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A SPECIMEN OF *SPOROGONITES* FROM THE « GRÈS DE WÉPION » (LOWER DEVONIAN, BELGIUM),

by William H. Lang (Manchester).

The specimen to be described and illustrated here is in the Musée royal d'Histoire naturelle de Belgique and is labelled « Fooz-Wépion, n° 17042 ». It was sent to me for examination and description by Dr. F. Stockmans. He had already recognised the interest of the plant and its main features; numerous linear unbranched axes, some of which bore terminal swellings. The interpretation of the latter and the possible affinities of the plant were in doubt. He informed me that *Arthrostigma* and other fragmentary plant-remains occurred in the same beds, which are known to be of Lower Devonian age.

The numbered specimen is a block of fine-grained stone some 3-5 cm. thick. The important face, bearing the fossil under consideration here, is represented of natural size in fig. 1. On the back are thin incrustations of pieces of fairly wide stems, 7-10 mm. across. Some of them show an indication of a central strand, 1.5 mm. wide, and others give a suggestion of the places of insertion of small spines. While hardly adequate for determination, these remains establish the presence of plants of the grade of size and organisation of *Psilophyton* and *Arthrostigma (Drepanophycus)*. A few small pieces of these wider stems occur, along with the smaller axes and terminal bodies, on the other surface (fig. 1) but can be readily distinguished and are of no significance.

This surface exposes planes at slightly different levels. On the left-hand side are slender axes, lying on the whole parallel to one another but well separated. On the extreme right is a short length of closely crowded parallel axes. The remains on the intervening higher and more irregular surface lie on the whole in the same direction but not so clearly. At places in all the regions axes can be seen to terminate in wider elongated sporangium-like bodies of considerable size. Many of these point in the same direction and indicate that the axes are directed upwards as fig. 1 is placed on the plate. One example isolated on the surface is seen on the right-hand side of the figure and there are a number of specimens towards the upper end of the group of axes on the left.

The preservation of all the plant-remains is similar. The form and size of the thin incrustations are clearly given by a yellow or orange film or stain on the surface of the rock. Against this film a thin layer of coaly material, or fragments of this, represents the organic remains of the flattened specimen. This coaly layer is apparently derived from the peripheral layers of the portions of the plants. It is a type of preservation which experience with specimens from other localities has shown to be valuable as a record of the external morphology but unpromising for ascertaining structural details. In the present case the only structure shown is the pattern of the epidermal cells on the carbonaceous material of the slender axes and terminal bodies and the impress of this on the yellow film. The evidence is sufficient to show that the cells were elongated on the axes and short on the sporangium-like bodies. In both cases the epidermis probably consisted of firm-walled cells. This pattern was for example evident on the yellow film in figs. 5, 7 and on the black material in fig. 9. In the latter specimen and a few other examples the organic material appeared to be represented by iron oxide rather than carbon.

The presence of numerous pieces of these axes in one thin layer of rock with practically no mixture of other remains is of interest. Their close association, parallel position and similar direction seem against chance carriage of isolated specimens but there is nothing to show the complete form and mode of growth of the plant. No case of branching of the axes has been found and, considering the number exposed, this is probably significant. All the axes are incomplete below and there is no evidence of any structure from which they arose. This incompleteness also makes

it impossible to speak with certainty of their length. Pieces of 4 cm long can be measured but the group of approximately parallel axes to the left in fig. 1 suggests that they attained a length of over 7 cm. The width of the axes, about 0.5 mm, is very constant. They have no appendages. Some pieces show longitudinal ridges or folds but, as the great majority are smooth, this is to be regarded as due to contraction during preservation. It would hardly be worth mentioning were it not for some features of the terminal bodies. No evidence of the presence of a central strand has been obtained; since however only the superficial layers appear to be preserved this negative evidence is not conclusive on this important question.

