The Wound Reactions of Brachyphyllum[1].

BY

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With Plates XXVII and XXVIII.

THE genus *Brachyphyllum* was established by Brongniart for the leafy branches of a Jurassic coniferous plant of doubtful affinities (Prod. Hist. Vég. Fossiles, p. 109, 1828). Saporta, who subsequently described a number of species of the genus (Plantes Jurassiques, vol. iii, 1884), placed it with the Araucarineae. This type of foliar shoot from the Cretaceous and Jurassic deposits of different parts of the world has been referred by various authors under several generic appellations to the Araucarineae, Cupressineae, and Sequoiineae, with perhaps the weight of authority inclining towards the last attribution. The present writer, in collaboration with Dr. Arthur Hollick of the New York Botanic Garden, on the basis of well preserved material, has been able to settle finally the systematic position of these interesting and omnipresent relics from the Jurassic and Cretaceous strata, from the investigation of internal structure. The anatomical features of *Brachyphyllum*, as exemplified by the North American species *B. macrocarpum*, Newberry, are such that there can now be no doubt as to its Araucarian affinities (Affinities of certain Cretaceous Plant remains commonly referred to the genera Dammara and Brachyphyllum, American Naturalist, vol. xl, pp. 189–215, March, 1906). In the article just cited, it has been demonstrated that *Brachyphyllum*, although presenting undoubted Araucarian features, differed markedly from existing and many extinct Araucarineae, both in the structure and wound reactions of its wood. These features are to be farther discussed in the present article, because they appear to be of considerable importance not only from the standpoint of the identification of lignites and mineralized woods, which are the remains of *Brachyphyllum*, but also from that of the general question of the affinities and phylogenetic history of the Araucarineae. The present writer has now in his possession a considerable amount of fossil

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woods belonging to the genus *Brachyphyllum*, which has come from Cretaceous deposits of somewhat extended geographical and stratigraphical range, on the eastern coast of the United States. For this reason it becomes possible to treat the subject of the wound reactions of the wood of this genus with some degree of thoroughness.

A feature which makes it possible to distinguish at once a well preserved specimen of the wood of *Brachyphyllum* from that of any living representative of the Araucarineae or fossil forms more nearly allied to these, is the absence of resiniferous elements in the wood, other than those found in the medullary rays. Photograph 1, Plate XXVII, which is of a remarkably well preserved lignite from the Androvette pit, Kreischerville, Staten Island, N. Y., illustrates the truth of this statement. Although there are three annual rings present in the field of the photomicrograph, it is impossible even by the use of a magnifying lens to distinguish the presence of any resinous elements, such as occur in numbers in the wood of either of the living Araucarian genera *Agathis* and *Araucaria*. A somewhat extensive study of both longitudinal and transverse sections of the wood of *Brachyphyllum* has failed to reveal the presence of resiniferous elements of any kind in the normal wood of this genus. In this normal absence of resiniferous elements in the wood, *Brachyphyllum* resembles the older Gymnospermous groups, such as the Cordaitales, the Cycadales, the Pteridospermae and their allies, not to mention the fossil Lycopodiales and Equisetales, in so far as these possessed secondary wood. In this respect too it also presents a striking degree of similarity to the very ancient although still flourishing coniferous genus *Pinus*, for in the pines there are no parenchymatous elements in the wood, other than those which surround the resin canals.

Photograph 2, Plate XXVII, represents a part of a radial section of the same material, highly magnified. The radial pits of the tracheids occur in a single row, and are flattened above and below by mutual contact. The fact that in *Brachyphyllum* the radial pits ordinarily occur in a single row only, is probably due to the xerophytic habit of the genus, which is very marked. Very rarely the pits are in a double row in the ends of the tracheids, and then they alternate in the manner typical for the Araucarineae. Such a case of alternation has been figured in the first article, already cited above. The mutual flattening of the bordered pits of the tracheids is a sufficient diagnostic of Araucarian affinities, where the radial pits occur in but a single row. Another pronounced Araucarian feature is the presence of numerous crowded pits on the lateral walls of the cells of the rays. As this character has likewise been figured in the article referred to above, it need not be further discussed at the present time (*op. cit.*, Pl. 5, Fig. 2).

The same block of lignite, which supplied the sections illustrated in the two photographs described above, showed at one end evidence of

a healed wound. The fact that the material was partially carbonized, especially in the region of the wound, made it difficult to secure satisfactorily thin sections through the traumatic region. This was regrettable on account of the fact that the black opacity of the tissues made thin sections particularly desirable. However, the partial burning of the material has on the whole been an advantage, for it has resulted in a superb condition of preservation. Photograph 3, Plate XXVII, shows a section through the partially callused wound, under a low magnification. Two folds of traumatic wood are seen overlapping the injured surface in the manner characteristic of ligneous wounds. Photograph 4, Plate XXVII, represents a view of a section either on a lower or higher plane than that shown in the last photograph. It is of course not possible to decide which alternative is the correct one, in view of the fragmentary condition of the piece of wood. The wound is closed over in the centre, at this level, as may be seen by comparing the two narrow annual rings, most clearly discernable on the left of the wound, with the two similar rings in the foregoing photograph. By the use of a lens, it may be observed, that stretching away tangentially on either side of the wound is a row of apertures in the wood. These are traumatic resin-canals. Photograph 5, Plate XXVII, shows the right margin of the wound in photograph 4, much more highly magnified. Towards the left of this photograph is a mass of resiniferous parenchyma, such as is found in connexion with healing wounds in nearly all Conifers. To the right of this mass of resinous parenchyma extends a tangential series of resin-canals. Photograph 6, Plate XXVII, shows the continuation of this series of traumatic canals, beginning about the centre of the former photograph. On the left of photograph 6 may be recognized the same canals as are found in the centre of photograph 5. These series of canals stretch to the extreme margins of the fragment of wood. Photograph 7, Plate XXVII, shows a row of canals from a plane of section so far removed from the actual wound, that there is scarcely any evidence of traumatic disturbance in the arrangement of the elements of the wood. In this photograph it is possible to distinguish, that although there are no resinous elements in the wood proper, dark coloured cells surround the traumatic resin canals. Photograph 8, Plate XXVII, shows one of the larger canals highly magnified. The contents of the resiniferous cells surrounding the canal are so dark, that they present no actinic contrast with the almost black walls of the cells themselves. In photographs 7 and 8 it is possible to make out that the row of traumatic resin-canals occur in the autumnal wood of the specimen under discussion. Photograph 9, Plate XXVII, is of a longitudinal section of the same piece of lignite, showing a traumatic canal in longitudinal section. The canal is obviously lined by dark hued cells and is constricted at intervals. The latter feature is found in the case of traumatic and even normal resin-canals in the Abietineae. The canals are jacketed not only by

