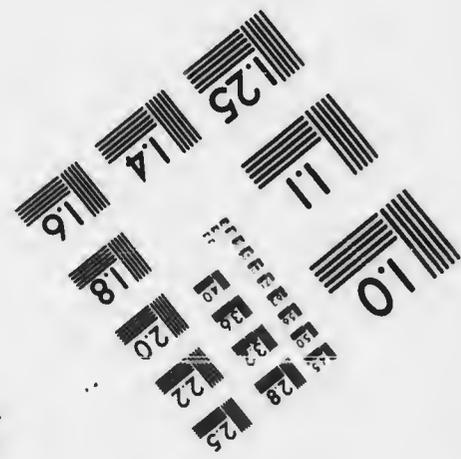
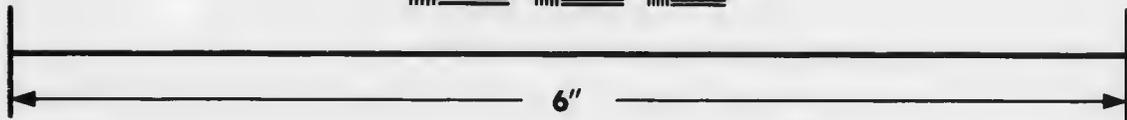
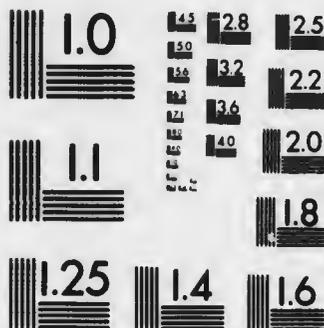


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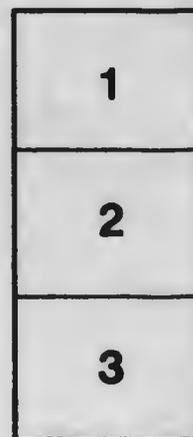
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NOTES on PROTOTAXITES and PACHYTHECA discovered by DR. HICKS  
in the DENBIGHSHIRE GRITS of CORWEN, N. WALES. By PRIN-  
CIPAL DAWSON, LL.D., F.R.S., &c., McGill College, Montreal.

SPECIMENS of the first-mentioned fossil were kindly sent to me by Dr. Hicks, at my request, but unfortunately arrived when I was at my summer residence at Little Metis. Though without the means of examining them microscopically, I ventured to write, after studying them with a good pocket-lens, that they resembled *Prototaxites*, and could not be referred to Algæ. The latter conclusion might appear rash; but there are, to the practised eye, indications in specimens of this kind which can scarcely deceive. The fibrous and highly carbonaceous nature of the darker specimens, and the silky and incoherent texture of the lighter-coloured ones, are characters never found in any fossil plants except those having durable woody tissues. Further, the occurrence of the material in angular fragments and in a condition approaching to that of the mineral charcoal of the Coal-measures, proves subaerial decay, little likely to have occurred in the case of aquatic plants. From the state of preservation of the specimens, I also inferred that, if really of the nature of *Prototaxites*, they might throw some additional light on its structure, as the specimens previously studied had been from entire trunks in a silicified state.

On my return to town, I found awaiting me the Journal of the Geological Society containing Dr. Hicks's paper; and the figures there given showed at once the correctness of the reference made by Mr. Etheridge of the plant to *Prototaxites*, and its close resemblance to *P. Loganii*\*, except in the appearance of bifurcating fibres, a character which I have not observed, and which may be merely an error in observation or in drawing.

Portions of the specimens sent by Dr. Hicks were at once prepared, not only by slicing but by treatment with boiling nitric acid, and by diffusion of the more lax fibres in water and in Canada balsam. On examination they gave the results stated below.

In state of preservation the two kinds of specimens examined are somewhat different. The dark variety has the long cells or woody fibres filled with rods of transparent siliceous matter, and the walls are represented by a thick structureless layer of carbon, which often shows angular cracks, such as appear in the walls of thick-walled woody fibres when carbonized. These cracks are sometimes transverse, giving a scalariform appearance, but they do not represent a true structure. The internal siliceous casts, when bared by nitric acid of their carbonaceous coating, show here and there transverse or spiral markings, produced by the projection of the ligneous lining on the inner side of the cells. There is no trace of

\* Report on Devonian Plants of Canada, 1871. pl. ii.

the intercellular flocculent matter produced by decay of the outer surfaces of the cells or their connecting tissue, such as I have described in the silicified trunks of *Prototaxites*.

