiferous root. The stolons do not, however, always terminate in a tuber; in a case figured in Fig. 26, a small leafy rosette has been developed immediately at the end of a stolon, without being preceded by a tuber, and in this same specimen the stolon had been developed in the axil of a scale-like leaf, situated on the underground stem, formed by the large tuber. The plant propagates then easily by tubers and, as mentioned above, all the specimens collected showed only this kind of offspring. There is, however, no doubt that it is able to propagate by seeds also, but the germination has not yet been examined, and might probably show something interesting in regard to the primary root and the first beginning of the formation of stolons.

[*There was a tuber represented in Mr. Holm's drawing on the stolon shown to the left of the figure, but it was accidentally omitted in the engraving.—Ed.]

As regards the interior structure of our plant, it is to be remarked that no mechanical tissue was observable, neither in the stolons, the rosette-bearing stem, nor, of course, in the tubers. The tuber contained inulin, forming great sphæro-crystals after being preserved in alcohol, and these occurred principally in the bark. A pith was found in the young tubers, which were perfectly solid, while the older ones were hollow on account of the partial disappearance of the pith. Cork was rather strongly developed in the older tubers, but otherwise there was nothing remarkable to be observed in the interior structure.

Explanation of Plates.

Plate CXI.

Fig. 1. The rhizome of *Uvularia perfoliata*, seen from before, showing the base of the two stolons, S, and four roots, natural size.

Fig. 2. A later stage of the same, showing the bud, B, which in the following year will develop a flowering stem. 3 × natural size.

Fig. 3. The end of one of the stolons of *Uvularia* with the beginning development of a root by R.

Fig. 4. The rhizome of *Oakesia sessilifolia*, seen from above. Br.[1] and Br.[2] are branches. St., the base of the flowering stem from this year, surrounded by two scale-like leaves. R., the roots, two-thirds natural size.

Fig. 5. Transverse section of the inferior face of the leaf of *Uvularia*. Ep., epidermis with a stoma. $\frac{I}{VI}$

Plate CXII.

Fig. 6. Transverse section of the inferior face of the leaf of *Oakesia*. Ep., epidermis with a stoma. $\frac{I}{VI}$

Fig. 7. Transverse section of the interior part of the root of *Uvularia*. B., the bark. End., the endodermis. Pr., the pericambium. Ph., the phloëm. X., the xylem. $\frac{I}{V}$

Fig. 8. Transverse section of the interior part of the root of *Oakesia*. The letters as above. $\frac{I}{V}$

Fig. 9. Transverse section of the median fibro-vascular bundle in the leaf of *Uvularia*. M., mesophyll. Ph., phloëm. X., xylem. $\frac{I}{V}$

Fig. 10. Transverse section of the median fibro-vascular bundle in the leaf of *Oakesia*. The letters as above. $\frac{I}{V}$

Fig. 11. Epidermis and the collenchymatous tissue of the median part of the inferior face of the leaf of *Oakesia*. $\frac{I}{VI}$

Fig. 12. Epidermis of the root of *Uvularia*, transverse section. $\frac{I}{V}$

Fig. 13. Epidermis of the rhizome of *Oakesia*, transverse section, showing the wrinkled cuticule. $\frac{I}{VI}$

$\frac{I}{VI}$ indicates Ocular I, Objective VI.

Plate CXIII.

Fig. 14. The rhizome with the leaves and an inflorescence of *Diclytra Cucullaria* Natural size.

Fig. 15. Part of the same, showing the petioles of two normal leaves (L), and the base of the inflorescence, (I). The scale-like leaves have been removed, and in their axils are clusters of small tuber-shaped leaves to be seen.

Fig. 16. One of these clusters from the axil of a scale-like leaf.

Fig. 17. A tuber-shaped leaf, showing the small rudimentary toothed blade.

Fig. 18. A small specimen, developed from a tuber-shaped leaf, showing the tuberous base of a leaf, of which the petiole has faded, and a short axis, carrying a root, one scale-like and one normal leaf. 3 × natural size.

Fig. 19. A similar plant with three scale-like leaves, surrounding the normal one. 3 × natural size.

Fig. 20. A similar plant, of which the scale-like leaves have dropped, and where the base of the normal leaf shows the tuberous swelling. 3 × natural size.

Fig 21. The base of a normal leaf, in the axil of which clusters of small tuber-like leaves are to be seen.

Fig. 22. Part of the rhizome of a specimen collected in August, showing a bud surrounded by tuber-like leaves.

Fig. 23. One of these tuber-like leaves at the same time, showing the cavity at the base, in which a bud is to be seen.

Fig. 24. The axillary bud, taken out from the cavity, showing two very young leaves.

Fig. 25. A mature specimen of *Krigia Dandelion*, showing the leafy rosette and the rhizome, natural size.

Fig. 26. The rhizome of another specimen, where a stolon has developed a leafy rosette, not being preceded by any tuber, as in Fig. 25. Natural Size.