parenchyma cells, but also by septate tracheids, such as have been described by Penhallow and Conwentz in the case of the normal and traumatic resin-canals of living and fossil species of *Pinus* and other Abietineous genera, as well as in the traumatic resin-canals of *Sequoia*. Photograph 10, Plate XXVII, shows a double row of traumatic resin-canals in another specimen of the wood of *Brachyphyllum* from Kreischerville, Staten Island, which was not charred in any way, and is consequently much less well preserved than is the case with the material in the foregoing photographs. The specimen in question is of some interest however, since it shows a double row of traumatic resin-canals in the same annual ring. This feature appears to be rare, although not infrequently rows of traumatic canals occur in successive, although not consecutive, annual rings. In none of the material which has been gathered have horizontal canals been found, connecting the rows of vertical ones, such as are present in the genus *Cedrus* among the Abietineae (Comp. Anat. and Phylog. of the Coniferales, 2; The Abietineae, Bost. Soc. Nat. Hist. Memoirs, vol. vi, No. I), and in a fossil *Sequoia* (A fossil Sequoia from the Sierra Nevada, Bot. Gazette, 38, 321–332, Nov., 1904).

The traumatic phenomena described in the foregoing paragraphs were found in fragments of lignite which, by comparison with the woody tissues of associated, well preserved branches of *Brachyphyllum macrocarpum*, were inferred to be portions of the wood of this or an allied species. It has, however, fortunately not been necessary to rest the case on inference alone. On sectioning one well preserved, partially carbonized branch of *B. macrocarpum*, Newberry, it was found that it had suffered injury, and that a large amount of traumatic parenchyma was present in the wood, in some cases enclosing traumatic resin-canals. The small size of the branch and the limited amount of woody tissue are doubtless responsible for the fact that the traumatic canals were not more abundant, since similar conditions are present in small wounded branches of the living Abietineae. Photograph 11, Plate XXVII, shows a general view of the central portion of a transverse section of the specimen of *Brachyphyllum* just mentioned. The fibro-vascular bundles on account of the youth and small size of the branch are still separate from each other, and have not become united into a continuous woody cylinder as in older stems of this genus. A parenchymatous stripe can be seen running through the outer half of the wood in most of the bundles shown in the photograph. This stripe in the case of a large bundle near the centre of the photograph encloses two resin-canals. Photograph 12, Plate XXVII, shows this bundle more highly magnified. On the left is a resin-duct surrounded by a layer of dark parenchyma, which has very largely collapsed. Farther to the right is another resin-canal less perfectly preserved. The two canals are situated in the parenchymatous stripe of traumatic tissue, which crosses the wood tangentially. It is thus apparent that traumatic resin-canals of the same type, as are

found abundantly in isolated fragments of wood possessing the characters of that present in leafy and determinable branches of *Brachyphyllum*, in this instance occur in the wood of an authentic branch itself. The diagnosis is thus placed beyond any reasonable doubt, since it is extremely improbable that two different extinct genera of Araucarineous remains should present this very remarkable traumatic reaction.

It becomes necessary at this stage to compare the traumatic reactions of the living genera of the Araucarineae with those of the extinct Mesozoic genus *Brachyphyllum*. Photograph 13, Plate XXVIII, shows a portion of the edge of a healed wound in *Agathis alba*, material of which was very kindly sent by the Director of the Botanic Gardens at Buitenzorg, Java. It will be seen from the photograph, that although there is a considerable amount of callus formed on the margin of the wound, there is no indication whatever of the presence of traumatic resin-canals such as invariably appear in connexion with healed wounds in *Brachyphyllum*, so far as has been observed. Through the great kindness of Dr. Treub, Director of the Botanic Garden at Buitenzorg, Dr. Maiden, Director of the Botanic Garden at Sydney, N.S.W., Dr. L. Cockayne, of Christchurch, New Zealand, and Professor G. L. Goodale, Director of the Botanic Garden of this University, the writer has had the opportunity of examining the traumatic reactions of a considerable number of species of *Agathis* and *Araucaria* of wide geographical distribution. In all the cases yet studied, the conditions resulting from wounds are substantially the same as those shown in photograph 13. It is not proposed to discuss this matter farther at the present time, as it will be sufficiently considered in a future memoir on the living Araucarineae. One feature of healing wounds in the existing Araucarineae is, however, worthy of present notice, viz. the fact that there is an abundant formation of mucilage in connexion with the wound, similar to that found normally with the resin, in their cortical resin-canals. This mucilage generally penetrates into the adjacent tracheids, especially in wounded roots.

Among the lignites gathered at Kreischerville, Staten Island, on several occasions in company with Dr. Arthur Hollick of the New York Botanical Garden, the writer found some specially well preserved ones in the Drummond pit, still coated with their inner bark. These lignites showed all the features of wood structure, which are found in the living *Agathis* and *Araucaria*, and differed as a consequence markedly from the Araucarian lignites found most abundantly in the adjoining Androvette pit, from which the major part of the material of *Brachyphyllum* has been derived. Fortunately the material from the Drummond pit showed numerous healed wounds, not only in the deeper layers of the stem, but also on the surface as well. The outside of the specimens was, in fact, in some cases marked by numerous cicatrices, representing healed wounds

