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CONTRIBUTIONS TO THE DEVONIAN FLORA OF WESTERN NORWAY. III.

BY

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With 1 Figure, 6 Plates.

In 1931 I published a small paper on some fossil plants from the Middle Devonian of the Nordfjord area, and in 1935 a second contribution, based upon a new collection from the same localities. The present paper deals with some additional material from Nordfjord and from other areas along our western coast.

I beg to express my thanks to Professor Th. G. Halle, Stockholm, who has given me permission to examine and describe the specimen from Nordfjord, and to Professor Th. Vogt, Trondheim, who has put at my disposal his collections from some of the other localities.

The specimens were examined and photographed more than 5 years ago; owing to the present conditions the descriptions published here have to be based on the photographs only, the specimens themselves being inaccessible at the moment. I have also had access to a very limited part of the literature only.

1. The Life-Form of *Hyenia sphenophylloides* Nath.

In the collections of the Paleobotanical Department of the Riksmuseum, Stockholm, there is a large slab brought home about 30 years ago by Professor Halle from the Devonian at the Gjegnalund Glacier, Nordfjord. It bears several branches of *Hyenia*. They are not particularly well preserved in detail, but there is scarcely any reason to doubt that they belong to *H. sphenophylloides*, which Nathorst described from this locality. Most of the branches are detached and scattered without any order on the slab, but three of them, at least, are still seen in organic connection with a thick horizontal axis, which is partly preserved along one edge of the slab (Pl. I, fig. 1). From what is known about *Hyenia* from other countries, this axis may be called a rhizome, or ground axis. It is preserved in a length of some-

what more than 10 cm, but it is nowhere seen in its entire thickness; evidently it has been at least 2 cm thick, probably more, but very uneven. Each branch is borne on a cushion, which in its present, laterally compressed state is triangular, with one side considerably longer than the other, the longer side being the basal, or proximal, one. The length of the cushion may be as much as 3 cm, or perhaps more, its height 2 cm. The specimen gives the distinct impression that the cushions have not formed a single line: As seen on the photograph reproduced, the cushion on the extreme left, with an incomplete branch, and the second cushion to the right of it, both seem to lie in the plane of the bedding of the rock, while the cushion between them (the one bearing the left one of the longer branches) distinctly seems to belong to another plane.

The branches preserved are about 10 cm long, but incomplete; how much longer they have originally been cannot be judged. They are parallel to each other, forming angles of about 60° to the rhizome.

This specimen shows us that *H. sphenophylloides* has the same life-form as *H. elegans* from the Middle Devonian of the Continent. That this was the case, was made probable by a small specimen in Nathorst's material (1915, Pl. I, fig. 4), which has preserved the widened basis of three branches. Also in some of his other specimens there are features which are understood in the light of the specimen described above.

In 1936, in a popular account of the fossil floras of Norway, I published a drawing of *Hyenia*, based particularly on the reconstruction of *H. elegans* by Kräusel and Weyland, in combination with the said specimens depicted by Nathorst. As it has now been confirmed that this reconstruction holds good in the case of *H. sphenophylloides*, the drawing is republished here.

2. The Flora at Døsvik, Ørlandet.

On the peninsula of Ørlandet, on the north side of the mouth of the Trondheim Fjord, Professor Th. Vogt in 1926 discovered fossil plant remains at Døsvik, on the north side of the peninsula (Vogt 1929, p. 61). Personally I have not seen the locality, but according to Professor Vogt there is scarcely any more to be found than the small collection which he brought home, and which he kindly submitted to me.



Fig. 1. *Hyenia sphenophylloides* Nath., reconstructed.
Etter „Naturen“.

