A New Araucarioxylon from New Zealand.¹

BY

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With Plate XX and three Figures in the Text.

TWO years ago Mr. J. Allan Thomson, Palaeontologist to the Geological Survey of New Zealand, sent me a specimen for description of which he wrote: 'I have a fine specimen of wood with bark preserved, from the base of the Cretaceous as developed at Amuri Bluff.' Later on he kindly gave me further information about its geological horizon: 'At Amuri Bluff the wood sands lie beneath a calcareous conglomerate which contains ammonites, belemnites, *Trigonia*, *Inoceramus*, and *Aporrhais*. This in turn is overlain by mudstones with saurians (*Cimiliosaurus*). There has been so much discussion as to whether certain Tertiary beds higher up in the section are conformable or not to the Cretaceous that the fact that there are undoubted Cretaceous beds is not always made clear.'

Though the necessary work on the mollusca in the beds above the wood-containing beds is not yet completed, it is clear that our fossil is certainly Cretaceous, and probably of mid-Cretaceous age.

The wood contains several interesting details in its structure, and the surprising paucity of fossil remains of Araucarians in the very region where they are now native renders its description desirable, particularly at present, when the Araucarineae are being so much discussed.

DESCRIPTION OF THE SPECIMEN.

General. The fossil consists of part of a small trunk or branch, and is at present roughly circular in outline and about 8 cm. in diameter. It may have been part of a much larger stem, and certainly must have been at least a little larger when alive because it is now entirely decorticated. When first observed the trunk appears to consist of a smaller woody core, surrounded

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by a thick bark, as is seen in Pl. XX, Photo 1. This deceptive appearance depends on a *peculiarity of petrification*: the central region, of darker and denser structure, is about 3–4 cm. in diameter, and rather irregular in out-

TEXT-FIG. 1. Transverse section of part of the wood, showing the sharp alternation between spring and autumn wood, *a, a*, limits of annual rings. *m*, medullary rays, bordered by special thick-walled tracheides *r.t.* *e* shows one of these with thick wall, but empty of resin; *x* shows some with thick walls and resin deposit round them.

line; its boundary bears no relation to the limits of the annual rings, but cuts sharply across them, as can clearly be seen in Photo 1, *s*; the outer zones of the fossil, as at *c*, are also composed of petrified rings of secondary

wood: the distinction between the two regions of the same woody trunk depends on the fact that the core is silicified and the outer zones preserved in carbonates. The contrast between the two regions is very well marked when weak hydrochloric acid is poured on the cut surface: the inner zones are not affected at all by the acid, but stand out like a placid island in a surrounding sea of excited effervescence. It is noticeable that the inner zones of the wood of the carbonate region (that is, those which lie just outside the part preserved in silica) are very poorly preserved, or are entirely eliminated. It looks as though the change in the petrifying medium had upset the preservative properties of the mineral. The outer zones of the wood, though in the carbonate matrix, are fairly well preserved. The mineralization of this specimen suggests a number of interesting problems concerning the mode of penetration of two different petrifying fluids, the possible priority of one and its replacement by the other, the time required for the preservation of the wood, &c.; but this one specimen does no more than suggest, it does not solve the problems it raises.

Topography of the Stem: Pith. Owing to imperfect petrification, and also to a break in the centre of the stem, little of the pith remains. It is clear, however, that it was small (i. e. not more than 1 mm. in diameter), and that the cells composing it were rather large and irregular in outline.

Growth rings are exceedingly well marked. The autumn wood cells are so thickened as almost to obliterate the cell lumen. The size of the rings varies from about 1 mm., consisting of about 36 cells, to small rings of about 10 cells in radial sequence. On an average the spring wood is about equal to the autumn wood in extent (see Photo 3), but owing to its markedly thinner walls it tends to be crushed in many parts of the specimen.

Wood elements. The radial diameter of the tracheides varies from 25 to 36 μ on an average, the last cells of the autumn wood being much less than this (see Text-fig. 1, *a*). Thickened 'resin' containing tracheides are noticeable on either side of the ray, and will be described below. The general build of the tracheides both of spring and autumn wood is indicated in Text-fig. 1 and Photos 3 and 4. But few pittings are to be seen in transverse section; in longitudinal section the preservation is not very sharp, but a number of elements show the typical Araucarian pitting, as indicated in Text-fig. 2, *t*. In the majority of the elements which show pitting at all, the pits are biseriate, alternating, and mutually hexagonally compressed. Special tracheides contain tannin (see below). Wood parenchyma was not observed.