of considerable extent. It was consequently possible in this case to compare with the wound reactions of the living Araucarineae those of a closely allied form from the Raritan Cretaceous. Photograph 14, Plate XXVIII, which is exactly on the same scale of magnification as those of *Brachyphyllum* shown in photographs 1, 5, 6, 7, and 9, shows a transverse view of the normal wood of the species above mentioned, from the Drummond pit. The field includes part of two annual rings, and the fossil wood differs clearly from that of *Brachyphyllum*, as described in earlier paragraphs, in the presence of resinous elements similar to those found in the wood of the living Araucarineae. These can clearly be made out as dark dots scattered throughout the area of the photograph. Most of the tracheids are occupied by a substance, which is apparently of the nature of a fossil mucilage, and are obviously of somewhat larger diameter than those of *Brachyphyllum*. This fossil mucilage, if such it be, is to be compared with the similar substance, which is found in the tracheids of *Araucaria* and *Dammara*, in more or less diseased stems, as indicated above. Photograph 15, Plate XXVIII, shows the margin of a wound in the species from the Drummond pit. It presents conditions identical with those found in the case of the existing *Agathis* and *Araucaria*, as illustrated by photograph 13. There is little reason to doubt that the wood in question belongs to an extinct species, in all probability of *Araucaria* or an allied genus, since Dr. Hollick has described leafy branches referable to that genus from the adjacent, although rather higher, deposits at Cliffwood, New Jersey (The Cretaceous Clay Marl exposure of Cliffwood, N.J., Pl. 12, Figs. 3*a* and 4, Trans. New York Acad. Sci., vol. xvi, 1896–7), and since remains of *Araucaria* are in general not uncommon in the Cretaceous beds of the Eastern United States. It will be well to defer the consideration of the significance of these facts until the wound reactions of other species of *Brachyphyllum* have been described.

In the spring of 1905, at the instigation of the writer, Mr. S. A. Starrat, a student in the Geological Department of this University, during the spring season in the field, collected a large quantity of lignites from the well-known Cretaceous deposits of Gay Head on the Island of Martha's Vineyard, Mass. Among these were some moderately well preserved specimens, which presented all the structural features of *Brachyphyllum*. Their attribution to this genus is farther justified by the often described occurrence in the same beds of cone scales, of the type referred by Heer to the genus *Dammara*. These in all probability, in view of the results obtained by Dr. Hollick and the writer, in the case of a very similar species from Kreischerville, Staten Island (*op. cit.*), do not belong to *Dammara* (*Agathis*) at all, but to a new and undescribed genus, to which has been given the name *Protodammara*. Reasons have been adduced in the article cited, for the conclusion that *Protodammara* represents the cone scales of

Brachyphyllum. Photograph 16, Plate XXVIII, shows a view of the wood of one of the specimens from Martha's Vineyard, under the same magnification as the wood of *Brachyphyllum* from Kreischerville, shown in photographs 1, 5, 6, 7, and 9. The tracheids are even smaller than in the latter species ; but there is the same absence of resiniferous elements in the wood, which is characteristic of *Brachyphyllum* in general. A marked feature of specific difference from the first described lignite, is the highly resinous character of the medullary rays, which appear as dark lines running across the field of the photomicrograph. Fortunately the specimen under consideration showed in one part a wound covered over by the layers of new growth, which are commonly found in injured woods. These folds contained rows of traumatic resin-canals. Photograph 17, Plate XXVIII, in which can be distinguished the same highly resinous rays as in the last photograph, shows a portion of one of these tangential rows of traumatic ducts. The ducts in this instance, as in the first mentioned species of *Brachyphyllum* (cf. photograph 10), contain mucilage as well as resin, the latter alone persisting in the sections, on account of the numerous solvents of resin employed in the process of embedding. In this respect they resemble the normal cortical resin-canals of the existing *Araucaria* and *Agathis*. Similar mucilaginous contents are found in the cortical canals of preserved leafy branches of *Brachyphyllum*, where they have not on the one hand been too much charred, or on the other hand become too much decayed in process of fossilization. This feature of the resin canals serves as one diagnostic character to separate Araucarineous remains from those of other groups of Conifers, and has been used by the writer, together with other characters, to distinguish the branches of *Brachyphyllum* from those belonging to the Cupressineae and Sequoiineae, of very similar habit (Hollick and Jeffrey, *op. cit.*).

Through the kindness of Professor J. B. Woodworth of the Geological Department of this University, the writer had the opportunity of investigating lignites showing the structural peculiarities of *Brachyphyllum*, from that classic Potomac locality, the Dutch Gap Canal. The specimens were not nearly as well preserved as those from Staten Island and Martha's Vineyard, but are nevertheless of very special interest on account of their much lower geological horizon. One of these lignites fortunately in addition to presenting the general ligneous characters of *Brachyphyllum*, showed very clearly the presence of two rows of traumatic resin-canals in remote annual rings. The wound to which these were in all probability related does not appear in the lignitic fragment, but there seems to be no reason to doubt that the canals in question are traumatic, in view of the similarity to those described in the case of material from Staten Island and Martha's Vineyard. Photograph 18, Plate XXVIII, illustrates at once the character of the traumatic canals and the rather bad state of preservation

of the wood, in this species. It resembles the species from Martha's Vineyard rather than that from Staten Island, in the resinous character of the rays ; but differs from it in the much larger size of the traumatic canals, as may be seen by comparing this photograph with photograph 17. The canals contain the same mucilaginous secretion, remaining after the removal of the resinous contents by solvents, as is seen in the species of wood of *Brachyphyllum* from Martha's Vineyard and Staten Island. The reference of the present lignite to *Brachyphyllum* is further justified by the description on the part of Fontaine in his well-known monograph on the plants of the Potomac beds, of a number of leafy branches belonging to that genus, as well as to the closely allied or identical genus *Arthrotaxopsis*.

Conclusions.

In his classic and admirable treatment of the fossil Conifers in Zittel's Palaeontologie, Schenk separates those fossil Araucarian genera, characterized by often flattened two-ranked branches, as a distinct family under the caption Walchieae. This family is made to include not only the Mesozoic extinct Araucarineae of microphyllous habit, but also the Permian genus *Walchia*. Concerning the latter genus nothing need be said at the present time, since it is not closely related to forms like *Brachyphyllum*, and nothing is accurately known as to its nearer affinities, on account of the absence of necessary details in regard to its reproductive organs and internal structure. Excluding *Walchia* itself, the Walchieae comprise a number of extinct genera of very similar habit. The oldest of these is the Triassic *Ullmannia*, of which Count Graf zu Solms aptly remarks in his Palaeophytology, that it can scarcely be distinguished except stratigraphically from the Jurassic *Pagiophyllum*. *Pagiophyllum* likewise cannot be clearly separated from the Jurassic and Cretaceous genus *Brachyphyllum*, which is the subject of the present article. The anatomical characters of *Brachyphyllum* certainly justify the separation of the Walchieae from the living Araucarian type, represented by *Agathis* and *Araucaria*. It has been shown above that *Brachyphyllum* differs markedly both in the normal structure of its wood and in its traumatic reactions from the existing Araucarineae and allied species from the Cretaceous. In the absence of resiniferous elements among its tracheids, *Brachyphyllum* resembles the older Gymnosperms, as well as the arboreal extinct Lycopodiales and Equisetales. In this feature it also resembles the still existing but very ancient genus *Pinus*. With the living and, so far as we know, the extinct Abietineae, *Brachyphyllum* also agrees in the nature of its traumatic reactions, more closely than with the living type of the Araucarineae, for in this extinct and ancient genus resin-canals were formed, as a result of wounding, just as invariably as they are in the living *Picea* and *Abies*.