The terminal bodies have all the appearance of being sporogonia or sporangia. They will be spoken of by the latter name taken to include the former as possibly more correct. In the light of our knowledge of a number of simple Early Devonian plants there is little or no reason to doubt that they were spore-producing organs. No evidence of the presence of spores has, however, been obtained by examination of all the specimens by reflected light, supplemented by the study of film-pulls from a few of the poorer examples. A considerable number are present, between 10 and 15 having been distinguished and carefully examined. Only a few need be illustrated and described, the other less satisfactory examples adding no further information. As is shown by the figures of selected examples enlarged 3 diameters in figs. 2-4 and 10 diameters in figs. 5-9, the sporangia all exhibit the same general features. The axis forming the stalk widens gradually to form a basal region. Then follows, with a horizontal line of junction, the main portion of the sporangium proper with almost parallel sides. At the upper end the outline narrows rather suddenly to form the bluntly pointed tip.

A difficulty in measuring lies in the gradual expansion of the basal region from the stalk but for practical purposes measurements can be obtained both directly from the specimens on the rock and from the enlarged photographs. The selected specimens were presumably full-sized and adult, though this is not quite certain without the demonstration of spores. They have a width of about 2 mm. and a total length, including the basal region, of 6-7 mm. This length is made up of the basal region 2 mm. or less long and the sporangium proper measuring 4-5 mm. A few smaller specimens were noted which were possibly immature; they were about 4 mm. in total length by 1-1.5 mm. in width. The

largest example found is shown above and to the right in fig. 4 and one of the small specimens can be seen near the bottom of fig. 3.

The basal region has a number of ridges or folds, which diverge slightly from one another in correspondence with the increase in width of the region. The definiteness of the ridges varies in the different specimens and their demonstration is of course dependent on the lighting. In the best marked examples 5 or 6 ridges are clearly shown (figs. 4, 6, 8, 9). While it must be regarded as to some extent an open question whether this ridging was originally present or is due wholly or in part to contraction during preservation, the ridges in this region are a characteristic feature of the fossil. Some three wider and more obscure longitudinal folds are sometimes indicated in the middle region of the sporangium proper (figs. 5, 8). In other cases (figs. 6, 7) this surface appears flat so that it is doubtful whether much weight can be attached to this feature. In several of the best examples there is a distinction of a marginal region from the main central region of the impression of the capsule. This is well shown in fig. 5 but is also evident in figs. 7, 8. This outer region, which is about 0.3 mm. wide, may be traceable over the tip where it appears somewhat wider. To what extent this is to be regarded as a structural feature is again doubtful but it may well indicate in the flattened condition of the specimens the rather thick wall of the sporangium, or this together with an inner tissue, continuous over a main central region. The best specimens show the blunt terminal region of the sporangium in complete continuity with the lower part of the latter (figs. 4, 6, 7). When there is an interruption, as in the example in fig. 8, it can therefore be regarded as an artefact due to the preservation.

Comparative Discussion.

The features described and illustrated above are those that have been ascertained by examining this fine and interesting specimen of a Lower Devonian plant. Some of them have been specially attended to in the light of comparisons that have now to be made, but the description is objective and wholly based on what is shown by the fossil from Wépion.

It was evident even on a first examination that it strongly suggested comparison with a remarkable fossil described by Halle (1. 2.) from the Lower Devonian of Röragen in Norway

Fig. 1 (x1).

Fig. 2 (x3).

Fig. 3 (x3).

Fig. 4 (x3).

W. H. LANG. — A specimen of *Sporogonites* from the Grès de Wépion (Lower Devonian, Belgium).

Fig. 5 (x10).

Fig. 6 (x10).

Fig. 7 (x10).

Fig. 8 (x10).

Fig. 9 (x10).

W. H. LANG. — A specimen of *Sporogonites* from the Grès de Wépion (Lower Devonian, Belgium).

under the name *Sporogonites exuberans*. In Halle's material there were a number of structureless incrustations and impressions, two flattened incrustations showing the spores and a single capsule preserved in the solid and semi-petrified. A section of this last specimen showed that the basal region was sterile, that there was a sterile columella in the capsule and that the spores occupied a dome-shaped spore-sac within the rather thick wall. Since the Belgian specimens have no internal structure preserved and no spores, direct comparisons can only be made with the similarly preserved specimens from Röragen. The further information as to structure afforded by the three examples referred to must, however, be borne in mind.

