

ON THE OCCURRENCE OF SUPERFICIAL ABAXIALLY PLACED SORI IN *OSMUNDA CLAYTONIANA*

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In some material of *Osmunda Claytoniana* collected by Professor Sahni at Gulmarg (Kashmir), about 3000 metres above sea-level, in July 1931, he noticed the occasional presence of distinct sori on the abaxial surface of some of the pinnae which were otherwise just like the sterile pinnae. As the soral condition has not previously been recorded in *Osmunda*, it was thought worth while to give a brief description of the material and also to review the question as to whether in the family Osmundaceae the superficial or the marginal position of sporangia is to be regarded as primitive.



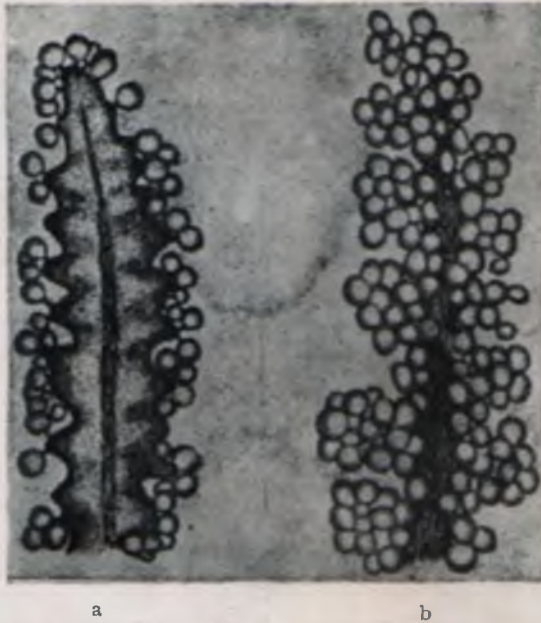
Text-fig. 1. *O. Claytoniana* Linn. Part of a frond bearing fertile and sterile pinnae, in the latter three or four basal pinnae (abnormal) bear abaxial sori(s) and linear thickenings (l. t.). (about nat. size).



Text-fig. 2. *O. Claytoniana* Linn. Magnified view of abnormal pinnae showing soral arrangement of sporangia(s) and elongated thickenings (l. t.) bearing one or two (? deformed) sporangia (d. sp.). \times ca. $6\frac{1}{2}$.

Description.

The general form and disposition of the abnormal pinnules is shown in text-figs. 1, 2 and plate 1, figs. 1, 2, where several pinnules are seen bearing distinct sori on the abaxial surface. In the same figures some normal sterile as well as fertile pinnules are shown. The abnormal condition was usually found at the transition from the fertile to the sterile part of the frond. Intermediate stages between sterile and fertile pinnules were also met with and there also such abaxial superficial sori were plentifully represented. This is by no means the first record of superficial sporangia in *Osmunda*¹ but their occurrence in definite sori has not, so far as I know, been previously recorded. The Osmundaceae are in fact regarded by Prof. Bower² as non-soral ferns, the sporangia being arranged in marginal tassels in *Osmunda* (text-figs. 1 and 3) and abaxially superficial in *Todea*.



Text-fig. 3. *O. Claytoniana* Linn. a A normal fertile pinnule showing groups of sporangia in marginal tassels. Sporangia on the upper and lower surfaces are brushed off for the sake of clearness. b. A normal fertile pinnule. \times ca. 9.

Another abnormal feature observed was the presence of linear thickenings over or between some of the lateral veins (text-figs. 1, 2 and plate 1); a few small spherical bodies (? abortive sporangia) were found attached to these peculiar thickenings. Nothing can be said

¹ Goebel (1915-1918) p. 1139 recorded a parallel case of superficial position of aborted sporangia in *Osmunda regalis*.

² Bower, F. O. (1926) p. 129.

definitely regarding the morphological nature of these thickenings; they may be abnormally developed placenta^e arisen by the swelling of the tissue lying in the forks of lateral veins, or they might represent a fused mass of aborted sporangia, a few of which, as stated, may still be found attached to them.

The sori were always placed on the lateral veins, the sporangia being normal in every respect; in each sorus the number of sporangia varied from two to about half a dozen. These sorus-bearing pinnules are distinguished from the normal fertile ones by their more expanded lamina, with no sporangia on the margins or on the upper surface (see text-figs. 2 and 3). From sterile pinnules they were distinguished by their usually less expanded, more or less stunted, lamina.

Theoretical Discussion.

The importance of the soral conditions just described will be evident from the following general remarks by Prof. Bower.¹ "The two positions, the superficial and the marginal, graduate into one another by many intermedial steps. But the position held by the sori of a species, genus, or even of still larger groups, is as a rule definite, showing that it is not a readily fluctuating character, but is so far constant in the individual species or genus that it may be depended on for comparative purposes. So marked is the constancy of position of the sorus in genera and species that the few exceptions which occur become notable."