The question here arises, why the living Araucarineae and their nearest fossil allies should differ so strikingly in the structure and wound reactions of their wood from *Brachyphyllum*, and why the latter should resemble so strongly in its traumatic phenomena that very ancient coniferous order the Abietineae. In this connexion it is apposite to point out, that the differences in the nature of the wound reactions obtaining between *Brachyphyllum* and existing Araucarineae are precisely the same as those which exist between the genus *Sequoia* and the remaining cupressinoid Conifers. The author has shown, that in both living and extinct species of *Sequoia* resin-canals are commonly formed as the result of injury, while such a reaction does not take place, so far as our present knowledge goes, in other cupressinoid genera (The Comparative Anatomy and Phylogeny of the Coniferales, pt. I. The genus *Sequoia*; A fossil Sequoia from the Sierra Nevada). It is important too in this connexion to note, as the writer has done (*op. cit.*), that in the living *Sequoia gigantea*, resin-canals, *although occurring only as the result of injury in the older wood*, are found normally *in the first annual ring of branches which bear the cones male and female*, as well as *in the woody axis of the female cone*. In *S. sempervirens* resin-canals appear only as the result of injury. The condition of affairs found in the cupressineous genus *Sequoia* is paralleled in the Abietineous genera *Abies* and *Cedrus*, which resemble *Sequoia* in the normal absence of resin-canals in the older wood, for here too in *Abies magnifica* and *Cedrus Libani* resin-canals occur as a *normal feature of the woody axis of the cone* as well as the result of injury to the wood, while in most of the remaining species of these genera they occur only as the result of injury to the shoot organs. In the genera *Sequoia*, *Abies*, and *Cedrus*, as the writer has indicated in the works already cited, the normal occurrence of resin-canals in such regions of vestigial persistence as the woody axis of the female cone and the *first* annual ring of branches and roots (not, however, in the roots of *Sequoia*) is good evidence, taken with other data, which need not be mentioned here, but which are recorded in the articles cited above, that the resin-canals in question are an ancestral feature of the wood. In *Sequoia sempervirens*, *Cedrus atlantica*, and *Abies balsamea*, the resin-canals no longer occur normally, even in the reproductive axis, but appear only as the result of injury.

The very constant occurrence of resin-canals as the result of injury in the genus *Brachyphyllum*, in several species of somewhat extended geographical and stratigraphical range, apparently calls for some explanation, in view of the great constancy of ligneous characters and the considerable phylogenetic importance attached to them, by those whose familiarity with the structure of living and fossil Gymnosperms makes their opinion of value. In the case of *Brachyphyllum* we in all probability have to do with a wood in the stage of *Sequoia sempervirens* or *Abies balsamea*, for in this genus,

so far as we know, resin-canals appear in the wood of the stem only as the result of injury. If the course of reasoning adopted in the case of the Abietineae and the genus *Sequoia* is correct, it may be assumed that *Brachyphyllum* has come from ancestry, which possessed ligneous resin-canals like those present in the living *Pinus* and its nearer allies, as well as in the fossil genus *Pityoxylon* Kraus. Ward has recently described a Triassic wood, which he names *Araucarites monilifera* (Monographs of the U.S. Geolog. Survey, 48, pp. 34, 35, Pl. 3) in which moniliform flattened masses of a secretion are found in the wood. He interprets these as a fossil resin. Very much larger traumatic resin-canals than those found in *Brachyphyllum* would give rise to just such moniliform rows of 'tears' of resin. It is unfortunate that this wood has not yet been structurally determined. The abundant occurrence and large size of the resinous masses would point to a condition of resiniferous activity of the wood corresponding more to that found in *Pinus* and its allies, than to that found in the Cretaceous *Brachyphylla* described above. This more abundant secretion may indicate that the older Araucarineae were more copious in their resinous exudations than their descendants of the later Mesozoic. This question can only be settled when the Triassic woods just mentioned have been subjected to proper microscopic investigation. In any case they probably belong rather to *Ullmannia* than *Brachyphyllum*. The living Araucarian genera *Agathis* and *Araucaria* and their near relatives of the Cretaceous appear to hold the same phylogenetic position towards the genus *Brachyphyllum* (and in view of the conditions found in Ward's *Araucarites monilifera*, possibly also to the older genus *Ullmannia* as well), as the cupressinoid genera as a whole occupy towards the very ancient genus *Sequoia*. For being of much more modern origin, they have quite lost the tendency to revert to the probable ancestral condition of the wood as a result of injury, which is found in *Brachyphyllum*. Such a conclusion would need, however, to be supported by structural and experimental morphological data derived from a study of fossil and living representatives of the Araucarineae, and especially the anatomical investigation of the leaves, cone scales, and reproductive axes of these, since such organs are more apt than others to retain vestigial features. Such evidence the writer hopes to supply in future articles.

In a recent memoir devoted to the Abietineae (*op. cit.*) the present writer has adduced arguments from the structure of the male and female gametophytes and from the structure and reactions of the sporophytes, for the conclusion that the Abietineae are a very ancient order of the Coniferales. This view is fortified by authentic data as to the ancient geological occurrence of cones referable to *Pinus* and *Pinites* (from the Jurassic onwards) and more especially of woods referable to the genus *Pityoxylon* (from the Carboniferous and Permian onwards). To this evidence is added that of sufficiently numerous impressions of leaves, branches, &c. (from the

Permian onwards). There is accordingly nothing inherently improbable in the derivation of the Araucarineae from an Abietineous stock. The modern representatives of the Araucarineae, however, occupy a peculiarly isolated position among the Coniferales, which has not been made less marked by the recent investigations of Penhallow on their anatomy and the very interesting results of Thomson, in regard to the growth of the pollen-tube through the substance of the ovule-bearing scales, unlike that found in any other Conifer, as well as by the discoveries of Thomson and Lopriore of numerous nuclei in the pollen-tubes of *Agathis* and *Araucaria*. The latter feature is, however, not without parallel in other Coniferous genera, since a similar phenomenon has recently been described by Juel in *Cupressus* and indicated by Coker in *Podocarpus*. It is consequently of importance to observe that the ancient Araucarian genus *Brachyphyllum* shows indications of affinity with the venerable family of the Abietineae both in ligneous structure and traumatic reactions. The wide gulf which separates the existing Araucarineae from other Coniferales, particularly from the Abietineae, is to some extent bridged over by this interesting extinct Araucarian. That this statement is not less supported by a consideration of the general normal anatomy of *Brachyphyllum*, than by experimental evidence derived from the study of traumatic phenomena, the writer hopes to show in a subsequent contribution.