The plant here described agrees with the flattened incrustations of *Sporogonites exuberans* in consisting of slender unbranched axes bearing terminal sporogonium-like structures; it further agrees in the latter showing a gradually widening basal region with a number of ridges and in the general proportions and shape of the capsule. The axis or stalk in Halle's material was of the same width (0.5 mm) and also afforded no evidence of the presence of a central strand. The terminal sporangia were however larger in the Norwegian specimens. Halle gives as the range in size 6-9 mm. in total length by 2-4 mm. in breadth; the largest and apparently full-grown examples described here are 6-7 mm. long by slightly over 2 mm. broad. The ridges on the basal region and the wider ridges on the capsule proper are well marked on the specimens from Röragen and, since they occur also on the petrified specimen, are probably features that were present in the plant when living. Similar appearances are shown in some of the Belgian specimens but, from their absence in others, it is more doubtful what morphological significance should be attached to them. Lastly the upper end of the capsule appears rounded in the type specimens of *Sporogonites exuberans* but seems to be better described as bluntly pointed in the best and most complete examples here described.

While *Sporogonites* is as yet known from the northern hemisphere only from one locality in the Lower Devonian of Norway, to which the Belgian locality can now be added, it is a remarkable fact that it is represented in the Upper Silurian flora of Victoria, Australia (4). The specimens so far described, under the name of *Sporogonites Chapmani*, come from the Centennial beds but others have since been collected by Dr Isabel Cookson from beds of Yeringian age in the type area. The Australian spe-

cimens exhibit some range in size and form; the largest are comparable with the smallest of the Norwegian specimens and the tip is more pointed than in the latter. In these features the Belgian specimens under consideration here are comparable but it would only lead to confusion if these were placed under the same name. A distinct name appeared advisable in the case of the Australian plant not only on account of these differences but because of the widely distant locality and different geological age.

The general agreement of the remains from Wépion with the specimens of *Sporogonites exuberans,* so far as the features that can be ascertained go, is so close that there seems to be no question as to the justification for placing them under the same generic name. It is a more difficult question whether the Belgian plant should be separated specifically. The chief differences are the smaller size and the somewhat more pointed tip of the capsule. These are unsatisfactory and minor differences on which to establish a species, but, on the other hand, the inclusion of the two sets of remains under the same name, without in some way indicating the differences, appears undesirable. For the present a distinct name may be given without creating a new species by calling the fossil described here *Sporogonites exuberans,* forma *belgica.*

These considerations as to specific distinctions, though necessary, are of minor importance compared with the discovery of additional specimens of this distinguishable type of fossil plant. That it should have been found in another European locality encourages the hope of procuring further material. The presence of numerous specimens of the slender axes with terminal sporangia or sporogonia on the one piece of rock is confirmation of the correctness of the partial conception already formed of the plant. What is required however is evidence showing how these stalked fertile structures were borne and also information as to whether the axes were vascular or not. Until these questions are cleared up it must remain an open question whether *Sporogonites* is to be regarded as an early type of sporogonium belonging to the Bryophyta or was a simple Pteridophyte allied to the Rhyniaceae (3). It is to be hoped that further specimens may be obtained from the Lower Devonian of Belgium which will help to clear up these outstanding questions.

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EXPLANATION OF PLATES.

All the figures are from untouched photographs taken by Mr. E. Ashby.

PLATE I.

Fig. 1. — The surface of the block of stone bearing numerous specimens of *Sporogonites exuberans*, forma *belgica* and a few fragments of larger plants. (Nat. size.)

Fig. 2. — A single sporangium terminal on a short length of an axis and lying isolated on the stone; from the right in fig. 1. (× 3.)

Fig. 3. — Pieces of the axes and a group of three sporangia from the left in fig. 1; lower in the figure are several less perfect sporangia, including one of small size terminal on a length of axis. (× 3.)

Fig. 4. — Portion of the surface from the middle region and above in fig. 1; above and to the right is the largest sporangium seen, while at the bottom of the figure are two sporangia preserved as iron oxide and less clearly defined. (× 3.)

PLATE II.

Fig. 5. — The sporangium to the left in the group above in fig. 3. (× 10.)

Fig. 6. — The sporangium to the right in the group in fig. 3. (× 10.)

Fig. 7. — The third sporangium in the group in fig. 3; only the upper half is preserved. (× 10.)

Fig. 8. — The isolated sporangium in fig. 2. (× 10.)

Fig. 9. — One of the two sporangia from the lower part of fig. 4. (× 10.)

* Seen after this paper was in the press.

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