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NOTES ON FOSSIL FUNGI.

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OF the various classes of plants of which structural remains are known from the Palaeozoic rocks, the Fungi would seem to have been the least fully studied. And this is hardly surprising in view of the attractions to investigation which the vascular plants offer. Some day, skilled mycologists will direct their attention to this promising field of study and we shall be able to realise, as we now do in the case of the Pteridophytes and Gymnosperms, what were the relations of the fungus-flora of that period to the group as it now exists. Meanwhile it is possible, as in the present instance, to place on record detached observations concerning some stage in a life-history. The present notes deal with two types of reproductive organ, both of which have been noticed by the French Palaeobotanists.

A Fungus on the pinnules of ALETHOPTERIS AQUILINA, Schlotheim.

The first case to which attention is drawn is that of the curious ovoid pockets occasionally met with in the pinnules of *Alethopteris aquilina*. The fern-like foliage which has received this name is regarded as having belonged to one of the Medullosas, and as the constant lack of sori on these and many other fronds of the older rocks has tended to strengthen the suspicion that these plants may have borne reproductive organs unlike those of true Ferns, a close scrutiny is desirable of any structure which might be construed as a possible sporangium. The pinnules of *Alethopteris aquilina* are quite common in the silicified nodules of permo-carboniferous age at Grand 'Croix, whence the specimens under consideration were derived.

The pockets in question (diameter about .2 mm.) were described by Renault¹ as lying between the forkings of the lateral veins of the

¹ Renault: Cours de bot. fossile III, 1883, pp. 159-60 and Pl. xxvii, fig. 10.

pinnules. In this writer's figure of a section parallel to the surface of a pinnule the pockets shew an oval outline, they are slightly variable in size, and contain numerous small spore-like bodies. A comparison of the similar preparation represented here (Pl. iv., fig. 1) with Renault's fig. 10, will shew the identity of the structures. In his comments on their nature Renault refers in the most guarded terms to the possibility that these pockets might be the sporangia of *Alethopteris*. On the whole he would seem to have been impressed with the resemblance which they present to *Excipulites callipteridis* of Schimper.¹

The specimens under consideration afford some additional features worth recording. The irregular distribution of the pockets finds confirmation in the cross sections of pinnules represented in figs. 2 and 3. In the former figure, which represents part of the lamina of a pinnule in transverse section (the midrib being on the extreme right of the figure), four of these pockets (*a*, *b*, *c*, *d*) are shewn lying in the areas of spongy parenchyma which alternate with the exarch bundles of the pinnule. They are closely approximated to the lower surface of the leaf which projects slightly in the form of convex blisters owing to the displacement due to the pockets. Another pinnule in transverse section is shewn in fig. 3 with two pockets (*a* and *b*), one close to the midrib, the other in the angle formed by the infolding of the rolled margin. These two pockets, like *a* and *d* in fig. 2, appear to have been cut in the middle plane and shew an ostiole-like aperture through which the contained spores were probably discharged. The wall of the pocket is badly defined. It is dark in colour and under a high magnification shews an obscure stratification (fig. 4). The appearance certainly suggests that this wall may owe its origin to the flattening of the neighbouring parenchyma cells of the leaf, a result of the expansion of the pocket. The small contained spores are not quite spherical, their longer diameter averages about 16μ . The wall of the spore is covered externally by numerous tiny rugosities, as represented in fig. 5. The general facts of their structure and distribution seem consistent with the view that these pockets are the fructifications of a parasitic fungus. Superficially they recall a minute Pyrenomycete, but no useful purpose would be served by a discussion of its possible affinities. The manner of origination of the spores in the pockets is quite an open question. A portion of the wall of a pocket together with some of the adjacent spores are represented in fig. 4. The details

¹See Schimper, *Traité d. paléont. végét.*, Vol. I., p. 142 and Pl. xxxii., figs. 6 and 7.

of the structure of the wall are obscure, though there is some slight ground for believing the pocket to have possessed a lining of hyphae. The state of affairs figured here, of spore-like bodies arising from hyphae, is brought forward with some reserve, as this stage has only been seen in a single instance.

When all the facts are taken into consideration, the distribution and form of the sacs, the smallness of the spores, and the ill-preserved character of the tissues generally in these specimens, there would appear little room for doubt as to the fungal nature of the pockets. What may have been the affinities of the fungus and its relations to recent parasitic fungi are questions that must be reserved till our knowledge of the Palaeozoic Fungi is more comprehensive than at present.

On certain supposed Chytridineous Sporangia.

The other fungi receiving mention here come from the same horizon and present a close resemblance with *Grilletia Sphaerospermii* described by Renault and Bertrand¹. The latter was met with in the peripheral layers of the nucellus of the seed *Sphaerospermum* in which hyphae and strings of sporangium-like vesicles suggested a reference to the Chytridinae. This same type of vesicle has been found in considerable quantity in Brongniart's seed *Polylophospermum*, occupying the same position as in Renault and Bertrand's example. The beak-like processes represented in two of the vesicles of the series of three in fig. 6 and in fig. 6a, marks, no doubt, the place of dehiscence. Though this specimen is less complete than that described by the French authors, for the hyphal threads are not preserved, there seems little doubt as to its identity. Fungal structures of this kind occurring in the wall of the nucellus of palaeozoic seeds were not limited to this particular horizon, as almost identical structures have been observed in a specimen of the seed *Conostoma* from the calciferous sandstone series of Burnt Island in Scotland (Lower Carboniferous). The vesicles of the *Grilletia* from *Polylophospermum* vary in diameter from 25μ to 40μ . They appear to have been approximately spherical in form, whilst dehiscence occurred by rupture at the tip of the beak rather than by the removal of an operculum. This was inferred in the case of MM. Renault and Bertrand's specimens from the fact that many of the sporangia had opened at this point.