Summary.

1. In three distinct species of Cretaceous Araucarian lignites, referred to the genus *Brachyphyllum*, on the basis of the study of leafy branches with structure preserved, traumatic resin-canals have been found similar to those which occur as a result of injury in the Abietineae and in the genus *Sequoia*.

2. Since these lignites have considerable stratigraphic and geographical range, it may be safely inferred that the formation of traumatic resin-canals was a constant feature of *Brachyphyllum*, and distinguishes that genus clearly from the modern Araucarineae and their relatives of the Cretaceous, which do not form traumatic resin-canals under any circumstances.

3. The traumatic reactions of the ancient and extinct Araucarian genus *Brachyphyllum* constitute one line of evidence to unite phylogenetically the Araucarineous stock with that of the Abietineae, which we now know to have been a very ancient order of the Coniferales.

The writer wishes to offer his sincere thanks to the Director of the Botanic Gardens of Buitenzorg, Java, the Director of the Botanic Garden of Sydney, N.S.W., the Director of the Botanic Garden of Harvard University, Dr. L. Cockayne, Christchurch, New Zealand, Dr. Arthur Hollick, of the New York Botanic Garden, and to Professor J. B. Woodworth, of the Geological Department of Harvard University, for numerous kindnesses in the securing of material.

DESCRIPTION OF PLATES XXVII AND XXVIII.

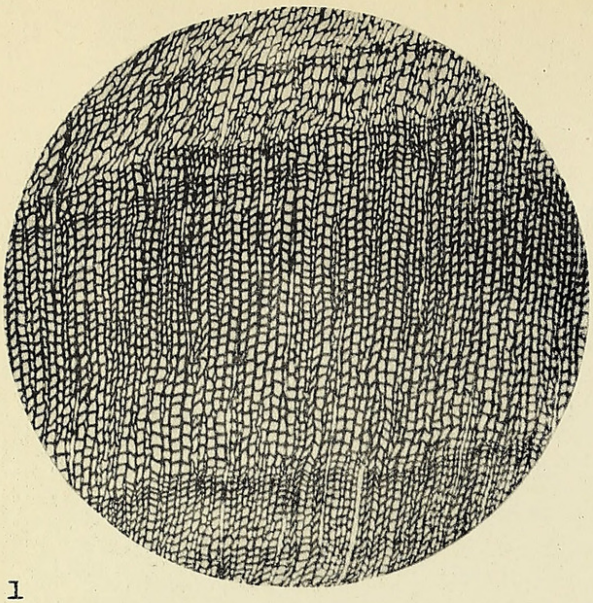
(Illustrating Professor Jeffrey's paper on *Brachyphyllum.*)

PLATE XXVII.

Photograph 1. Wood of *Brachyphyllum macrocarpum,* Staten Island. × 40.
Photograph 2. Longitudinal radial view of the same. × 200.
Photograph 3. Transverse section of wound of same. × 12.
Photograph 4. The same at another plane of section. × 12.
Photograph 5. Right margin of wound in photograph 4. × 40.
Photograph 6. The same farther to the right. × 40.
Photograph 7. Transverse section of the same wood at another plane. × 40.
Photograph 8. Part of a similar section to show resin-canal. × 200.
Photograph 9. Longitudinal section of the same lignite. × 40.
Photograph 10. Transverse section of another specimen. × 40.
Photograph 11. Centre of a wounded branch of *Brachyphyllum macrocarpum.* × 40.
Photograph 12. Part of the same highly magnified to show the traumatic resin-canals. × 200.

PLATE XXVIII.

Photograph 13. Margin of a wound in *Agathis alba.* × 40.
Photograph 14. Wood of a Cretaceous plant allied to *Araucaria.* × 40.
Photograph 15. Margin of a wound from the same material as 14. × 40.
Photograph 16. Wood of a *Brachyphyllum* from Martha's Vineyard. × 40.
Photograph 17. Traumatic resin-canals from the same. × 40.
Photograph 18. Traumatic resin-canals from a *Brachyphyllum* from the Dutch Gap Canal, Potomac beds. × 40.



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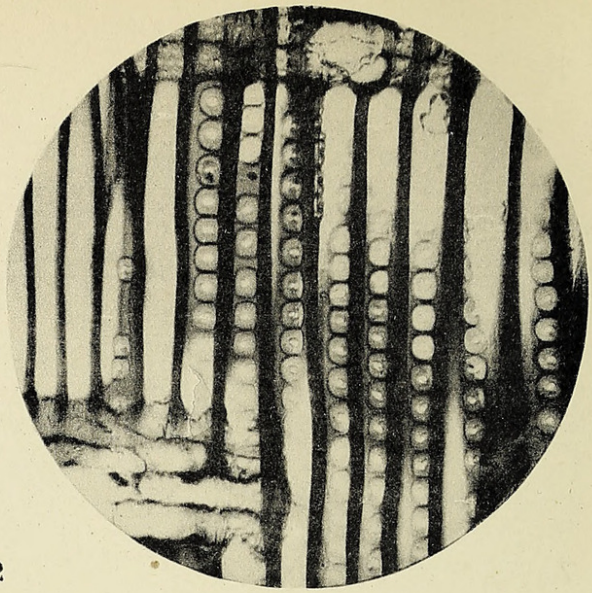

