NOTES ON THE FOSSIL SPORES IN AN OIL-SHALE FROM TASMANIA.

By

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Plate IX. and Three Text-figures.

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Tasmanite is an oil-shale known to occur in the Permo-carboniferous (1) of the North and North-Western districts of Tasmania. The shale is of sedimentary origin and is brownish grey in colour, being largely impregnated with spores which have been named by Newton as *Tasmanites punctatus* Newt. (2). On distillation the shale yields an artificial petroleum which is claimed to be obtained from these spores (3). Thus it is chiefly for its economic importance rather than palæo-botanical that it has been engaging the attention of investigators from time to time.

During the course of an examination of these spores, few points have come to notice which deserve mention.

As stated above, the shale is mainly composed of spores. They appear—even with the naked eye—as flattened circular dot-like bodies, thousands of them sticking to the fine-grained arenaceous matrix. When a small piece of the shale is gently crushed and stirred under water in a ptre-dish, the spores, being lighter, separate off from the heavy sandy particles. On treatment with *Diaphanol* they become somewhat bleached and show the structure more clearly. They, however, are rather averse to taking up stains except for a little of Safranin.

When not damaged the spores are circular and are of varying size (fig. 1)—200 μ to 533 μ in diameter (4). The

(1) McIntosh Reid, A. (1926), p. 43.

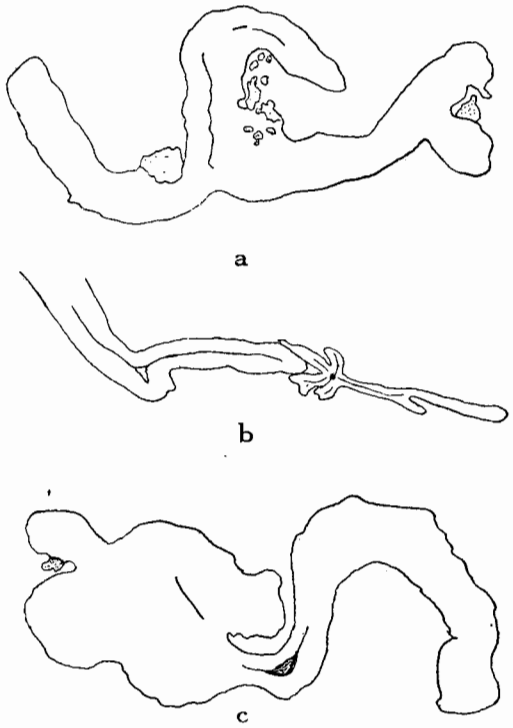
(2) Newton, E. T. (1875), p. 341.

(3) McIntosh Reid, A. (1924), pp. 35-37.

(4) Measurements of a dozen and a half representative spores taken at random, are as follows:—200μ x 283μ; 233μ x 233μ; 250μ x 275μ; 266μ x 233μ; 283μ x 316μ; 291μ x 308μ; 316μ x 333μ; 333μ x 350μ; 333μ x 366μ; 358μ x 333μ; 366μ x 450μ; 400μ x 433μ; 416μ x 425μ; 433μ x 450μ; 450μ x 466μ; 466μ x 500μ; 500μ x 500μ; 500μ x 533μ.

punctated surface to which Newton alludes (5), is not at all seen in any of my slides, instead, in favourable cases characteristic surface-sculpturings have been observed (figs. 2. 4, 5, 7, and 8). In others these surface-sculpturings seem to have been rubbed off during fossilisation. In certain spores distinct tri-radiate marks (fig. 3) are clearly visible.

Serial microtome sections (6) (figs. 10-12 and text-figs. a-c) were cut with a view to seeing the presence of cell-contents, but the result has so far turned out to be negative. However, one thing is plainly evident, namely that the spores appear to have been pressed hard during fossilisation in



Text-figures a-c. (Camera-lucida sketches.) Microtome sections of spores, showing peculiar shapes. (The dotted shading represents the sand-particles.)

(5) Newton, E. T. (1875), p. 341.

(6) Sections as thin as 6μ have been microtomed with ease. The process is dehydration, etc., is exactly similar as employed in usual micro-technique.

various planes, and have thus been reduced to thin strips, which show slight stratification. Not unoften, the spores ruptured only on one side may be met with (fig. 6). The shape of the spores is determined by the planes of the strata abutting on them, such that they present often very peculiar shapes in section (fig. 12 and text-figs. a-c).