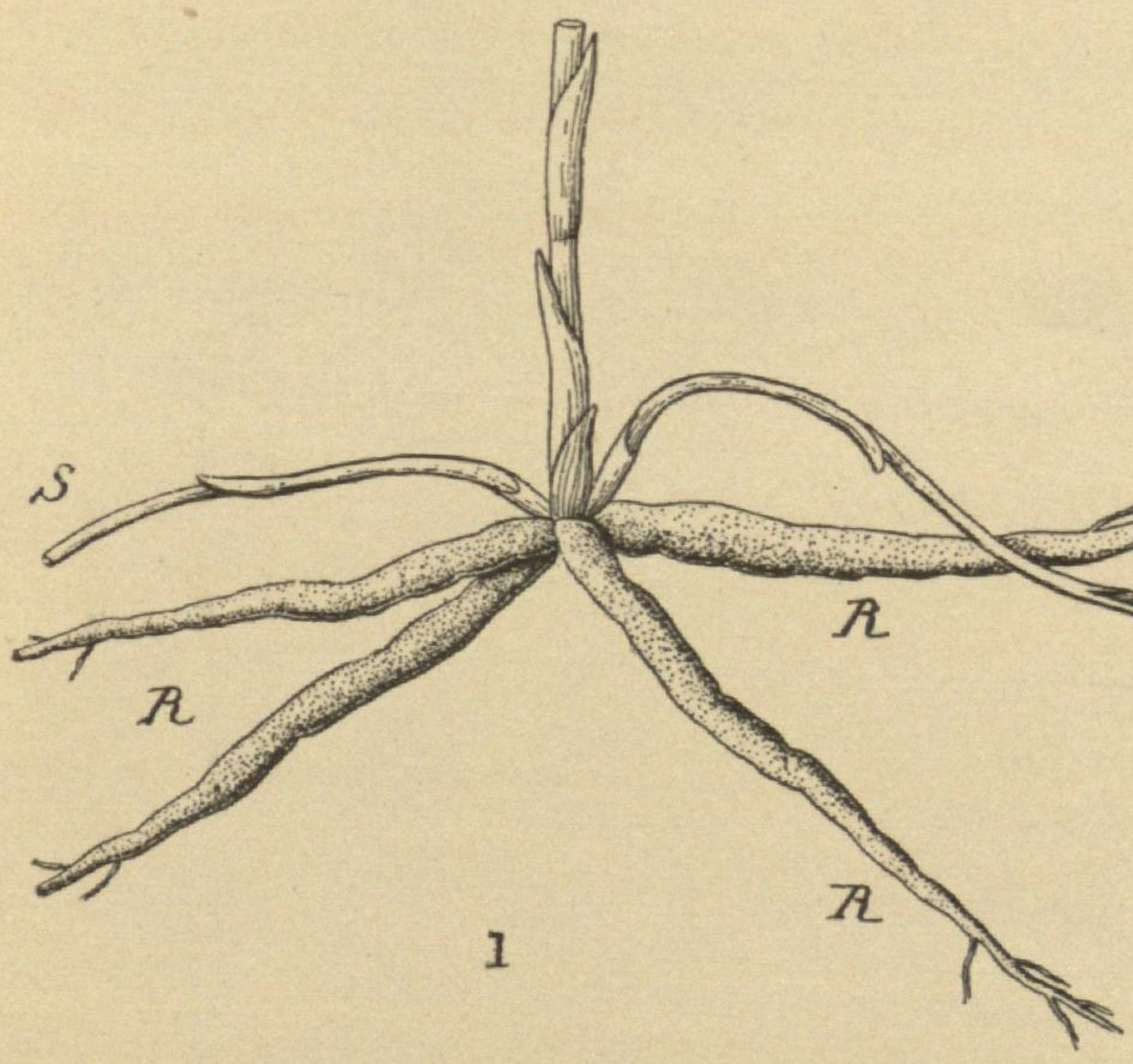
U. S. National Museum, Washington, D. C. Aug. 1890.

Recent Contributions to the Literature of the Diatomaceæ.

La Structure de la Valve des Diatomees. Dr. Henri Van Heurck. (Annales de la Societé Belge de Microscopie. xiii. 1890).

By the aid of Zeiss's new apochromatic one-tenth inch objective of 1.63 N. A., using monochromatic sunlight, compensating eye-piece and condenser 1.6 N. A., Dr. Van Heurck has produced a series of photographs which go far towards clearing up our ideas of the structure of the diatom valve. From his researches he derives the following conclusions:

1. Diatom valves consist of two membranes or thin films, and of an intermediate layer, the latter being pierced with openings. The outer membrane is very delicate. It is supposed that these membranes are sufficiently permeable to allow circulation by endosmose, though they have no real openings during the life of the diatom.



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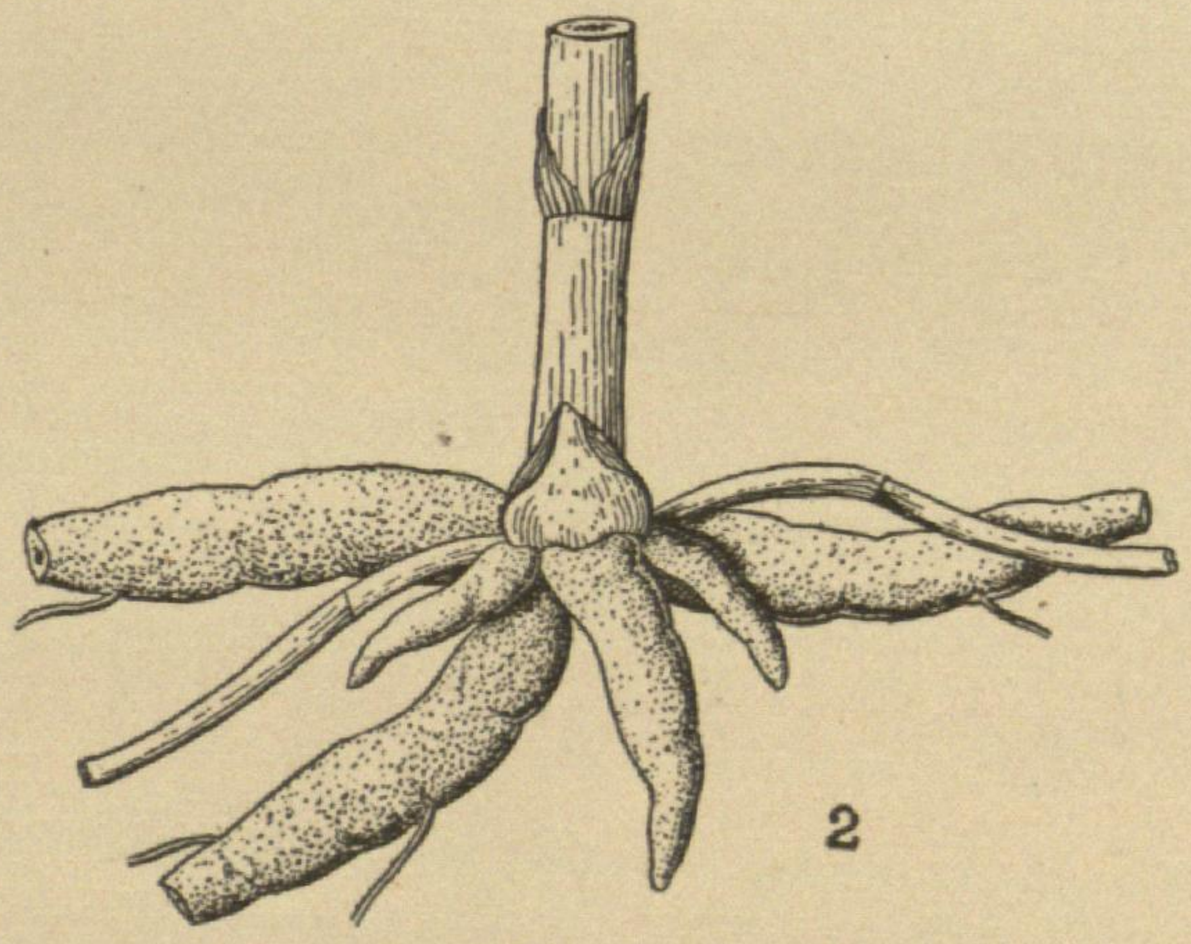