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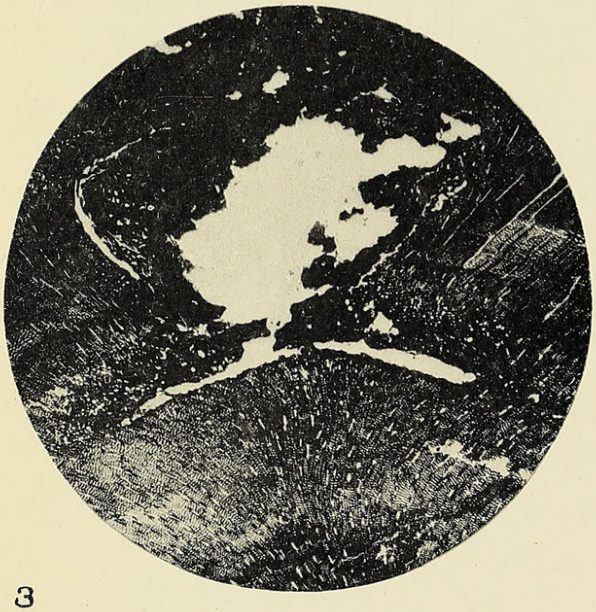

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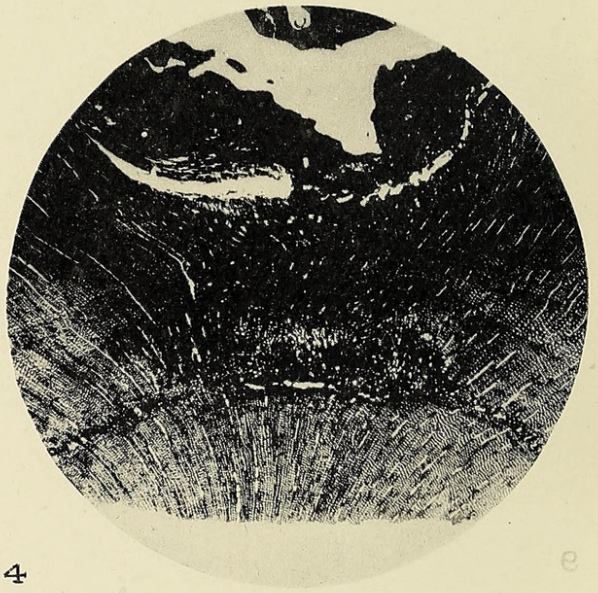

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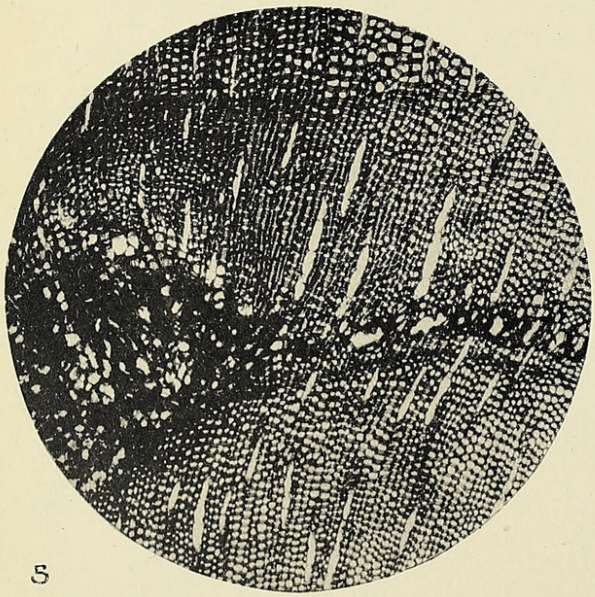

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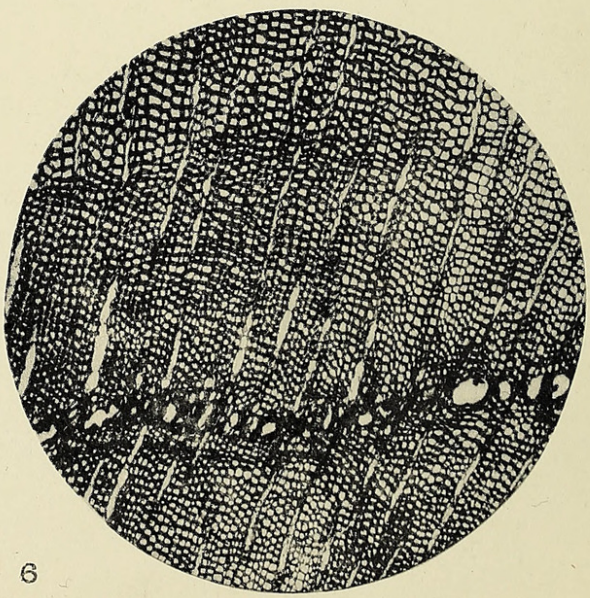

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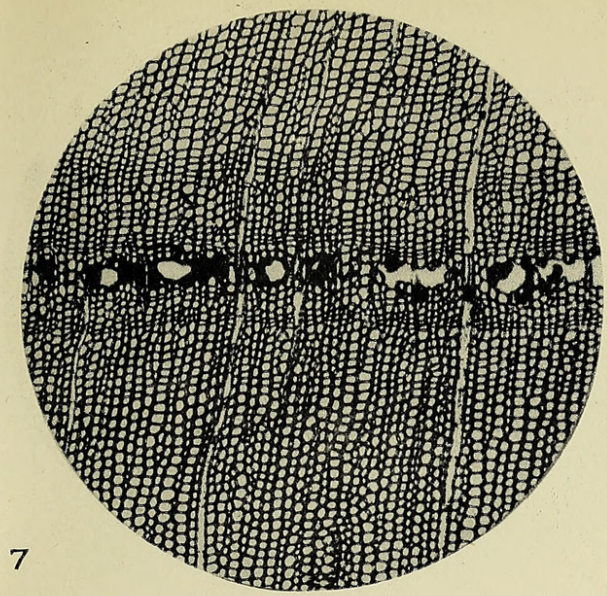

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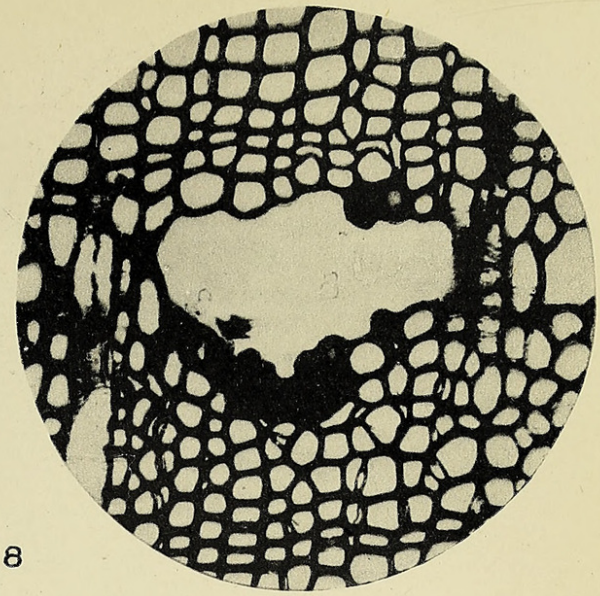