The specimens are preserved in a rather hard and fine-grained shale, splitting in fairly regular planes; but the specimens are very fragmentary and show few details.

a. *Psilophyton rectissimum* n. sp. (Pl. II, figs. 1—4). — The species is represented by several axes of a uniform character. They are straight or nearly so, up to 17 cm long, not tapering upwards and thus giving the impression that the complete specimens must have been very much longer. No apical parts are preserved. The breadth is uniform, 4—5 mm, or in a single case (Pl. II, fig. 3) 7 mm. They are very sparingly branched. The longest specimen is not branched at all, while in a few other cases there is a branching of distinctly lateral type (Pl. II, fig. 3); the side-branch is then nearly as thick as the main axis, the direction of which, however, is not altered perceptibly at the point of ramification. — The surface is smooth and even, or nearly so, but bears spines. These are lacking in some parts, but it is difficult to say whether this fact corresponds to the original condition, or the spines have been lost before or during the fossilization. In other parts the spines are very numerous. They are about 3 mm long, straight, pointed, standing out at right angles. In a few places the scars left by the spine bases are seen on the surface of the fossil (Pl. II, fig. 4); they are circular and distributed without any

order. There are a few cases suggesting that the bases have been widened, but this is not certain.

What is left of organic matter is carbonized, giving no hope for maceration. Along the middle of the stem there is, in a few places, a somewhat thicker layer, fairly well delimited and resembling the remains of a central strand; but this interpretation is quite uncertain, and at all events no anatomical details are left.

Affinity. Although we know only restricted parts of the vegetative system of this plant, we may safely, with the necessary reservation for the defective material, refer it to the genus *Psilophyton*. But it is impossible to identify it with any species previously known. Its long and straight axes, of uniform thickness and sparingly branched, give it a very characteristic appearance, which would no doubt make it easy to recognize the species if it should be found in other localities. I therefore, in order to facilitate reference, feel it correct to give it a new name:

Psilophyton rectissimum. Diagnosis: Axes long and straight, of uniform thickness 4—5(—7) mm, sparingly branching pseudomonopodially, bearing acute spines about 3 mm long, standing out at right angles. — Holotype PA 1269 (Pl. II, figs. 1, 2), Paleontological Museum of the University, Oslo.

b. *Hostimella* (Pl. I, figs. 2—4, Pl. II, fig. 5). — There are a few naked branch-systems, mostly of a strictly dichotomous type. They do not look as if they all belong to one and the same species, but it is scarcely possible to say anything more definite about their affinity.

c. Sporangium of a psilophyte (Pl. II, figs. 6, 7). — The collection comprises a single specimen of a fertile telome. It has a thin, straight stalk, about 1 cm thick, widening upwards, so that there is a gradual transition into the sporangium. The latter is 5 mm long and 3 mm wide, oval and obtusely pointed, with some delicate but distinct longitudinal lines or ridges below the middle. To judge by the number visible (Pl. II, fig. 7) there may have been something like 30 of them, if they have occurred at the same distances all round the sporangium. It is not possible to say with full certainty how great part of this body has been taken up by the spore-case itself; probably it has been the greater part of it. The wall makes the impression of

having been rather thick, but perhaps the organ has been immature when fossilized. No maceration has been attempted, on account of the scarcity of the material, and also because there would be very little hope of success.

At first sight the specimen has some resemblance to *Sporogonites exuberans* Halle from Røragen, but if it is correct that the whole of the oval part in our specimen has contained spores, this character, among others, shows that it is no *Sporogonites*. Our specimen is the fertile branch of some psilophyte or other. A closer determination is impossible on the basis of this material.

Age of the flora. — Among the few plant forms known from Døsvik, there is no typical Middle Devonian species. Nevertheless, the flora might belong to the lower part of the Middle Devonian, but from what is present and what is lacking, one would rather suggest a Lower Devonian age, if one should express an opinion on the basis of such a scanty material, which really is insufficient. It is regrettable that no more is left, as more complete remains of this flora no doubt would have made us acquainted with some interesting plant forms.