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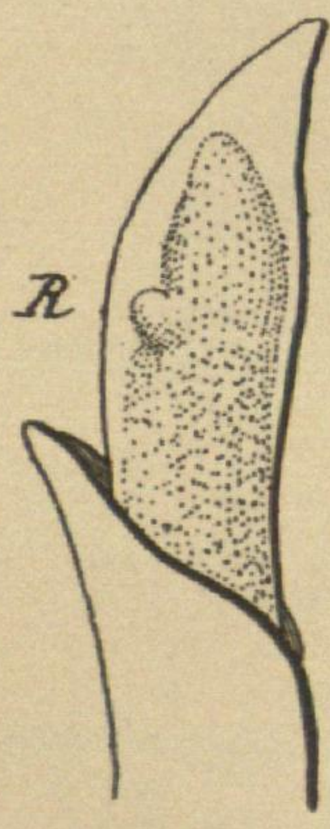

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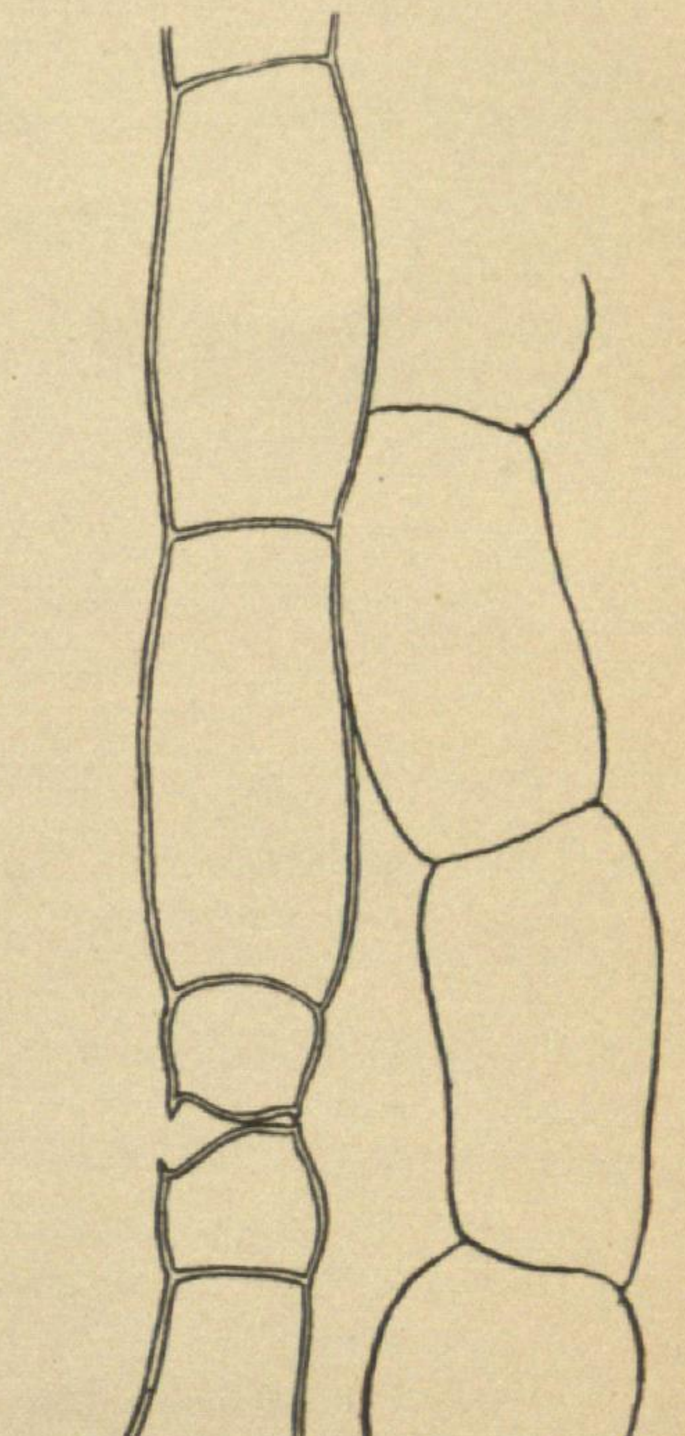