According to Prof. Bower, the superficial position of sporangia was relatively late in evolution and derivative. The abaxial position guaranteed protection and easy dissemination of the spores. In the ontogeny of many ferns also, e.g., *Schizaea rupestris*, *Mohria* and *Pteridium*, a transition from the marginal to the superficial position is met with,² which probably indicates that a similar change may have occurred in evolution. Thus Prof. Bower³ says that probably "a distal or marginal position of the single sporangium was general in the first instance for the Filicales; but that as the leaf-blade expanded the marginal sorus, whether monangial or composed of many sporangia, slid to the lower surface, and this has happened along many distinct phyletic lines, sometimes early, sometimes late in their Evolution."

¹ Bower (1923) p. 217.

² Bower (1923) pp. 219 and 223, and figs. 213, 214 and 218.

³ Bower (1923) p. 225.

—— (1929) p. 23.

Plant names.	Position of Sporangia.	Arrangement of Sporangia.	Age.
Living Osmundaceae.			
<i>Osmunda</i> spp. ...	Marginal, occasionally [†] superficial ...	Non-soral, rarely soral.	...
<i>Todea</i> spp. ...	Abaxial superficial	Non-soral.	...
Fossils (Mesozoic).			
<i>Tobias Williamsoni</i> (Brongniart) ¹² ...	Abaxial superficial	Scattered	Jura and Rhaetic.
<i>Cladolea unilans</i> (Lindl. and Hutt) Hallé ⁹ (= <i>Tostites denticulatus</i> (Brongn) Krasser ⁴ = Fertile frond of <i>Cladophlebia denticulata</i> Brongn.) ¹³ ...	" "	Linear sori	Jurassic.
<i>Osmundopsis Sturii</i> (Racib.) Harris ⁶ (= <i>Osmunda Sturii</i> Racib. 1891 ⁷ = <i>Osmundites Sturii</i> Racib. 1894) ...	No lamina x, ? marginal (Harris 1931 b.) Abaxial superficial (Racib ⁶ 1891)	Clusters (Harris).	Lower Jurassic ⁷ (Poland.)
<i>Osmundopsis plectrophora</i> Harris ⁸ ...	No lamina x, ? marginal	Soral (acc. to Racib) ... Clusters ...	Rhaetic (Greenland)

<i>Tolosa australis</i> (?) Morris) Ren- ault ^a probably identical with <i>Alethopteris</i> (<i>= Cladophlebis</i> Presl (<i>= Cladophlebis</i> (Tolites) Roos- sert))	...	* Closely resembling fertile frond of <i>Cladophlebis denticulata</i>	Ilhaeitic ^{11a} (Franconia)
<i>Loucheopteris virginianensis</i> ¹¹	...	Abaxial superficial	...	Upper Trias (Virginia)
(= <i>Speracourpus virginianensis</i>)	...	Resembles <i>Tolites Williamsoni</i> in the distribution of sporangia.	...	
<i>Speracourpus tenuifolius</i> (Em- mons) ^{11b} (= <i>Acrostichites tenuifolius</i> Font.)	...	Seward (1931) p. 146. Walton (1923) p. 346. Harris (1931 b) p. 48. Seward (1910) p. 344. — (1931) p. 346. Harris (1931 a) p. 156. — (1931 b) p. 48. Rachiborski (1891) pp. 1, 9 & Pl. I, fig. 2. — (1894). Seward (1910) p. 339.	...	* Harris (1931 b) pp. 49-52. * Renault (1883) An. 3, p. 81, Pl. XI. * Seward (1910) p. 346. * Fontaine (18-3) Pl. XXVIII, XXIX. Leuthardt (1904) Pl. XVIIII. (as cited in Seward 1910 p. 339). Seward (1931) pp. 216, 217. * Seward (1910) p. 332. Worsdell, W. C. (1916), pp. 5-7.
* Doubtfully Osmundaceous. * Goebel (1915-18) p. 1139. * Seward & Ford (1903) p. 254. Seward (1910) p. 341 & fig. 256 B. — (1931) pp. 313, 332 & 343. Harris (1931 b) p. 30. Thomas (1911) pp. 365-386. * Halle (1911) p. 5 & fig. 1. — (1921) pp. 13-14. Thomas (1911) p. 306.	

On the other hand, as is well known, many authors¹ including Prof. Bower himself² have interpreted some abnormalities as *reversions to a primitive state*. Such an interpretation in the present case would show the superficial condition of the sori to be primitive rather than advanced. It is by no means suggested that an isolated instance like the one here under discussion can materially affect the general theory, built up by Prof. Bower on a wide foundation of facts, developmental and comparative. It must be agreed that these facts, viewed as a whole, seem to support his idea that "the primitive position of the sporangium or sorus was distal or marginal, and that the superficial position is derivative." But the frequency with which the abaxial sori here described occurred in the plants observed by Prof. Sahni, on pinnules which were otherwise normal, suggests that this "abnormality" has nothing pathological about it and that it may be of some phylogenetic interest. It is that kind of deviation from the normal which Strasburger distinguished from monstrosities or pathological malformations, and which sometimes almost grade into normal variations.