Medullary rays. Simple, uniseriate rays are numerous throughout the wood. In radial extension they tally with 3-4 tracheides. The rays are principally 3 and 4 cells high, as judged from 133 counts in various regions of the sections.

	6	rays	were	1	cell	high,
20	„	„	2	cells	„	
42	„	„	3	„	„	
43	„	„	4	„	„	
15	„	„	5	„	„	
6	„	„	6	„	„	
1	„	„	7	„	„	and none were higher than seven.

The cells of the ray are all alike, and undifferentiated into various types of elements (see Text-fig. 2 and Photos 5, 6 and 8). In radial sections the ray pitting can clearly be seen, at *mr*, Text-fig. 2, and in

TEXT-FIG. 2. Radial section of wood showing 'resin spools', *rs*; the pitting on the tracheides *t*, and the pitting on the ray-cells *mr*.

Photo 6 in several cells along the ray *mr*, also in Photo 8 on a larger scale of magnification. These pits are in groups of five or six, and are bordered. The slit is very noticeable in some cells, and is placed obliquely, which is the case in all living *Araucarians*, according to Thomson ('13).

Resin-containing tracheides. In both radial and tangential sections the most noticeable feature is the extensive 'resin' deposit in the elements neighbouring the medullary rays (see Photos 5, 6, 7 and 8, and Text-figs. 2 and 3). In transverse sections the radial series of tracheides running on either side of the medullary ray are generally differentiated from the others more or less noticeably, both by the thickening of their walls and by the filling up of their lumina by resin-like, thick contents. These can be seen at *rt* in Photo 2, and more clearly in Photos 3 and 4. Owing to the opaque nature of the fossil, even Photo 4, clearly as these cells show in it, does not convey quite the same noticeable contrast between these cells and the other

tracheides as is evident to the eye of the observer. Text-fig. 1 perhaps gives a fairer idea of the appearance of the woody tissues. These cells show up particularly well where the summer wood is just a little crushed, as in Photo 3, where, outlining the slightly wavy rays, the blackened and relatively uncrushed resin-containing tracheides on either side of them show up distinctly. This is enlarged in Photo 4. The deposit of 'resin' collects in the form of large discs or 'spools' opposite the middle of the medullary rays, the lateral extensions of these discs running up and down the containing cell-wall for some distance (see Text-figs. 2 and 3 and Photos 5, 6, 7, and 8). As a consequence of the great quantity of this deposit there is a black, wing-like mass on either side of the medullary rays, as seen in a low-power view of the tangential section (see Photo 7), which gives the wood an unusual appearance. The rays are also rendered very conspicuous in radial section (see Photo 8).

The extent of this phenomenon seems to be greater in this fossil than in any other described form.

Some mention of such an appearance on a lesser scale has been made by Penhallow ('07), Lignier ('07) and Jeffrey ('12), but without great emphasis or much illustration. I had nearly finished my work on this new fossil, and concluded that it was very exceptional in the extent of its 'resin-spool' tracheides, when Professor Thomson's ('13) paper reached me. He gives, for the first time, adequate treatment and illustration to this peculiar feature; and as his work has largely forestalled what I had to say on the subject, I cannot do better than refer the reader to his paper, pp. 23-28, as I agree with his conclusions. The present fossil, however, seems to show this character even more markedly than the plants he mentions, so that its description appears justified and may help to draw attention to an interesting feature in the evolution of resin-containing tissue which has been considerably overlooked.

In 1907 Penhallow (pp. 53-58, Text-figs. 4-7) described the wood of living Araucarians as showing 'more or less numerous elements containing resin' which may be scattered, but are more commonly in rows next the medullary rays. He said: 'The walls of the tracheides may be much thicker just opposite the ray where the resin plate comes,' and he thought that in *Dammara* and *Araucaria* these resinous tracheides may be of specific value. Lignier ('07, Pl. XVII, Fig. 2), from his new species *Cormarauca-xylon crasseradiatum*, gives an outline drawing of a portion of a medullary ray with specially thickened tracheides on either side. Regarding Lignier's and Penhallow's interpretation of these tracheides as having a thickened wall, Jeffrey ('12, p. 538) says: 'Lignier has described the thickening up of the tracheides adjacent to the rays in certain Araucarian woods from the French Jurassic. It seems entirely probable that he has mistaken resin-filled tracheides for thick-walled ones.' Jeffrey continues, saying that his