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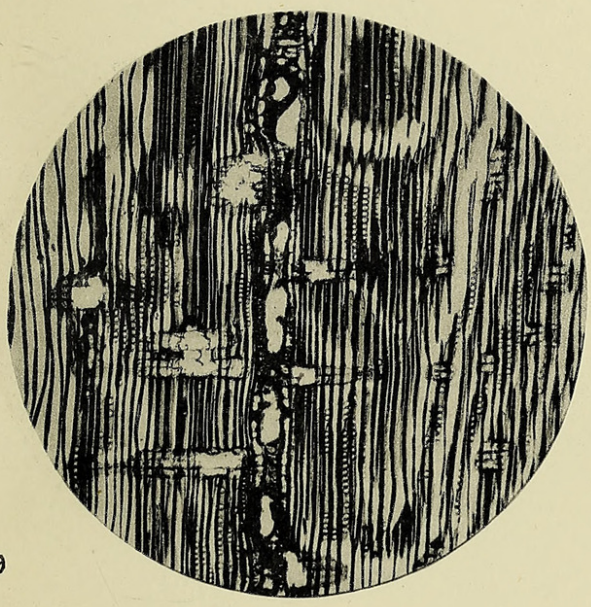

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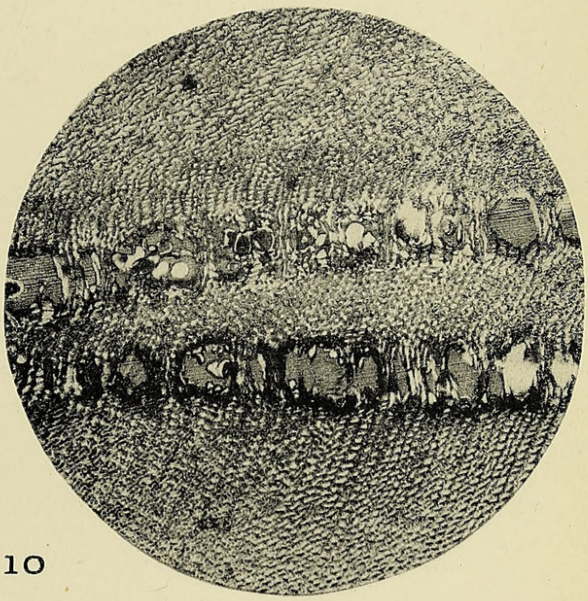

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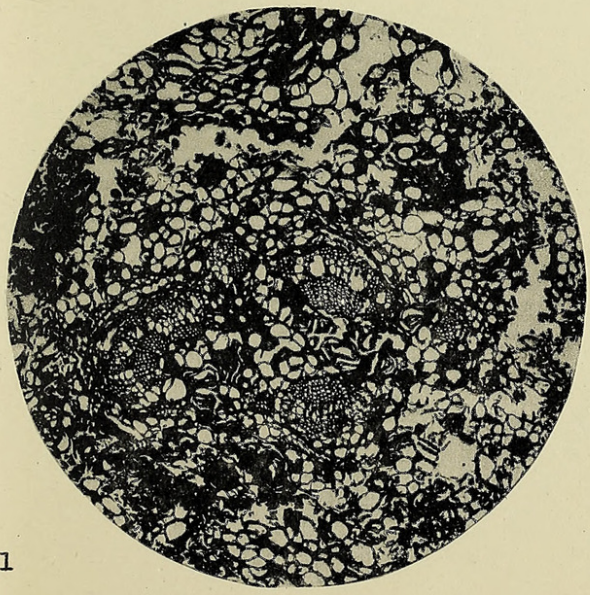

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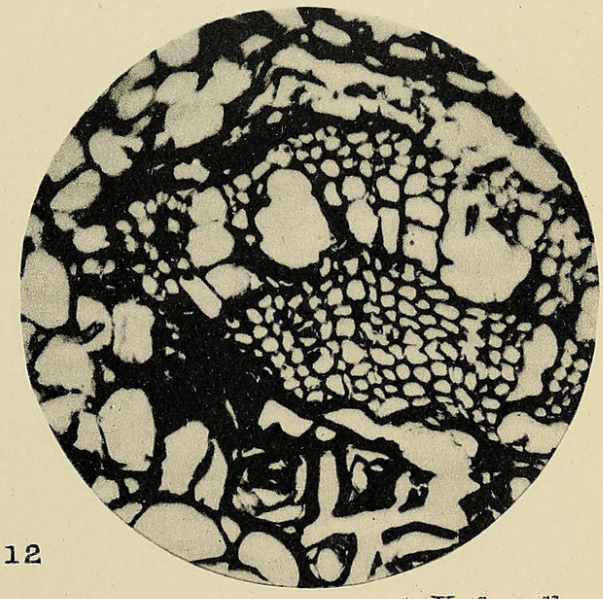

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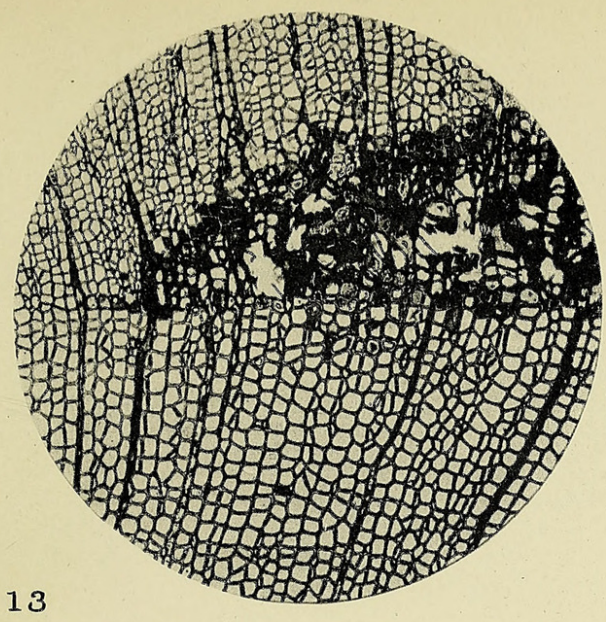