3. The Flora of Tristein.

In 1926 Th. Vogt discovered some Devonian fossil plants on a small skerry near the island of Tristein, off Vällersund (see Vogt 1929, with map, cf. also Vogt 1924). The first fossils, collected by Vogt, were sent to Professor Halle, who referred them to *Psilophyton princeps*.

In the summer 1927 I visited the locality. In contrast to Professor Vogt, I was very fortunate as regards the weather conditions: The sea was so calm as it very rarely is in these exposed places, and, having gone out in a somewhat larger motor-vessel, my assistant (a fisherman from Vällersund) and I were able to row about in a small dingey from one skerry to the other. Some of the skerries on which we landed, were so small and low that in most days of the year they would be inaccessible, even if the swell was very moderate. — Fossil plants were found in several places. The Devonian sediments mostly consisted of coarse conglomerates and sandstones, but there were lenses of more fine-grained sandy shales of red colour, and here the plants might be both numerous and fairly well preserved, although

with no anatomical structure left. I gave the localities different numbers, but in reality the flora is so uniform that it is not necessary to keep them apart. — Also my collections were sent to Professor Halle, but returned later; until now they have not been mentioned in any scientific publication.

a. *Psilophyton* sp. (Pl. III, IV, V). — The dominating species, present on a great number of slabs, is a spinous psilophyte of considerable size. It is represented by numerous fragments which, in spite of their different aspect, probably all belong to one species.

The thickest axes are 5 mm thick (Pl. III). They are rather coarse and often slightly curved. They branch frequently, with internodes up to 5 cm long, and mostly in regular dichotomy, indications of overtopping being scarce. All these coarser axes bear numerous spines, which seem to be 3—4 mm long, with somewhat widened bases; most of the spines are half erect, while others stand out at nearly right angles.

Other axes (Pl. IV, V) are more slender, about 3 mm thick, with prolonged, straight main axes, bearing lateral branches which often are only slightly thinner than themselves. The spines of these axes are shorter and less coarse than those of the thicker stems, and seem to form more open angles. Axillary tubercles (see Høeg 1942, p. 173) are distinct in several cases (Pl. V, fig. 1).

Some of the lateral branch-systems are naked, of the *Hostimella* type. Such branches are seen in connection with the spinous axes, for instance in Pl. V, fig. 1, which also shows that an ordinary spinous axis may end, apically, in a spineless part. Naked branch-systems, with regularly dichotomous dividing, are also found detached and scattered in great number among the other fossil remains.

Extreme tips are scarce. It is of interest to note that in addition to those of the thin naked branches there is a case of another type, seen in the lower right-hand side of Pl. III: It is the enrolled tip of a spinous axis, rather thick and bearing well developed spines at least out to fairly near the very end. If this specimen really belongs to the same species as the naked branches, it throws some light upon a certain side of the morphology of the plant: It shows that the thicker axes are not only basal, always ending in more slender and less thorny ones, but that they themselves might end directly in enrolled tips of the characteristic primitive type.

No fertile telomes are found.

That the naked branch-systems belong to the spinous axes of the relatively slender type is certain enough from the organic connection observable, while it may be questioned if the latter have formed parts of the same plant as the thickest ones. There seems to be transitions from one type to the other, so probably there is no reason to doubt that it is so; but the proof in the form of organic connection is lacking.

Affinity. In spite of the extensive material it is not easy to determine the name and systematic position of a plant like the present one, even if one disregards the possible doubt as to the combination of the various parts.

The thickest axes (Pl. III) have a striking resemblance to some of the specimens of *Psilophyton princeps* from Gaspé; however, a specific identity is out of the question, provided that they really, as assumed here, belong to the same plant as the thinner axes. On the other hand slabs like the one reproduced in Pl. IV, with its association of spinous and naked axes, are indistinguishable from the Middle Devonian plants described as *Asteroxylon*. But the entire lack of typical *Thursophyton* stems would form an argument against referring the plant to the genus *Asteroxylon*, and in view of the considerable number of specimens examined some weight must be attributed to this negative evidence. Finally one might also recall *Ps. Goldschmidtii*, to which some of the thinner axes and branch systems have a great resemblance.