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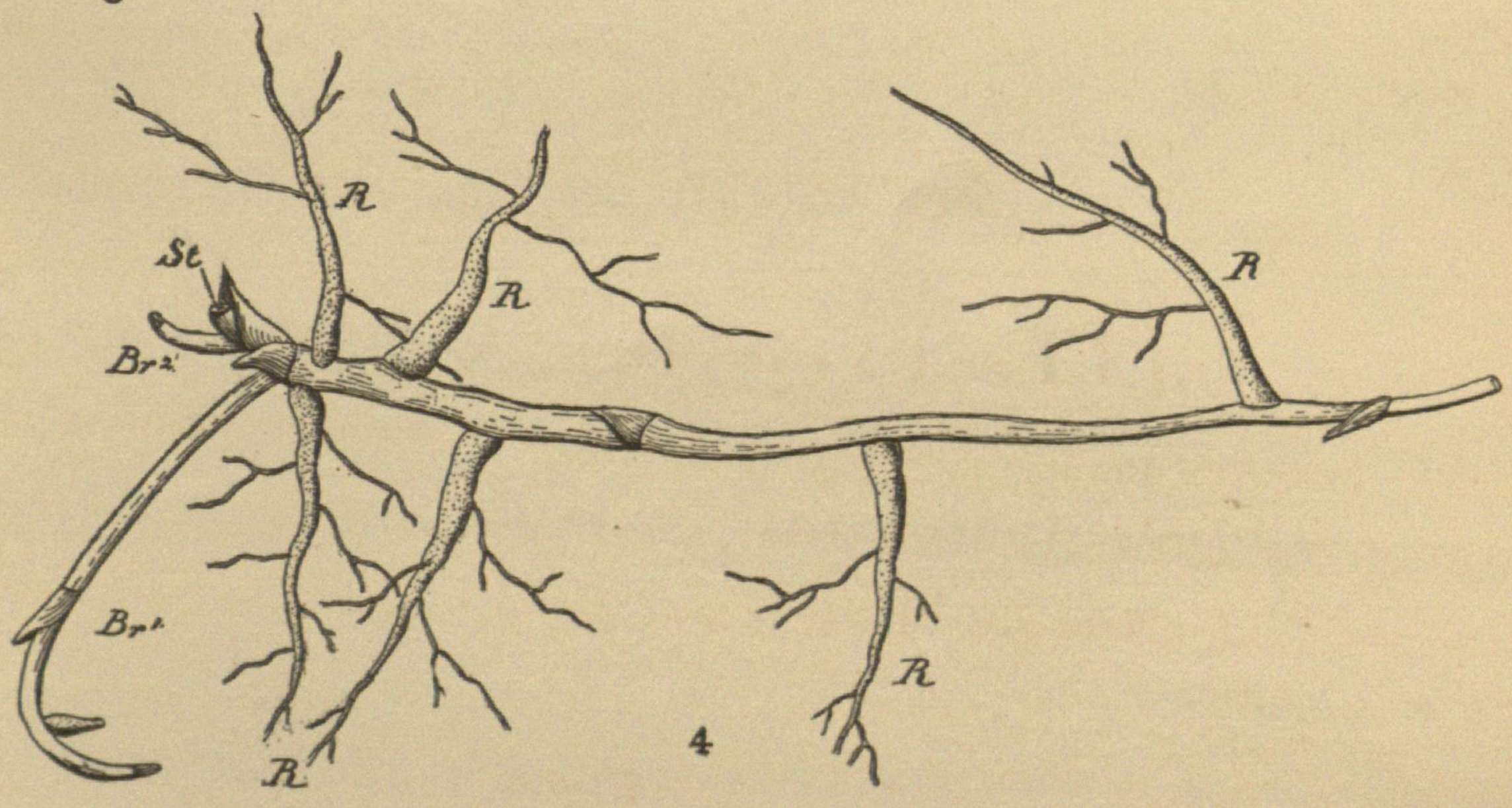

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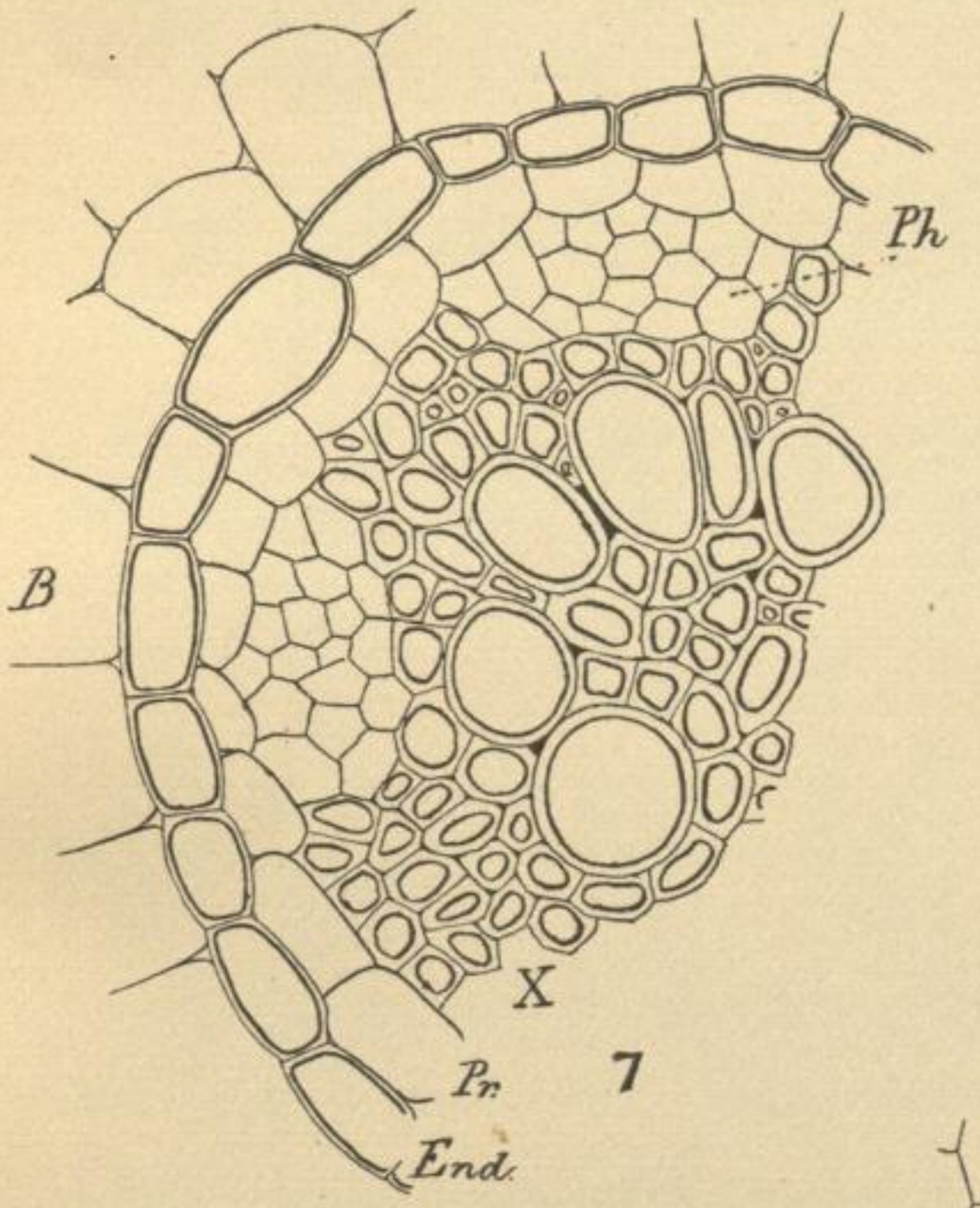
Theo. Holm.—Rootstocks of Uvularia and Oakesia.