The lighter-coloured variety has probably been originally preserved in a similar manner; but the woody envelope of the fibres has been entirely removed, leaving only the siliceous internal casts, which are so lax that they can be scraped into water and viewed as transparent objects without slicing. This is precisely the state of the asbestos-like silicified Coniferous wood found in the gold gravels of California. These rod-like siliceous casts preserve on their surfaces distinct traces of the irregularly spiral ligneous lining of the perished cell-wall. A few of them also show rounded bodies of brownish colour in their interior. These may be ferruginous concretions, but are possibly granules of resinous matter, in which case such tubes may represent resin-cells.

In all the above particulars these specimens confirm my original determination of the woody character of *Prototaxites*, to which genus they undoubtedly belong. They differ, however, from *P. Loganii* in the smaller diameter of the fibres, and in the ligneous lining, which presents the appearance of interrupted transverse bands rather than regular spirals. These characters would seem to indicate a distinct species, which may therefore be named *P. Hicksii*, in honour of its discoverer\*. I may recall here a statement made in my report on the Devonian plants of Canada, that in 1870, when Mr. Etheridge was so kind as to permit me to examine the slabs in the Jermyn-Street Museum, with *Pachytheca* of Hooker from the Ludlow, I recognized, associated with this, fragments of wood having the structure of *Prototaxites*. The similar association in Dr. Hicks's specimens and the peculiar fibrous structure of the walls of *Pachytheca*, as figured by Mr. Etheridge, may well excite the suspicion that these bodies are connected with *Prototaxites*, especially as similar round bodies are seen in beds holding this fossil in Canada, though without distinct structure. In this connexion it is to be observed that the bodies in question are probably seeds rather than spore-cases, and that they have the structure of *Ætheotesta*, to which, in a recent paper in the Journal of the Geological Society†, I have referred a similar seed, found in the Devonian of Scotland.

With reference to the affinities of *Prototaxites*, I have not made the crude assertion attributed to me, that this plant "belonged to Taxineæ." I merely compared its structure to the lax spiral fibre of some Taxine trees, and especially to certain Taxine woods fossilized after long immersion in water, with which we are familiar in the Tertiary formations. This was all that was intended by the name *Prototaxites*, except to suggest that this plant was one of the prototypal gymnosperms of the Palæozoic period. Further, in consequence of its upper limit in Canada being apparently the Lower Devonian, where it comes into contact with the wood of the earliest species of *Dadoxylon*, I have conjectured that it would be found in much older

\* Instead of *Nematophycus Hicksii*, as proposed by Mr. Etheridge.

† Vol. xxxvii. p. 306, pl. xii. fig. 14.

formations\*, and am therefore not surprised to find this conjecture realized by the discovery of Dr. Hicks.

In the specimen sent to me there appears, besides the fragments of *Prototaxites* and a few rounded impressions probably of *Pachythecca*, a fragment of the rhizoma of *Psilophyton* and portions of epidermal tissue. The state of preservation of these bears additional testimony to the woody and durable texture of *Prototaxites*. Still further, in recent explorations in the Bay de Chaleur, I have found in the Lower Devonian silicified trunks of *Prototaxites* two feet and a half in diameter; and these lie in beds abounding in entire specimens of *Psilophyton*, some of them apparently in the place of their growth, and in a formation which contains only land plants, associated in some layers with remains of fishes and of bivalve Crustaceans, minute Gasterepods, and *Spirorbis*, the whole much resembling the coal-formation in its mineral character and grouping of fossils. The idea that *Prototaxites* may have affinities with Algæ has been sufficiently disposed of in my communication to the 'Monthly Microscopical Journal' in 1873; and the characters and state of preservation of Dr. Hicks's specimens fully confirm the reasoning in that paper. The large specimens recently obtained at the Bay de Chaleur also enable me to reaffirm the existence of a dense coaly bark at the surface of these trees. Some of them show on their weathered ends evidence of remarkably regular exogenous rings, extending from the surface nearly to the centre. There may, however, have been an internal axis or medulla, different from the outer structure; and this I hope to be able to ascertain by series of slices from the centre to the circumference of the trunk.

I have lately had a number of slices made of the large silicified trunks found last summer near Campbellton, New Brunswick. They present appearances of a very peculiar and interesting character. In the better-preserved specimens the large cylindrical fibres are filled with rows of rounded concretions of silica, often enclosing limpid hexagonal crystals. In many cases they present the most deceptive resemblance to the bordered pores of coniferous wood, and in other modes of occurrence might be mistaken for spores of some parasitic fungus. Under polarized light, however, they are seen to be merely crystalline and concretionary; and when the fibres show their true structure, this is reticulated or spiral, as in the ordinary specimens of *Prototaxites*. In many parts of these specimens, however, the formation of granular crystals of quartz has completely disorganized the structure. I have referred to concretionary appearances of the kind above described, in my "Report on the Devonian Plants of Canada," as occurring in the Gaspé specimens of *Prototaxites*; but they are coarser and less beautiful than in those from Campbellton.