Another example of possible Chytridineous sporangia is that of

¹ Renault and Bertrand, *Grilletia Sphaerospermii*, Chytridiacée fossile du terrain houiller supérieur. Comptes Rendus, tom 100, p. 1306.

certain dubious structures recently found in the surface layers of the nucellus of what is probably a second species of *Stephanospermum*.¹ The bodies in question lie at the surface of the nucellus everywhere between the pollen-chamber and the chalaza. The sketch of part of a tangential section of the nucellus of this seed (Fig. 7) shews the nucellar epidermis (*e*) detached from the underlying parenchyma (*np*) within which follows the tracheal mantle (*t*). Finally the wall of the macrospore (*mw*). Lying here on the nucellar parenchyma are these small ovoid bodies (*a*, *b* & *c*) which are perhaps referable to a fungus like *Grilletia*. The average dimensions of these little vesicles is $23\mu \times 16\mu$. Further details of their structure are given in figs. 8, 9 and 10. Each vesicle is of ellipsoidal outline and shews a considerable degree of flattening upon the nucellar parenchyma. The examples represented in figs. 8 & 10 are typical. Each is represented lying on the crushed parenchyma of the nucellus, whilst a portion of a tracheide is also given in fig. 8. In the middle of the convex face of the vesicle an oval area is generally present symmetrically divided along its major axis by a slit-like line (figs. 8 and 10). The bodies by themselves are difficult of interpretation, especially as no traces of connecting hyphae are present. Until the frequency with which *Grilletia*-like fungi occur in this actual situation was realised, it seemed possible the bodies might even belong to the nucellus. However, the most reasonable view of their nature seems to be that they are the sporangia of some fungus of similar nature.

A comparison has been drawn between *Grilletia* and the Chytridiaceae. If we turn to that group, forms are not lacking in which the sporangia bear specialised opercula connected with the discharge of the swarm-spores. This is the case for instance in the genera *Chytridium*, *Tetrachytrium* and *Zygochytrium*.² The curious pore-like appearance seen on these vesicles may possibly indicate the presence of an operculum which has become, perhaps owing to the confined position, partly pressed into the sporangium. One of these bodies is represented in fig. 9 with its convex surface partly ground away. The slit-like furrow (?) is still apparent, so that it may be inferred that this portion of the mechanism projected an appreciable distance into the vesicle. The whole structure, it may be conjectured, was a sporangium with an operculum of oval contour, in which, owing to the circumstance of its development,

¹ *S. caryoides*, as yet undescribed, also from Grand 'Croix.

² Schröter, Chytridiaceae in Engler and Prantl, Die natürlichen Pflanzenfamilien, I Teil, 1 Abt., pp. 80, 84 and 87.

the more or less conical lid being prevented from projecting outwards had become invaginated into the cavity.

DESCRIPTION OF THE FIGURES ON PLATE IV. ILLUSTRATING
F. W. OLIVER'S NOTES ON FOSSIL FUNGI.

FUNGUS ON ALETHOPTERIS.

- Fig. 1.—Section of a portion of a pinnule of *Alethopteris aquilina* cut parallel to the surface. At *a* one of the pockets filled with fungal spores is cut through. $\times 50$.
- Fig. 2.—Vertical section of part of a pinnule; the midrib is on the extreme right. *a*, *b*, *c* and *d*, the receptacles of the fungus. $\times 20$.
- Fig. 3.—Cross-section of another pinnule; *a* and *b* fungal receptacles. $\times 20$.
- Fig. 4.—Part of the boundary wall and a few spores from one of these receptacles. The spores appear to be attached to hyphae coming from the wall. $\times 625$.
- Fig. 5. A single spore. $\times 1250$.

FUNGAL SPORANGIA FROM SEEDS.

- Fig. 6.—Three sporangia in series, from the nucellus of *Polylophospermum* resembling those belonging to *Grilletia*, Renault and Bertrand. $\times 600$.
- Fig. 6a.—Another detached sporangium from the same source.
- Fig. 7.—Portion of the wall of the nucellus of *Stephanospermum caryoides* cut in longitudinal tangential section. *mw*, wall of macrospore; *t*, tracheal sheath of nucellus; *np*, remains of parenchyma of nucellus; *c*, nucellar epidermis; *a*, *b*, *c*, supposed sporangia of a *Grilletia*-like fungus. $\times 85$.
- Figs. 8, 9, 10.—Three examples of the supposed sporangia, 8 and 10 shew the oval operculum with its characteristic furrow (*a*); in 9 the supposed operculum appears to have been ground away, but traces of the furrow remain. The cells upon which the oval bodies lie belong to the parenchyma of the nucellus. $\times 850$.

A CONVENIENT FORM OF POTOMETER.

[TEXT-FIG. 1.]

THE apparatus that forms the subject of this note does not lay claim to any special originality, and is merely a convenient modification of a form that I have used for a number of years.

The corked bottle is provided, preferably, with an india-rubber cork with three holes bored through it. One of these takes the bent glass tube (τ) which has a fairly fine tubulus, such as is ordinarily used for a potometer. It is important that this tube should not project beyond the lower surface of the cork, as otherwise any air that may accumulate, or be present, above the water inside the bottle cannot easily be got rid of.

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