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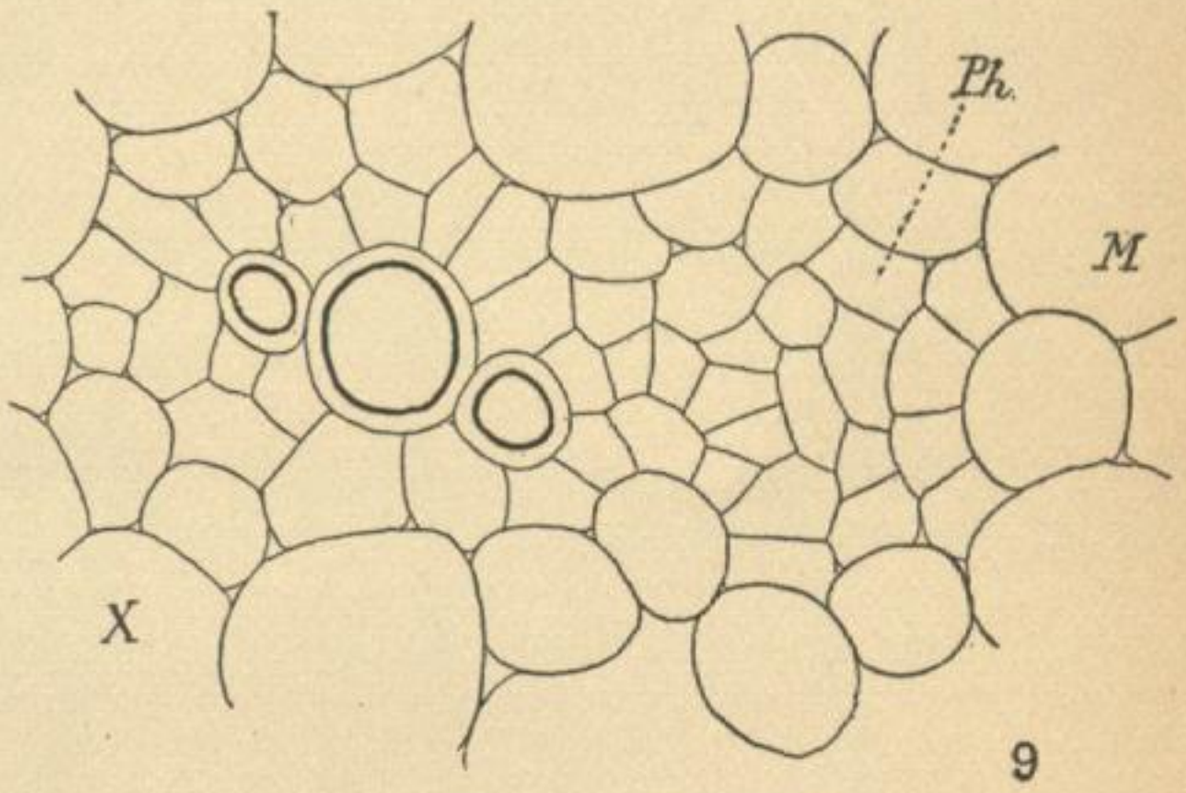

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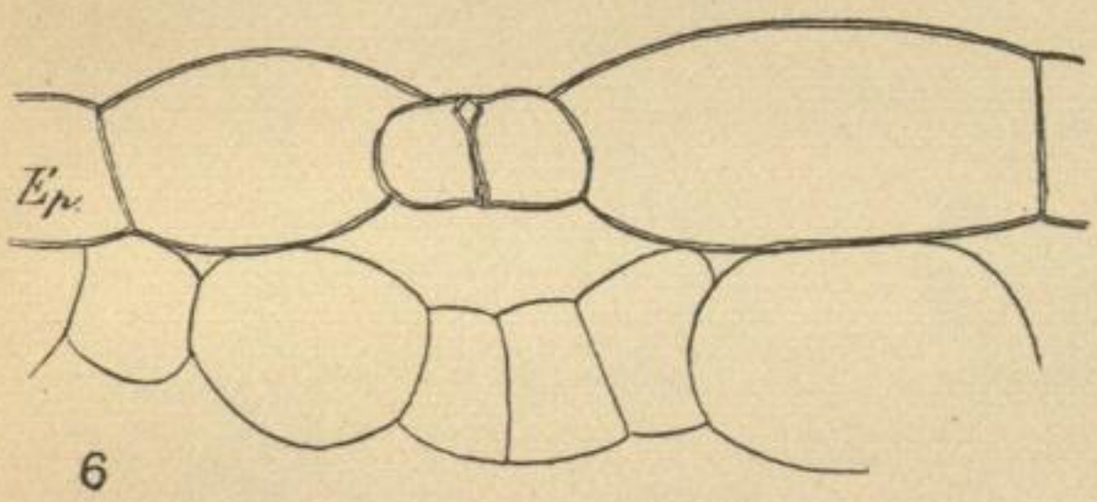