DISCUSSION.

These spores have variously been regarded by different (7) authors as resin, marine deposit, algæ of spherical form, spores, and sporangia. The present observations, however, lend support to the last view. The demonstration of a tri-radiate mark and surface-sculpturings removes the suspicion of the algal nature of the spores.

Newton, supported by others, has made a suggestion that "their (spores) form and size seem to indicate that they are "more nearly allied to Lycopdiaceous macrospores than any-"thing else" (8). An experiment performed in this connection by Stewart (9) is rather significant. He, on distillation of a mixture of 25 per cent. of Lycopodium powder and 75 per cent. of fuller's earth was able to condense a substance similar to the shale-oil obtained from the *Tasmanite*. But an examination of the surface characters of the spores of the living Lycopods (10) does not show any identity with those of *Tasmanites punctatus*. At the same time, it is rather curious that no fossil Lycopods, or even their allies, have so far been recorded near about the same horizon from Tasmania (11). The only members from the same strata as the oil-shale, are either Gymnosperms or one of the Equisetales—*Phyllotheca australis* Brong. (11). With such incomplete data before us, it is rather unsafe to relate these spores to one or the other until some positive evidence is forthcoming.

Considerable variation in the size of spores has suggested some authors to think that they include a mixture of both micro- and macro-spores, but this does not seem to be tenable, because even the smallest spores are rather too big to be regarded as microspores as compared with the bigger ones, and besides this nothing of the like is known in any other fossil plant so far. There may, however, be another possibility, namely, that they are derived from closely

(7) Twelvetrees, W. H. (1911), Bull. 11.
(8) Newton, E. T. (1875), p. 341.
(9) Stewart, D. R. (1912), pp. 164-5.
(10) I am thankful to Prof. M. O. P. Iyengar, of Madras, who was kind enough to send me spores of certain living Lycopods. This helped me a good deal in making comparisons.
(11) Sahni, B. (1926), p. 325.

related species of plants. If this is true, then more than half-a-dozen species may be involved. Nevertheless, the shape and structure of the spores are so very similar that they suggest being derived from a single species. This variation in size seems to be due to a mixture of mature and immature spores. Such a polymorphic phenomenon is quite common among vascular plants (12).

SUMMARY.

An examination of the fossil spores present in *Tasmanite* has been made, and the following results have been obtained:—

(1) The surface of the spores is not punctated (in my specimen) as stated by Newton, but instead has definite sculpturings.
(2) Tri-radiate mark on the spores is present in favourable cases.
(3) These spores have been microtomed for the first time.
(4) The spore-wall in section often shows slight stratification.
(5) These spores are averse to taking up any stain except a little of safranin.
(6) The suggestion of their Lycopod-origin is doubted.
(7) Variation in the size of spores is due perhaps to the mature and immature spores being mixed together.

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BHOWALI (Nainital Hills),
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REFERENCES.

BOWER, F. O. (1923): *The Ferns* (Filicales), Vol. I., pp. 263-264. (Cambridge University Press.) Variation in the size of spores is known to occur in *Platyzoma microphyllum* and *Notholæna affinis*.

(12) Bower, F. O. (1923), pp. 263-4.
Singh, T. C. N. (1929), p. 207.
Ibid. (1930), p. 21.
Singh, T. S. N. (1930), p. 16.
Demerec, M. (1927), p. 329.

Cotton pollen grains showing variation in hybrid plants. (*Ministry of Agriculture, Egypt.*) *Cotton Research Board,* Third Annual Report, 1922, p. 41.

DEMEREC, M. (1927): A case of Pollen Dimorphism in Maize. *Expt. Stn. Record,* Vol. 56, No. 4, p. 329.

McINTOSH REID, A. (1924): The Oil-shale Resources of Tasmania. *Tasm. Geol. Survey Mineral Resources,* No. 8, Vol. I.

Idem (1926): The Oil-Shale of Tasmania. *Papers and Proceedings Roy. Soc. Tasmania,* p. 43.

NEWTON, E. T. (1875): On Tasmanite and Australian White Coal. *Geol. Mag.* New Series, Decade II., Vol. II., p. 341.

