On the Affinities of the Genus *Yezonia*.¹

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With Plate LXV.

RECENTLY Dr. Marie C. Stopes of the University of Manchester and Professor K. Fujii of the University of Tokio have published an extensive monograph on the Cretaceous plants of Hokkaido, Northern Japan. Among the remains described are species of Pteridophyta, Gymnosperms, and Angiosperms. The present communication has to do with one of the Gymnospermous species published by these authors, viz. *Yezonia vulgaris*, of which they state that 'it is impossible to find any family among the Gymnosperms with which we can satisfactorily include this plant. That it is a Gymnosperm is proved by the character of the wood of the main axis, by the guard cells of the stomates, as well as by a variety of minor characters.' It will be the aim of this article to show that *Yezonia* represents the unrecognized twigs of one of the commonest of the Mesozoic Conifers and that its affinities are with the Araucarineae. This state of affairs would in all probability have been recognized by the Anglo-Japanese authors had they been able to study the external form as well as the internal structure of their material. Unfortunately the condition of the material, which occurs in the form of nodules, and the methods adopted by these investigators made such inference difficult.

It will be well to describe in some detail the internal structure of the Jurassic and Cretaceous genus *Brachyphyllum*, especially in regard to the peculiarities of structure emphasized by Stopes and Fujii as characteristic of their supposed new genus *Yezonia*.

EXTERNAL FORM.

Figures of the superficial appearance of *Brachyphyllum* are common in all memoirs dealing with Upper Jurassic and Cretaceous plants. The reader may be referred to the recent memoir of Dr. Arthur Hollick and the writer for a representation of a species common in the Cretaceous deposits

¹ Contributions from the Phanerogamic Laboratories of Harvard University, No. 35.

of New Jersey and New York (Memoirs of the New York Botanical Garden, vol. iii, Studies of Cretaceous Coniferous Remains from Kreischerville, New York, Pl. 4, Figs. 12-14). It is obvious from these figures and similar ones published by other authors that in the case of *Brachyphyllum* we have to do with leafy twigs characterized by spiral phyllotaxy of fleshy leaves appressed to the surface of the stem and originating with a broad base. The leaves were free from the surface of the stem only along their extreme margins and were characterized by superficial striations converging towards the apex, marking lines of sclerified hypodermal tissue.

GENERAL INTERNAL STRUCTURE.

Fig. 1, Pl. LXV, shows a transverse section of a young specimen of *Brachyphyllum macrocarpum* from the Kreischerville deposit. Indications of the presence of five leaves may be seen on the surface of the stem, two of which are much broader because cut through their bases in the plane of section and are on the left of the figure. Three remaining leaves, cut nearer the apex, appear on the right. The central cylinder can scarcely be seen with the degree of magnification employed, but is composed of separate strands of xylem. Fig. 2, Pl. LXV, shows a somewhat tangential longitudinal section of a similar specimen. Here again a number of leaves occupy the margins of the figure. Several of the fibrovascular strands of the central cylinder appear in the middle of the figure. A bundle can be seen passing into the second leaf apex on the right of the figure. This is the normal mode of fibrovascular supply to the foliar organs of *Brachyphyllum*. Fig. 3, Pl. LXV, shows a tangential section through a leaf of the genus under discussion to illustrate the branching leaf veins, which distinguish this Conifer from the mass of other Mesozoic representatives of the order. The branching of the foliar strands is from above downwards, the figure being oriented in its natural position. To the left of the figure can be seen indications of the presence of stone cells, such as are common in both the cortex and pith of Cretaceous Araucarineae. In the outer portion of the leaf the numerous fibrovascular strands become merged in a broad zone of transfusion tissue. This is well shown in the longitudinal radial view presented in Fig. 4, Pl. LXV, the light stripe down the middle of the figure marking the position of the transfusion tissue.

THE STOMATA OF THE LEAF.