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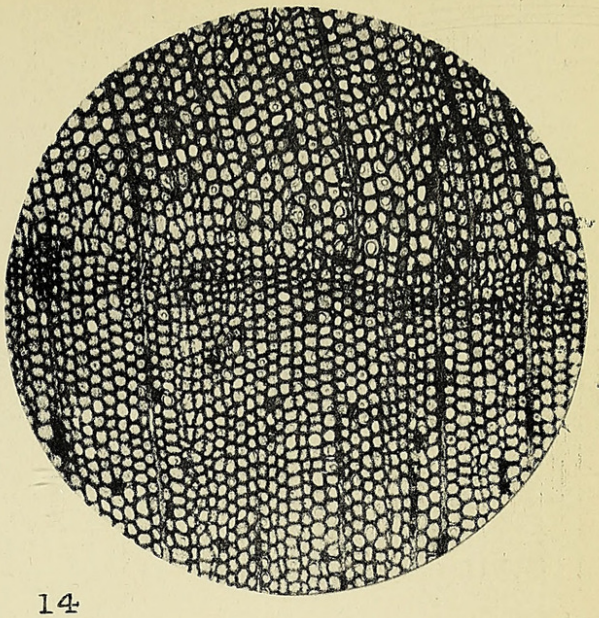

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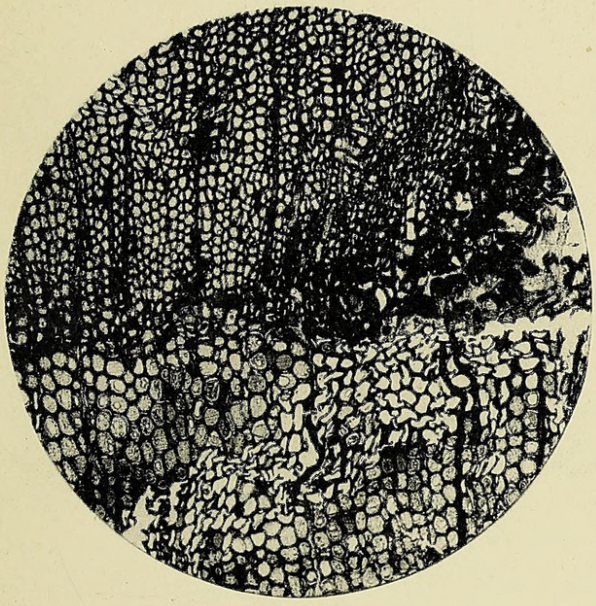

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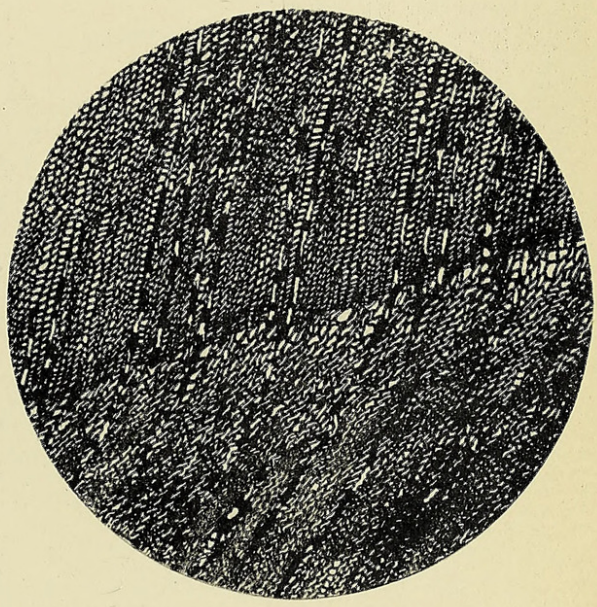

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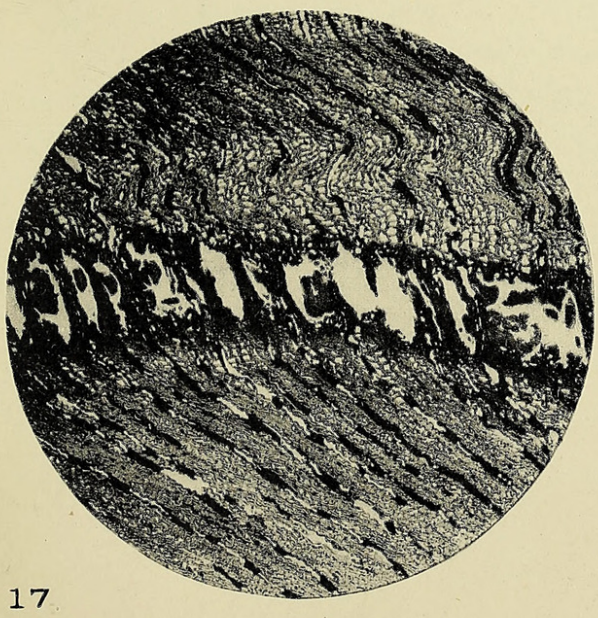

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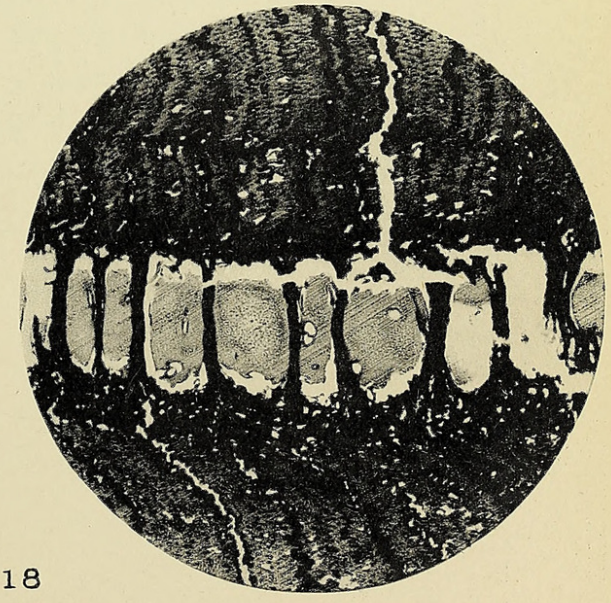

18

Huth, coll.

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