own Fig. *f* 'makes it clear that the apparently thick-walled tracheides are in reality only tracheides more or less occupied by a plugging exudation from the rays'. While I think that the excessive thickness indicated by Professor Lignier is probably due to resin deposited round the wall (cf. Text-fig. 1, *x*), it is certain that the view that these tracheides do have thickened walls is correct. Professor Jeffrey's figures are on a very small scale of magnification, and are taken from a specimen in which the phenomenon is not nearly so fully developed as in other cases, and they do not suffice to disprove the view that these tracheides have thickened walls *as well* as resinous contents. Reference to my Pl. XX, Photo 4, as well as Text-fig. 1, will make it abundantly clear that in this fossil the walls are thicker

TEXT-FIG. 3. Tangential section showing the 'resin spools' *r.s.* on either side of the rays.

than in the adjacent tracheides, (1) because there the thick walls are, and (2) because where the rest of the wood cells with their thinner walls are somewhat crushed and distorted, as in Photo 3, the rows on either side of the ray are rounded and uncrushed, and stand out as of sturdier build even in the cases where they are empty of their resin contents. In the living *Agathis australis*, where a similar, though less marked, phenomenon occurs, the thickening of the wall in the region of the ray is readily observable and is well figured by Thomson ('13, Pl. V, Fig. 44 *b*).

Penhallow made a comparison between these 'resin-spools' and the trabeculae of Sanio. This could only have been suggested by the ordinary cases where the amount of the deposit is very small. Had such an example as the present fossil been the first to be observed, no such comparison could have been made.

COMPARISON WITH PREVIOUSLY DESCRIBED SPECIES FROM
NEW ZEALAND.

The poverty of records of fossil Araucarians from this region has already been remarked. Ettingshausen ('87, '91) has described a few impressions of foliage and imperfectly preserved woods from beds then called Tertiary, but some of which are now known to be Cretaceous. From foliage impressions he founded a species *Araucaria Haastii* in 1887 (p. 154, Pl. II, Figs. 1, 2) which has an axis richly set with leaves which are truly Araucarian in appearance, and agree closely with the living *A. chilensis*, Mirb. His *diagnosis* of the species takes into account only the external morphology, nevertheless following this diagnosis he appends the remark, 'A petrified wood has been found in the Tertiary strata at Malvern Hills which agrees best with that of *Araucaria*, with which species I classify it'. He then figures and describes a few details of the wood, which is poorly preserved, including it in the name *A. Haastii* just given to *foliage* impressions, without even referring to the fact that there is not the slightest evidence that the wood and the leaves belonged to the same plant. Modern palaeo-botanical diagnosis will not, of course, allow this name to stand; but for the present purposes of this paper I shall continue to call the wood *A. Haastii*.

Ettingshausen describes another Araucarian foliage branch with smaller leaves, under the name *Araucaria Danai*. The original specimens of the Paratypes, kindly sent me by the Geological Survey of New Zealand for examination, are very poorly preserved and I should hesitate very much to base a species on such foliage.

Under the one name *Dammara Oweni* Ettingshausen describes the impression of a cone, a cone scale, a leaf, and a piece of wood (!), all detached fragments, about which he had no evidence that they really belonged to each other. Consequently, they cannot properly be included under the one name. This material, however, does not seem to me to be well enough preserved to justify the founding of three fresh names for it, though an ardent species-monger will be bound to do so some day. The wood which is included in this comprehensive name *Dammara Oweni* appears truly to be a different species from the so-called *A. Haastii*, having very much larger pits, with closely adjacent hexagonal areas instead of the small, rounded, and separated borders of *A. Haastii*.

These records, it is evident, are of little phylogenetic or morphological value.

The New Zealand Geological Survey kindly sent me the type specimen of the wood described by Ettingshausen as *A. Haastii*, with permission to cut it for comparison with the present fossil. It is part of a trunk, larger

than the new one now described, and is very poorly preserved, so that accurate comparison is not possible.

In the following points the new specimen differs from *A. Haastii*. *A. Haastii* has rather larger tracheides (about $45\ \mu$ as against 25 to $36\ \mu$), with less rounding at the corners; the bordered pits are rounded and separated by considerable areas of tracheide wall; the rays are higher than in the new fossil, averaging 2 to 5 cells and running up to as many as 16; and the 'resin-spools' are not evident.¹ Consequently, the new specimen cannot be the same plant as the so-called *Araucaria Haastii*, and as I am not aware of any other specimen with which it might be included, I will therefore proceed to name and diagnose it as a new species.