In this connexion a comparative survey of the position of sporangia in all the forms, living as well as extinct, more or less definitely referred by various authors to the Osmundaceae, may be of some interest. The facts are summarised in the accompanying table.

The available evidence from the fossil record and from the abnormalities here described thus seems to favour the view that the superficial sorus is a primitive character for the Osmundaceae.⁴

At first it might seem that the non-soral state was primitive, because it played so important a rôle in fossil forms, but definitely soral types were also represented, as in *Osmunda Sturni*, *Cladotheca undans*, etc. Again in the earlier fossil forms "while *Botryopteris* itself appears to be non-soral, there is a distinct indication of a disposition of the sporangia around a central point in *Zygopteris*, while in *Corynepteris* there are very definite sori."⁵ Among the

¹ Sahni (1923) pp. 188, 190.

Sahni (1925) p. 207.

² Bower (1923) pp. 332-33 'from the comparative, morphological point of view the creting is essentially a reversion'.

³ Bower (1923) p. 218.

⁴ Since the above was written Prof. Sahni has referred me to a recent paper by Harris (1931) pp. 136-137 where the same view has been expressed.

⁵ Bower (1908) p. 633.

living ferns also instances of clear indications of a soral state passing into non-soral are not rare, e.g., *Dipteris*.¹ Similar spreading of the soral sporangia over an enlarged surface is indeed suggested by such genera as *Gymnogramme*, *Hemionitis*² etc. Thus Prof. Bower concludes³ that probably the soral state is the original condition and the non-soral the derivative, notwithstanding its early appearance. However, he cautiously adds⁴: "Though a probability is thus established of progression of the sorus from the margin to the lower surface, this does not prove that the former position was prior for the Ferns at large. It must be remembered that Marattiaceous types with sori intra-marginal are recorded as far back as the Culm; and it is quite possible that they may have originated from forms with sori superficial from the first."

Summary and Conclusion.

In an examination of several specimens of *Osmunda Claytoniana* from Kashmir, the following abnormal features were found:—

(1) *Superficial sporangia* occurring very frequently at the transition between the fertile and sterile regions of the frond.

(2) *Their arrangement in definite sori on the under surface of pinnules* which are otherwise like the normal sterile pinnules.

The above features may *possibly* be of the nature of a reversion; they recall the condition described by Halle and Walton in the Jurassic form *Cladotheca undans*.

(3) The available evidence indicates that the primitive condition for the Osmundaceæ was the superficial (abaxial) sorus.

I wish to express my sincere thanks to Prof. B. Sahni for suggesting this piece of work and for his painstaking guidance and helpful criticisms.

My thanks are also due to Mr. R. S. Sharma for help in drawing the original of text-figure 3.

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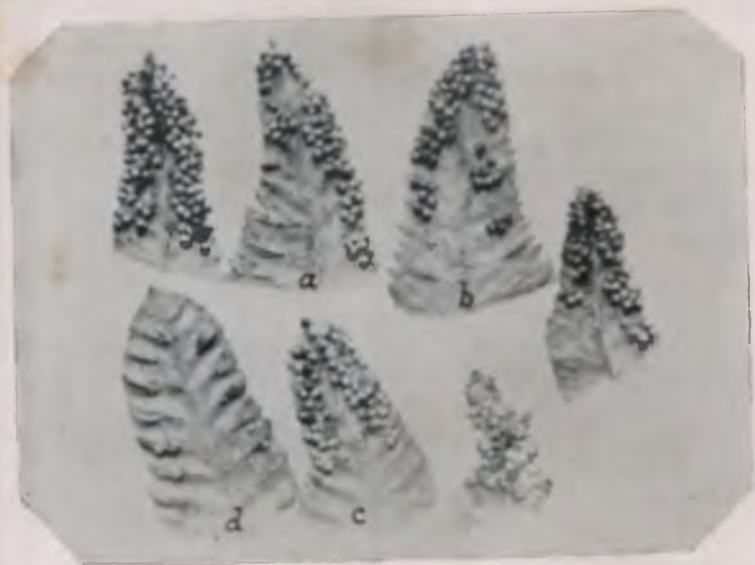
¹ Bower (1908) p. 620.

² " " p. 633.

³ " " p. 633.

⁴ " " p. 634.

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Explanation of Plate I.

- Fig. 1. *O. Claytoniana* Linn. Portions of leaves bearing sterile and fertile pinnae. In every case the basal three or four pinnules in each sterile pinna are abnormal, bearing sori(s) or linear thickenings (l. t). (about nat. size).
- Fig. 2. *O. Claytoniana* Linn. Magnified view of a few abnormal pinnules bearing sori and linear thickenings on their abaxial surfaces. The pinnules *a*, *b*, *c*, bear distinct sori; in *d* occur the linear thickenings with two deformed sporangia on one of them. $\times 5$.