It is possible that these appearances may throw some light on the globular bodies observed in the cells of the Welsh specimens of *Prototaxites* and *Pachythecca*, though I cannot certainly affirm that the latter are concretionary and not structural.

\* Report on Devonian Plants.

I have sent a fragment of the Campbellton *Prototaxites* to Mr. Carruthers, and have no doubt that, if sliced, it will show the peculiar state of mineralization above described.

Mr. Hicks having been so kind as to send me a specimen of the *Pachytheca* from Corwen, I have compared it with Mr. Etheridge's figures and description, and with similar objects from this country and elsewhere. Mr. Etheridge's figures very accurately represent the specimen examined by me; but I would make the following additional remarks. The specimen is globular, but slightly flattened in the plane of the bed. It is three millimetres in diameter, and consists of an internal globular nucleus of granular texture, rather more than one millimetre in diameter, surrounded by a thick testa or outer envelope of radiating fibres. The fibrous part is in the same state of preservation as one of the kinds of associated fossil wood, the walls of the fibres being carbonized and the cavities filled with transparent silica. Under high powers the "spore-like bodies" referred to by Mr. Etheridge resolve themselves into alternate swellings and contractions of the cavities of certain of the fibres, others presenting a more uniform cylindrical form. The latter occasionally show the irregular transverse bands observed in the wood of *Prototaxites* from the same locality. The internal nucleus is apparently wholly granular, as if it had been composed of parenchymatous tissue.

There are in my cabinet specimens of similar bodies in a pyritized state, from the Upper Silurian (Lower Helderberg) of Cape Bon Ami, in New Brunswick, where they are found associated with fragments of wood of *Prototaxites*. Though on the whole less perfectly preserved, as to structure, than the Welsh specimens, when sliced in certain directions they present traces of a micropyle and embryo, and are, in my judgment, true seeds.

There seems little doubt that these New Brunswick specimens and those from Corwen may be referred to Brongniart's genus *Ætheotesta*, and that they are nearly allied to my *Ætheotesta devonica* from the Devonian of Scotland (discovered by Rev. Thomas Brown, of Edinburgh). In connexion with the structures observed in the Corwen specimens, it is worthy of note that Brongniart says of his species *Æ. subglobosa*, from the coal-formation, that the testa is "thick, homogeneous, formed of fibres or elongated cells perpendicular to the surface. These fibres appear, in one specimen, to be intermixed with little globular cells, possibly in consequence of alteration of the tissue"\*.

This is precisely the appearance presented by the testa of *Pachytheca*. Brongniart's *Ætheotesta* is undoubtedly a seed, and he compares it with the nut-like seeds of *Taxinæ*.

*Pachytheca* has now been found associated with *Prototaxites*, not only at Corwen, but also in the Upper Ludlow of England, in the Upper Silurian of Cape Bon Ami, and in the Lower Devonian of Bordeaux Quarry opposite Campbellton in New Brunswick; and since the structure of the Corwen specimen corresponds with that of *Pro-*

\* Annales des Sciences, tome xx. série 5.

*totaxites*, the presumption becomes strong that the connexion is not accidental. Under these circumstances, and considering the Taxine affinities of *Æitheotesta*, it would seem that *Pachytheca* may be accepted as affording some corroboration of the gymnospermous nature of *Prototaxites*\*.

Dr. Hicks has also sent a specimen of the so-called "microspores" found with *Pachytheca*. They occur in this specimen in a little semicircular patch or group, and are represented by mere impressions without any trace of organic matter. The lobed or furrowed appearance which they present gives to some of them the aspect of tetraspores enclosed in mother-cells, like the "*Triplospores*" of Brown, in which case they might, as suggested by Mr. Carruthers, be Lycopodiaceous; but these furrows are so irregular that they may be accidental wrinkles. The occurrence of these objects in patches or groups suggests affinities with the *Parka decipiens*† of Fleming, a Devonian fossil at one time believed to be vegetable, but more recently referred to ova of Crustaceans. Similar groups of small rounded bodies occur in the Devonian of Gaspé; but I have not been able to decide as to their nature.

#### DISCUSSION.

The PRESIDENT referred to the wide interest which the discoveries of Dr. Hicks had evidently excited.