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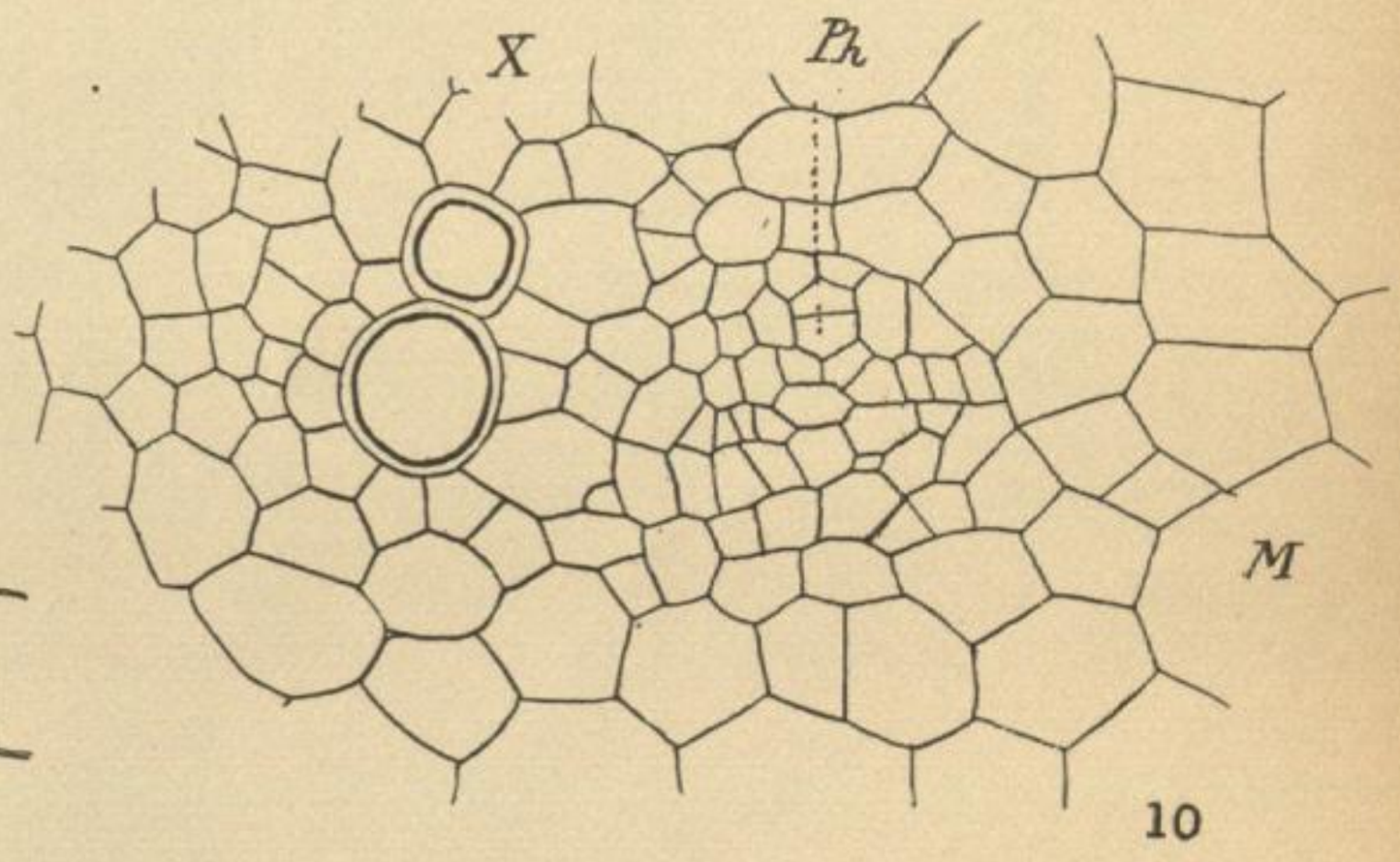

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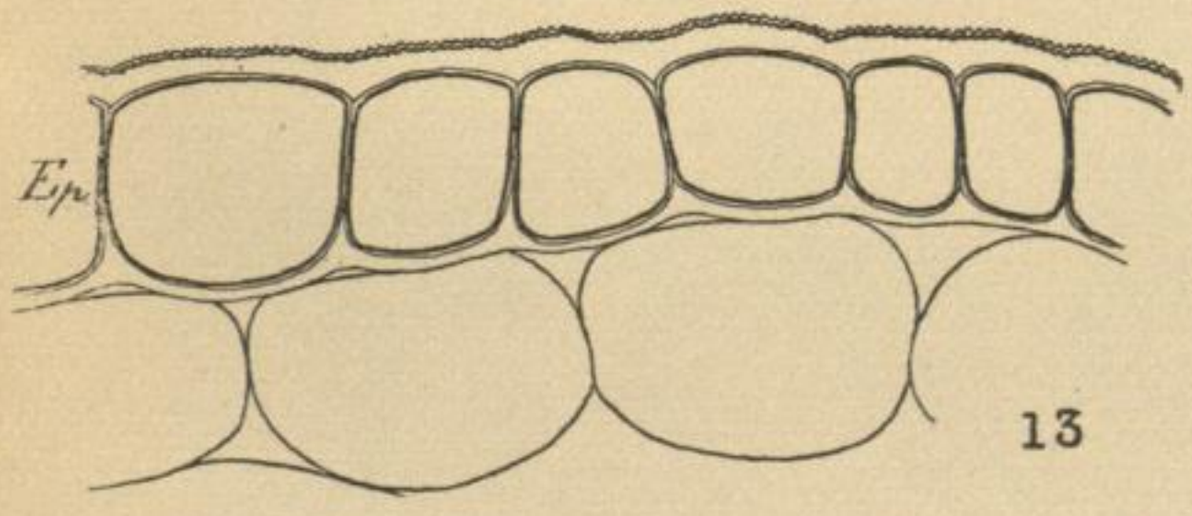