Fig. 5, Pl. LXV, illustrates the appearance of the outer and free surface of the leaf. Along the free margin is seen the epidermis thickened by a layer of hypoderma, the latter being interrupted opposite depressions in the surface of the leaf corresponding to the stomata. Fig. 6, Pl. LXV, represents the leaf surface in the vicinity of a stoma highly magnified. The

stomatic guard cells appear as two small elements of equal size in the centre of the figure. Over them impend the accessory cells, the whole stomatic apparatus strongly resembling the similar structures found in the leaf of the living *Pinus*. Above and below the stomatic guard cells and their accessory elements is the epidermis, strengthened by the hypodermal cells mentioned above. Fig. 7, Pl. LXV, shows the surface of the leaf of *Brachyphyllum* in tangential section. Lines of stomata can be clearly seen, in some instances separated by rows of elongated hypodermal fibres. Towards the lower side of the figure the plane of section dips into the mesophyll, while on the sides and above it passes out into the cuticle. Fig. 8, Pl. LXV, shows the epidermal and hypodermal structure somewhat highly magnified. The rows of stomata appear clearly in alternation with stripes composed of intervening hypodermal cells. The degree of enlargement is now sufficient to show that the hypodermal elements have a striated condition of the wall which is an artifact due to fossilization. The guard cells of the stomata appear as dark lens-shaped bodies on either side of the stomatic aperture. On the lower right-hand side, as well as on the upper left, the plane of section is deep enough to engage part of the cavities of the guard cells. Outside the guard cells lie the accessory cells, which are quite generally four in number. Comparison may be made between the two last figures and the one made from much less favourable material by Stopes and Fujii.¹ The magnification is less than that used in our Fig. 8, so that the details of structure stand out less clearly.

STRUCTURE OF THE AXIS.

The feature of the anatomical structure of the axis which the Anglo-Japanese authors most strongly emphasize in connexion with their genus *Yezonia* is the occurrence of irregularly alternating zones of thicker and thinner walled wood tracheides, which do not correspond to annual rings. Fig. 9, Pl. LXV, illustrates this peculiarity with particular clearness for *Brachyphyllum*. There are obviously two successive zones of thin-walled and thick-walled tracheides respectively. In Fig. 10, Pl. LXV, the same feature is shown less clearly in another specimen. Fig. 11, Pl. LXV, illustrates the same phenomenon under a higher degree of magnification. These figures may be compared with Text-fig. 9, *A, B, C, D, E*, and Text-fig. 10, *A, B, C, D*, of the memoir of Stopes and Fujii cited above. In our Fig. 10, Pl. LXV, may be distinguished the cortical and medullary sclerotic nests, which equally characterized *Brachyphyllum* and *Yezonia*, Stopes and Fujii. The Anglo-Japanese authors lay considerable stress on the presence of a layer of periderm in the outer region of the stem of their genus *Yezonia*. In the upper region of our Figs. 10 and 11, superior to the

¹ Studies on the Structure and Affinities of Cretaceous Plants. Phil. Trans. Roy. Soc., London, Series B, vol. cci, Pl. 3, Fig. 9.

cavities representing resin canals, may be seen a somewhat meandering zone of periderm. The general topography of this layer is shown more clearly in Figs. 1 and 4, Pl. 11, and Figs. 1 and 2, Pl. 12, of the joint memoir by Dr. Arthur Hollick and the writer, cited above. On the left of Fig. 11 of the present article may be seen with particular clearness the radial rows of periderm cells.

In Fig. 12, Pl. LXV, is shown a longitudinal section of the wall of the woody cylinder under a sufficient degree of magnification to indicate the height and position of the medullary rays of the wood. It is obvious that the latter are from one to two or three cells in altitude, precisely as in the description of the ray structure of *Yezonia*, Stopes and Fujii. The pitting in the tracheides of *Yezonia* also corresponds absolutely with that found in *Brachyphyllum*, for in both the pits occur in a single row on the radial wall of the tracheides. It has been observed in *Brachyphyllum*, especially in older stems, that the pits are flattened by mutual contact, as in the *Araucarineae*. This feature, however, is often not distinguishable in the wood of smaller twigs.