Araucarioxylon novae zeelandii, sp. nov.

Diagnosis. Characters of a typical *Araucarioxylon*. Growth rings exceptionally well marked, tracheides uniform, 25 to $36\ \mu$ in diam., radial rows uninterrupted. Tracheides adjacent to medullary rays with noticeably thickened walls, filled with 'resin' which makes very large and conspicuous 'spools' on either side of the ray cells in tangential and radial section. Rays uniseriate, undifferentiated, 1 to 7 cells high, principally 3 and 4 cells high.

Type. Block and sections, Geological Survey, New Zealand.

Age. Cretaceous [Mid-Cretaceous?].

Locality. Amuri Bluff, New Zealand.

The existence of such well-defined growth rings in an Araucarian of Cretaceous age in this region is of special interest because it affords evidence which is strongly presumptive of well-marked seasons. Mr. Allan Thomson writes that this is the first piece of evidence obtained in New Zealand on this point either from plant or animal fossils. It is well known that among living Araucarians annual rings are by no means always clearly developed. A *résumé* of the various views on the annual rings in this family is given by Professor R. B. Thomson ('13, p. 32), and he says that in a Cretaceous species he has found poorly marked growth rings of irregular occurrence. The present specimen, however, has such extremely well marked rings that there is every reason to see in them true annual

¹ Though I greatly object to naming such poorly preserved material, as this specimen is an original type of Ettingshausen's, and as I have examined new sections of it, and as its name cannot stand, I must propose a new name for it. The pitting is very poorly preserved and I cannot see the ray pitting at all, but the round widely separated pits leave me in doubt if it is an Araucarian. ? *Araucarioxylon Ettingshauseni*, sp. nov.

Diagn. Tracheides average $45\ \mu$ in diam.; bordered pits rounded and separated; rays chiefly 2 to 5 cells high, up to 16. 'Resin-spools' not evident.

Type. Ettingshausen's wood included in his foliage species *Araucaria Haastii*; very poorly preserved.

Age. Doubtfully Cretaceous.

- SEWARD, A. C., and FORD, S. O. ('06): The Araucariaceae, Recent and Extinct. Phil. Trans. Roy. Soc., Lond., B., vol. cxcviii, pp. 305-411, Pls. XXIII-XXIV.
- THOMSON, R. B. ('13): On the Comparative Anatomy and Affinities of the Araucarineae. Phil. Trans. Roy. Soc., vol. cciv, pp. 1-50, Pls. I-VII.

EXPLANATION OF PLATE XX.

Illustrating Dr. Marie Stopes's paper on a new *Araucarioxylon* from New Zealand.

All figures illustrating *Araucarioxylon novae zeelandii*, sp. nov. Photos 1, 3, and 4 taken by Mr. Herring, and 2, 5, 6, 7, and 8 by Mr. Pittock.

1. Part of the area of the petrification, showing the whole central core of silicified wood (this shows up darker than the rest, its broken outline marked at *s*) surrounded by less well preserved zones in carbonate, the outer regions at *c* showing again the annual rings and the wood tissue fairly well preserved. ($\times$ slightly over 2 diam.)

2. Small part of transverse section. *rt*, resin-containing tracheides bordering annual rings.

3. Transverse section showing clearly the alternation of spring and autumn wood; the spring wood slightly crushed, through which the resin-containing tracheides bordering the medullary rays stand out very clearly.

4. Part of Photo 3 highly magnified. *aa*, limit of annual ring. The contrast between the thin-walled summer wood and the thicker-walled, resin-containing tracheides running on either side of three rays shows up very clearly at *x*.

5. Radial longitudinal section of the wood showing the masses of the 'resin-spools'.

6. Portion of a similar section, showing also the pitting of the ray cells along ray marked *mr*.

7. Tangential section of wood, showing the rays with the wing-like masses of resin adjacent to each.

8. High power view of radial section, showing two medullary rays largely obscured by the quantities of 'resin-spools'. Below *mr* the pitting of the ray cells can be seen.

5.

6.

7.

2.

4.

3.

STOPES — ARAUCARIOXYLON.

Stopes, Marie Carmichael. 1914. "A new Araucarioxylon from New Zealand." *Annals of botany* 28, 341–350.

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