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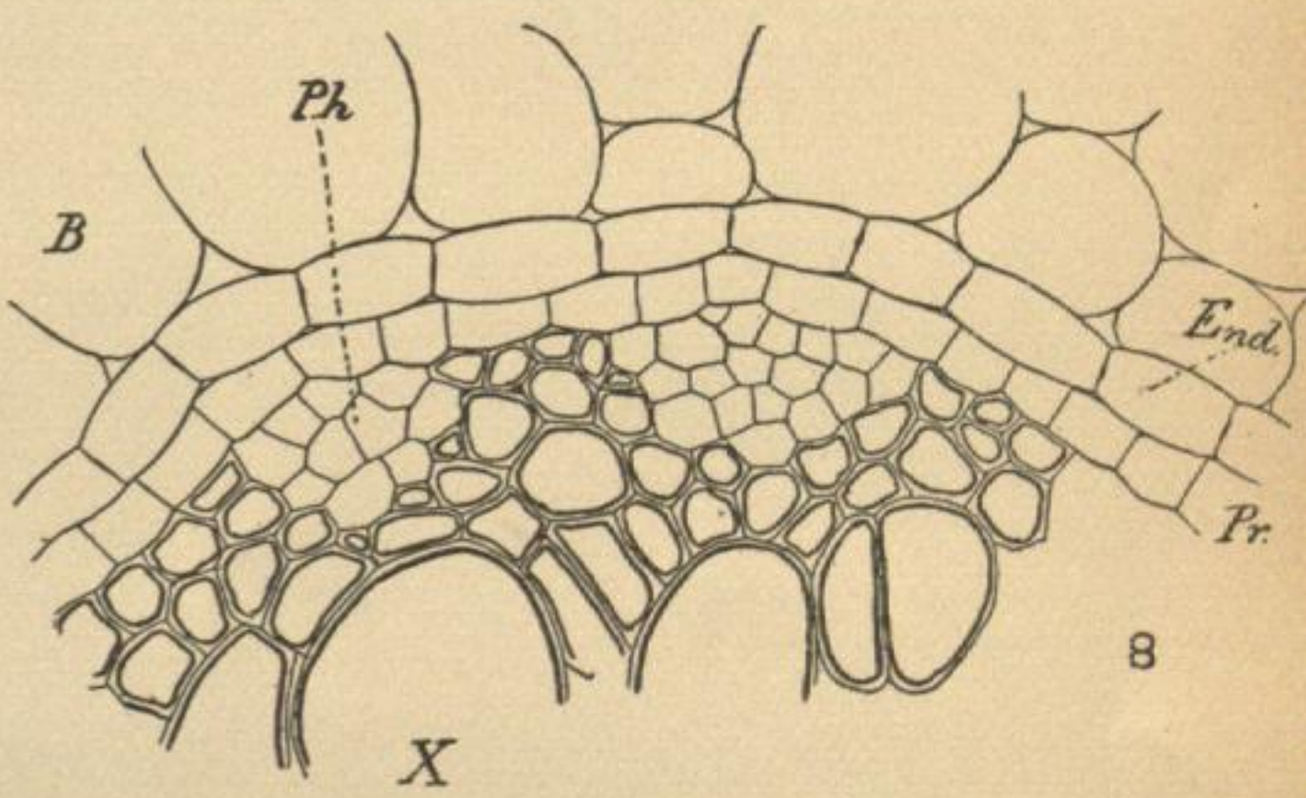

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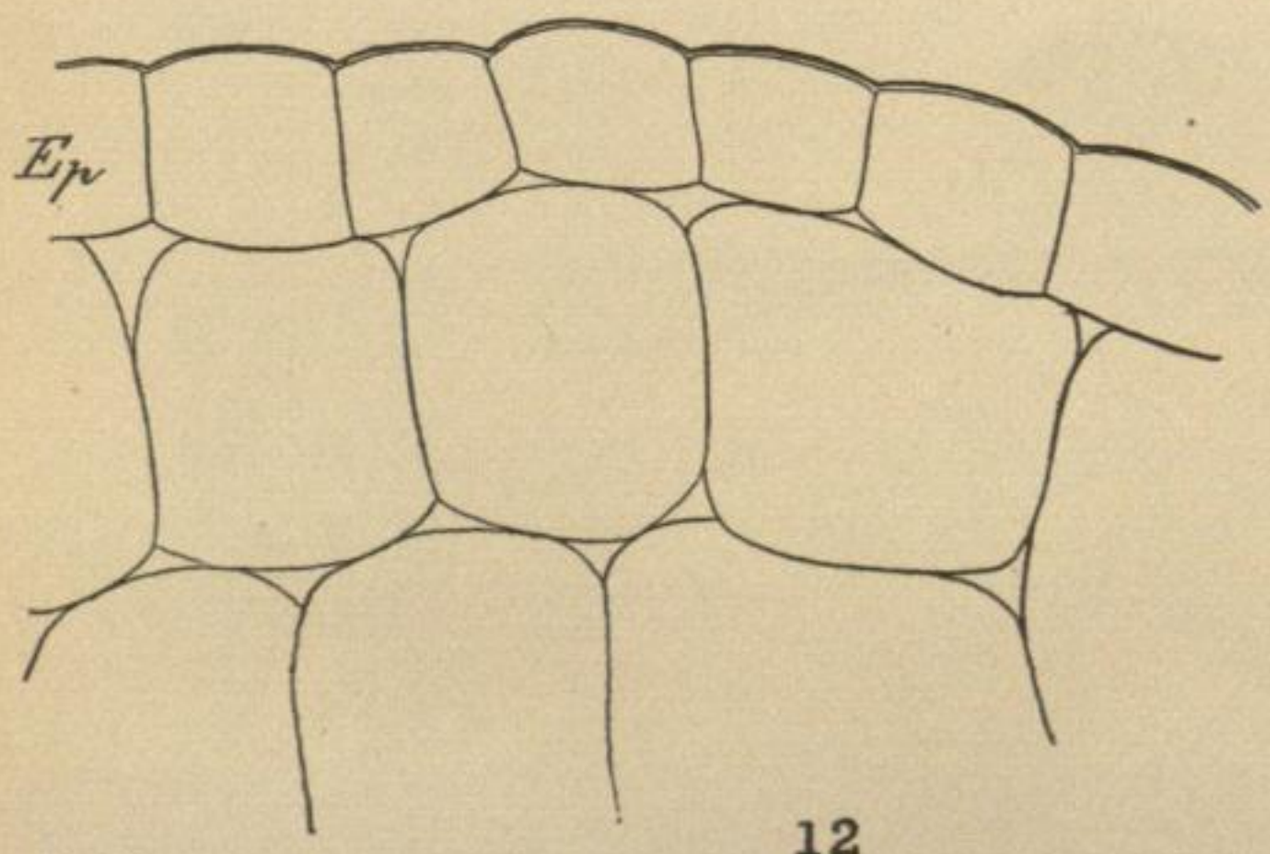

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Theo. Holm.—Rootstocks of Uvularia and Oakesia.