Mr. CARRUTHERS referred to a specimen sent to him by Dr. Dawson, which had its structure beautifully exhibited externally from weathering, and which he hoped to study by means of sections. He thought that Dr. Dawson's ideas were the result of having examined the specimens by imperfect means. He insisted that the minute structure of these plants was quite different from that of Conifers. The stems are made up of interlacing tubes: the smaller, which crossed the larger obliquely, were not spiral fibres inside wood-cells as supposed by Dr. Dawson. He thought no one acquainted with the minute structures of Coniferous wood and of Algae could be led to accept the views of Dr. Dawson. The pseudo-exogenous structure is found in some living Algae, as in *Laminaria*. With respect to *Pachytheca* he had always experienced great difficulty at arriving at any conclusion. He

\* It occurs to me to add here that the beds in which *Prototaxites* is met with, in Gaspé and near Campbellton, contain no marine remains, but only land-plants; and though it would appear that in the Corwen beds the plants are associated with marine remains, yet the nature of the specimens sent to me is evidently of littoral rather than deep-sea character, and here also they are associated with land vegetation. These modes of occurrence, as I have elsewhere pointed out, are not in harmony with the supposition that in these plants we have to deal with great oceanic Algae. Nor does this supposition accord with the fact that the wood of *Prototaxites* retains its form and is silicified in beds in which herbaceous land-plants are perfectly flattened.

† Lyell, 'Student's Elements,' p. 444; Nicholson, 'Palæontology,' vol. i. p. 382 (Dr. Hicks has, I see, made the same suggestions in his "Additional Notes," Quart. Journ. Geol. Soc., Feb. 1882).

thought that Sir Joseph Hooker was justified in referring it to Lycopodiaceæ from the materials at his command. He had long known that *Pachythea* had a cellular structure filling its interior, consisting of tubular cells like those of the wall, but matted together. He was inclined to doubt whether they are really vegetable, and may not be animal remains. Mr. Storrie, of Cardiff, had sent him, years ago, well-preserved and beautifully prepared sections of *Pachythea* showing the whole from centre to circumference; these led him to doubt their vegetable origin. He wished that zoologists would examine *Pachythea*. He was satisfied, from the specimens on the table exhibited by Dr. Sterry Hunt, that the *Eopteris* of Saporta is really not a plant but a crystallization of pyrites, as suggested by M. Meunier-Chalmas.

Dr. DUNCAN remarked upon the wonderful discrepancies of opinion that prevailed. He did not regard the central part of *Pachythea* as a mycelium. He regarded it as the float or conceptacle of a seaweed.

Prof. JUDD stated that he exhibited, on behalf of Mr. THISELTON DYER, two sections of *Pachythea*. Mr. Thiselton Dyer regretted that he was unable to be present at the Meeting, but had sent Prof. Judd a letter, from which he read the following extract:—

“ Kew,  
November 15, 1881.

“ I have to thank you for drawing my attention to the paper and discussion in the August number of the Quarterly Journal. Having read this, I venture to think that the specimens which I am placing in your hands may be found of some importance if exhibited at the meeting.

“ Their history is briefly this. Some time ago Sir Joseph Hooker received from Mr. Grindrod a number of specimens of *Pachythea in situ* on pieces of rock. As these examples of the fossils were apparently well preserved, two or three were detached and intrusted to Mr. Norman, who made the sections which are now in your hands. Sir Joseph Hooker did not see his way to any definite conclusion as regards the structure which they exhibited. He, however, allowed me to examine them, and they have since remained in my possession. The conclusion which I arrived at was that their structure agreed, in general plan, with that of *Codium*, as shown in Kützing, ‘Phycologia Generalis,’ pl. 42. f. 1.

“ As a possible algal nature has been suggested for *Pachythea* by Mr. Etheridge, I think it may not be considered presumptuous on my part to now state that I have been of opinion, ever since I studied the sections, that *Prototaxites* and *Pachythea* are both referable to the same morphological type of structure. The radiating cells in the latter terminate internally in loosely interlacing slender filaments, with which the central cavity has been apparently filled. *Pachythea* does not resemble any type of sporangium with which I am acquainted; the structure, as displayed in the specimens, has a certain resemblance to that of the sporocarp of *Pilularia*; but I cannot reconcile what I have seen of it with the supposition that it

was a reproductive structure belonging to any type of vascular cryptogam.

"According to the view which I take of *Pachytheca*, it was an algal organism, closely resembling in essential structure a diminutive *Codium*, but with the peripheral cells branched instead of simple. I do not see any evidence to lead me to suppose that it was related to *Prototaxites* as a sporangial organ. The existence of *Prototaxites* on modern biological views necessarily implies the existence, at some time or other, of allied forms; and I do not see why *Pachytheca* should not have been a contemporaneous one."

Dr. Hicks explained the way in which the specimens had come into Principal Dawson's hands.

The PRESIDENT supported Mr. Carruthers's views as to the non-coniferous character of *Nematophycus*. With regard to *Pachytheca* he felt great doubts.