The Anglo-Japanese authors attach considerable importance to certain features of the resin canals in the cortex of their genus *Yezonia*. They found, for instance, that there is frequently a layer of periderm present outside the resin canals, which may in some instances invade the cavity of the canal itself. All these features are paralleled in *Brachyphyllum*, and are illustrated in Figs. 10 and 11 of the present article as well as in those of the large memoir cited above. They also emphasize the absence of any clearly defined epithelial layer around the secretory cavities or resin canals. A similar condition occurs in *Brachyphyllum*, as may be seen by examining the resin canals occurring in our Figs. 10 and 11. That resiniparous epithelial cells were really absent in the living plant is doubtful. It has been pointed out in an article written by Dr. Arthur Hollick and the present author¹ that the resin canals of *Brachyphyllum*, with a strong degree of probability, secreted both resin and mucilage, as is the case with the resin canals of *Araucarian Conifers* of the present epoch. The dark substance surrounding the resin canals in our Figs. 10 and 11, as well as the similarly indistinguishable cellular boundaries of the resin spaces described by Stopes and Fujii for their genus *Yezonia*, is in all probability of a mucilaginous nature or represents a combination of limiting cells and mucilaginous contents. We have found a similar obscurity of the limiting layer of the resin canals in the cone-scales of almost all the *Araucarian Coniferales* from the Kreischerville deposits. This condition is shown particularly well in Figs. 1, 2, and 3, Pl. 26, of our large memoir on the *Conifers of Kreischer-ville*. The feature emphasized by Stopes and Fujii has no special

¹ Affinities of certain Cretaceous Plants commonly referred to the Genera *Dammara* and *Brachyphyllum*. *American Naturalist*, xl, pp. 189-215, 1906.

importance and certainly cannot be interpreted in any way as indicating some affinity between the genus *Yezonia* and the Cycads as they suggest.

The consideration of the facts adduced in the foregoing paragraphs for *Yezonia* and *Brachyphyllum* makes it clear that these two genera agree absolutely in the following points: structure, relative size, phyllotaxy and venation of the leaves, including the organization and arrangement of the stomata in rows between hypodermal bands; anatomical structure of the fibrovascular tissues, including irregular zonal variations in the thickness of the tracheides not in any way corresponding to annual rings, pitting of the tracheides, height of the medullary rays; structure of the pith and cortex, stone cells being present in both; structure of the phloem devoid of the hard bast fibres characteristic of Cupressineous and Taxodineous Conifers; and finally by the presence of a broad transfusion zone in the outer region of the stem corresponding to the lower surface of the appressed leaves.

Or to put the matter in another way, if all the points of agreement between the description of the supposed new genus *Yezonia*, given on p. 32 of the memoir of Stopes and Fujii, and the account of the anatomy and habit of *Brachyphyllum*, given in the present article and in the large memoir of Dr. Hollick and the present author, were italicized, it would be necessary to italicize the whole description.

It is appropriate at this point to refer to another supposed new Gymnospermous genus described by the Anglo-Japanese authors. On pp. 52-7 of their memoir they refer to certain remains, which they designate under the name *Cryptomeriopsis antiqua*. These are characterized as densely leafy twigs, with falcate four-sided foliar organs, which have internally a single fibrovascular bundle flanked by downwardly curving stripes of transfusion tissue. There are three foliar resin canals. The stem possesses a woody cylinder traversed by low uniseriate rays, and the phloem is without the hard bast fibres found in living representatives of the Cupressineae and Taxodineae. In the pith were found evidences of the presence of stone cells. All these details of structure correspond absolutely with the account of the structure of *Geinitzia* (*Sequoia*) *Reichenbachii*, one of the commonest Cretaceous Conifers, given in the joint memoir by Dr. Hollick and the writer (op. cit., pp. 38-41, Pl. 5, Figs. 7-10, Pl. 8, Figs. 3 and 4, Pl. 16, Figs. 2-4, Pl. 17, Figs. 1-4, Pl. 18, Figs. 1-4). There can accordingly be little doubt that the *Cryptomeriopsis antiqua* of Stopes and Fujii is in reality not allied in any way to the Cupressineae and Taxodineae, but represents the leafy twigs of the well-known Cretaceous species *Geinitzia* (*Sequoia*) *Reichenbachii*, which, as has been pointed out by Dr. Hollick and the writer in the memoir so often cited in the present article, is in reality an Araucarian Conifer and has not the slightest affinity with the existing genus *Sequoia*, to which it has been most generally

referred by those who have studied it only in impressions. It is of course possible that the *Cryptomeriopsis antiqua* of Stopes and Fujii may not be specifically identical with *Geinitzia Reichenbachii*. In any case there can scarcely be any doubt as to the generic equivalence, and the species must be very closely allied.