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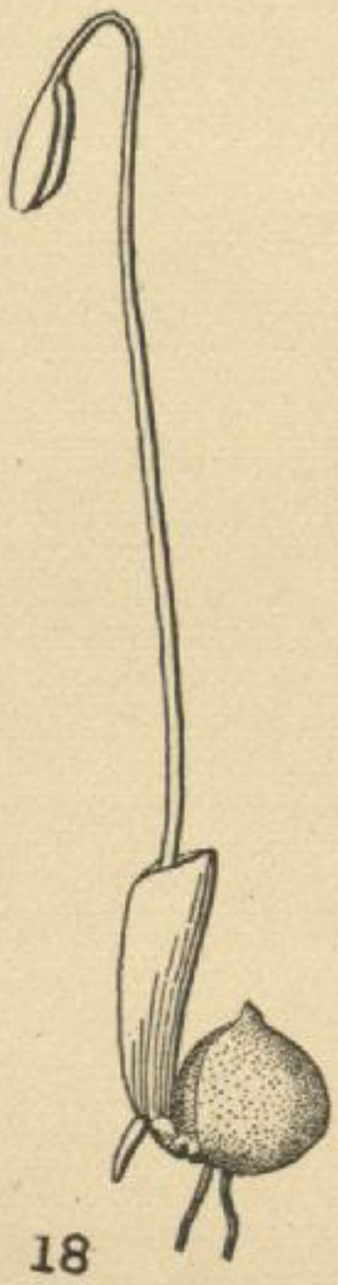

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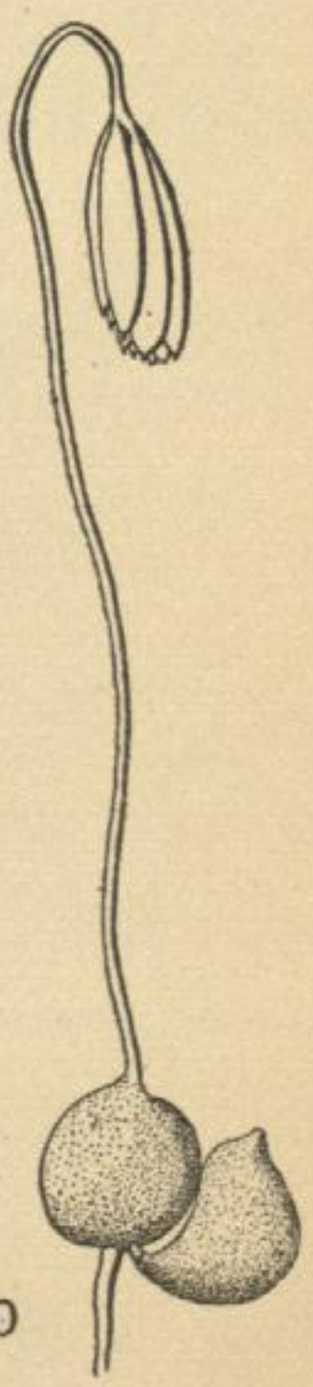

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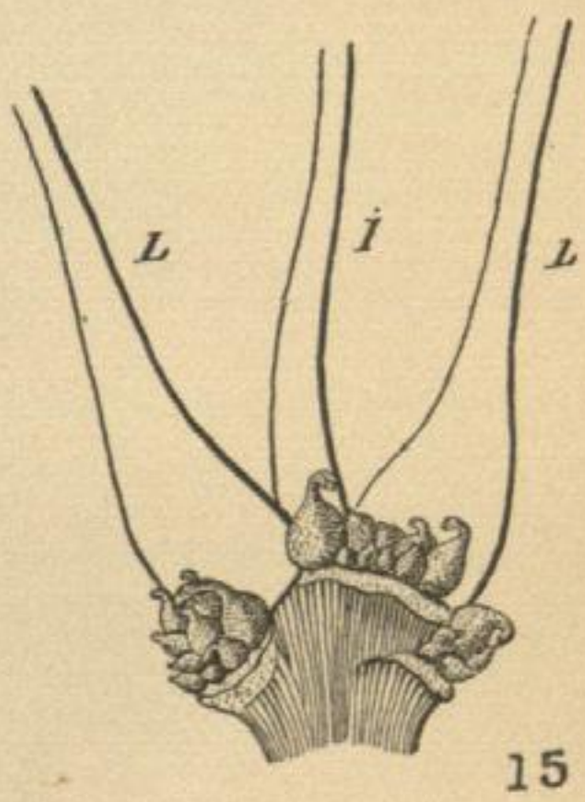

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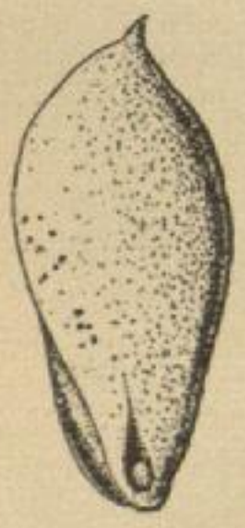

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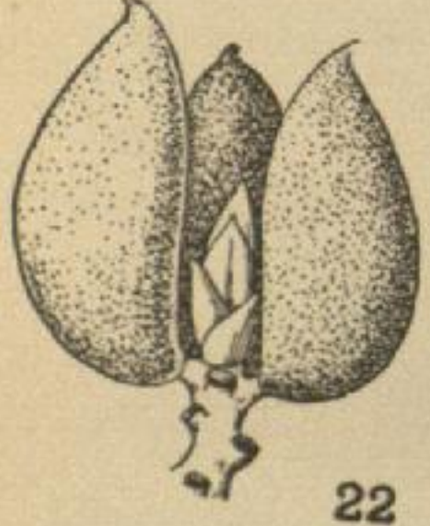

22

Author ad nat del.

Theo. Holm.—Rootstocks of Diclytra and Krigia.