SAHNI, B. (1926): The Southern Fossil Flora: A Study in the Plant Geography of the Past. *Proc. 13th Indian Sc. Congress.*

SINGH, T. C. N. (1929): A Note on the Presence of a Sporangium on the Indusium of *Cheilanthes albomarginata. Jour. Indian Bot. Soc.* Vol. VIII., p. 207.

Idem (1930): Studies in the Morphology of Pollen Grains—Part I. (a) Boraginaceæ. *Jour. Indian Bot. Soc.* Vol. IX.

SINGH, T. S. N. (1930): Studies in the Morphology of Pollen Grains—Part II. (b) Boraginaceæ. *Proc. 17th Indian Sc. Congress.*

STEWART, D. R. (1912): *Mem. Geol. Surv. Scotland,* Part III., pp. 164-5.

EXPLANATION OF THE PLATE.

(All are camera-lucida sketches, and the shaded area in the figures denotes the sand-particles yet sticking to the spores.)

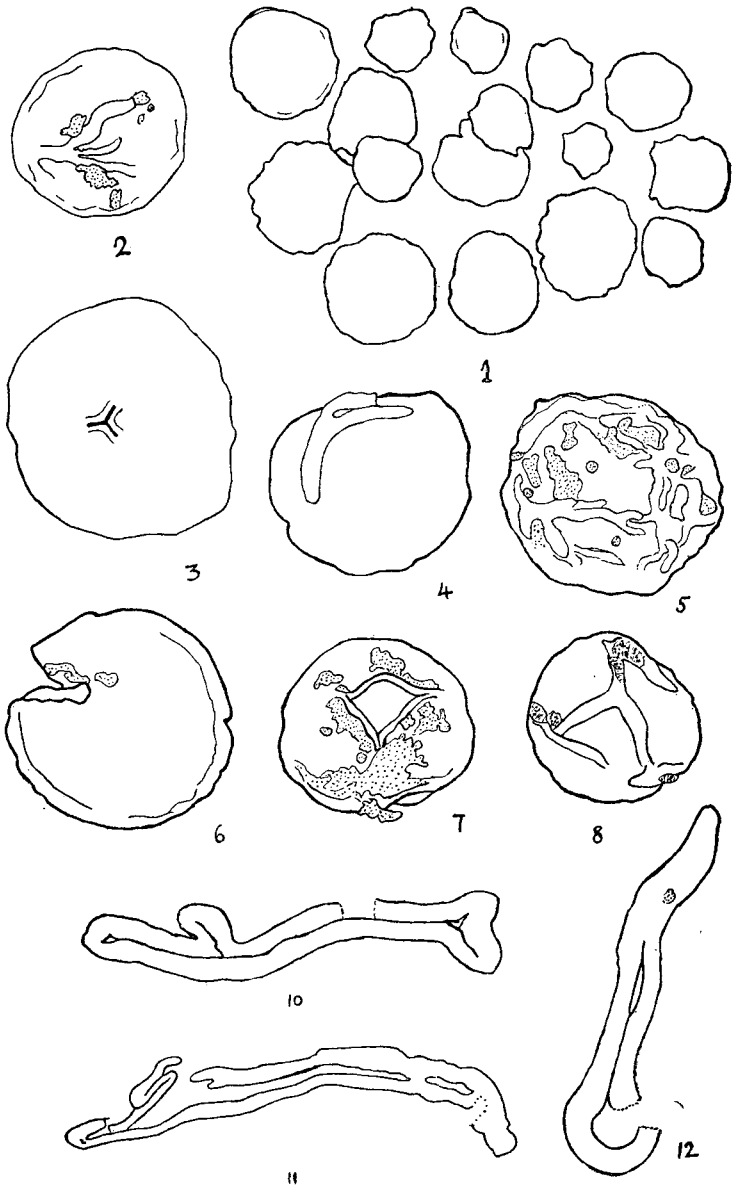
Fig. 1. Spores of various sizes. X 44.

Figs. 2, 4, 5, 7, 8. Spores with surface sculpturings, fig. 5 being typical. Figs. 2 & 7 — X 102; Figs. 4-5 — X 92; Fig. 9 — X 126.

Fig. 3. A spore with a distinct tri-radiate mark. X 100.

Fig. 6. A spore ruptured on a side, showing the mouth-like fold. X 102.

Figs. 9-11. Microtome sections of spores. X 203.



Tasmanites punctatus.