CONCLUSIONS.

It will be apparent from the foregoing paragraphs that there is the closest superficial and structural resemblance between the genera *Yezonia* and *Cryptomeriopsis* of Stopes and Fujii and the Cretaceous genera, of world-wide distribution in the Northern Hemisphere, *Brachyphyllum* and *Geinitzia* respectively, so well known from impressions and recently described for their structural features as well. There seems accordingly no reason to maintain these new generic names since the older ones already hold the ground.

This conclusion as to the true affinities of these two supposedly new Cretaceous genera of the Anglo-Japanese authors will have the advantage of connecting the interesting Cretaceous flora of Hokkaido, Northern Japan, with the Cretaceous flora of the rest of the Northern Hemisphere. The validity of this conclusion is much strengthened by the nature of the Abietineous remains recently described by Miss Stopes from the same deposits, since these correspond closely, so far as they go, with the similar remains described structurally from the Cretaceous clays of Kreischerville, Staten Island, N.Y.¹ If this general inference is correct, and it seems supported by very strong evidence, it is clear that regions so widely separated geographically as Southern New England and Northern Japan were characterized during the Cretaceous period by a similar and characteristic Coniferous flora, including Abietineae and Araucarineae, the latter simulating in their external appearance both vegetative and reproductive genera of the Cupressineae and Sequoiineae (Taxodineae), which in reality did not exist at so early an epoch, and with which they certainly have not the slightest affinity.

SUMMARY.

1. *Yezonia*, Stopes and Fujii, is in reality *Brachyphyllum*, and as a consequence should be known, in accordance with accepted principles of nomenclature, only under the earlier generic name.
2. *Cryptomeriopsis*, Stopes and Fujii, is in reality another long known Cretaceous genus, *Geinitzia*, and should likewise be eliminated.
3. The Cretaceous Coniferous flora of Northern Japan had much in common with that described structurally and from impressions from the eastern coast of North America.

¹ Stopes and Kershaw, Ann. Bot., xxiv, No. 94.

DESCRIPTION OF PLATE LXV.

Illustrating Prof. Jeffrey's paper on the genus *Yezonia*.

- Fig. 1. Transverse section of young stem of *Brachyphyllum macrocarpum*. $\times 10$.
Fig. 2. Longitudinal section of a young branch of *B. macrocarpum*. $\times 10$.
Fig. 3. Tangential section of the leaf of *B. macrocarpum*. $\times 40$.
Fig. 4. Longitudinal radial section of older stem of *B. macrocarpum*, showing zone of transfusion tissue. $\times 40$.
Fig. 5. Transverse section through a part of the leaf of *B. macrocarpum*. $\times 40$.
Fig. 6. Section through the stoma of *B. macrocarpum*. $\times 180$.
Fig. 7. Tangential section of surface of leaf of *B. macrocarpum*, showing stripes of hypodermal tissue and rows of stomata. $\times 80$.
Fig. 8. Stomata of the same much more highly magnified. $\times 180$.
Fig. 9. Part of woody cylinder of *B. macrocarpum*, showing the irregularly thickened zones of tracheids. $\times 80$.
Fig. 10. Another specimen, less highly magnified, showing resin canals and periderm above the zone of wood. $\times 40$.
Fig. 11. The same in a different region more highly magnified. $\times 80$.
Fig. 12. Section through the wood of the wall of the fibrovascular cylinder of an older specimen of *Brachyphyllum*. $\times 40$.

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Jeffrey, Edward C. 1910. "On the affinities of the genus Yezonia." *Annals of botany* 24, 767–773. <https://doi.org/10.1093/oxfordjournals.aob.a089303>.

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