The difficulty is that the delimitation of these plants, their inter-relationship and generic position, are far from clear. These questions will scarcely be solved until the whole group has been taken up to a comparative study on a broad basis, and, particularly, until the organization of the various species of *Psilophyton* and their ranges of variability have been cleared up. Most probably it will then turn out to be inevitable to institute a new form genus for all cases when it is impossible or difficult to decide whether the fossil belongs to *Psilophyton* or *Asteroxylon*, or, in some cases, even to *Drepanophycus*. These three genera must be regarded as natural ones.

Until such a revision has been undertaken it is really of no great use, or perhaps even be a disadvantage, to refer a plant like the one from Tristein to one or the other species. Regrettable as it is, I there-

fore find it most correct provisionally to call our plant only *Psilophyton* sp., keeping in mind that the genus *Asteroxylon* may as well come into consideration.

b. *Hyenia* (*Hyeniopsis*?) *ramosa* n. sp. (Pl. VI). — Of this species there are only a couple of specimens with a few fragmentary stems. The preservation is not good, but they show up fairly well when photographed.

The stems are straight, mostly about 5 mm thick, but sometimes more. They are only preserved in lengths upwards to 10 cm. As is often the case in *Hyenia*, the lateral organs are not exactly verticillate, although more or less on the same level. In the present specimens these side-organs are not of a foliar nature, but 'branches, which, from somewhat widened bases, stand out at angles of 45° or somewhat more. The branches are much thinner than the stems. They are straight, or slightly curved outwards. Mostly they bear ramifications of second order, which may probably be called leaves, although they seem to be thin, straight, undivided, and rigid, looking more like branches than leaves. It cannot be seen if they are verticillate; in some cases (Pl. VI, fig. 2) they are certainly not regularly so. It happens that the branches of first order are simple, evidently without any 'leaves' (see, e. g., the right-hand specimen on Pl. VI, fig. 1), but it is difficult to say if this represents the original condition, as it seems to do, or if the more delicate side-organs have been lost. — In the cases when the branches of first order have disappeared, either before or during the process of fossilization, their widened bases are left.

Affinity. — This plant is rather different from the type species of the genus, *Hyenia sphenophylloides*, particularly because the main stems have branches in the places of leaves. Otherwise the arrangement is more or less the same. *H. Vogtii* from Spitsbergen (Høeg 1942) is a connecting link, a certain number of the leaves on the main axis of that species being replaced by branches. We may therefore refer our plant to *Hyenia*, at least provisionally.

H. Vogtii is the type species, and, so far, the only species, of the subgenus *Hyeniopsis*, characterised not only by the said branching, but also by the presence of spines. In our specimens from Tristein there is no trace of spines. If we refer them to *Hyeniopsis*, the diagnosis of that subgenus will have to be altered accordingly.

Our plant no doubt represents a new species, and in spite of the defective material I propose to give it a new specific name:

Hyenia (Hyeniopsis) ramosa. Diagnosis: Stems rigid and coarse, 5 mm and more in thickness, with subverticillate branches from widened bases. Branches bearing thin (terete?) 'leaves' in subverticillate arrangement. — Holotype PA 1193 (Pl. VI, figs. 1, 2), Paleontological Museum of the University, Oslo.

In the cases when the main branches have fallen off, their widened bases alone being left, it is of some interest to compare the *Hyenia* from Tristein with some fossils described and figured previously from other localities. Particularly there is a close resemblance between our Pl. VI, fig. 3 and a fossil from Spitsbergen which I have figured a few years ago (1942, Pl. XXXV, fig. 1). I then expressed the opinion that it belonged to some relative of *Hyenia*, an assumption which has now received a strong support. As regards other cases in older literature, see references l. c. (Høeg 1942, p. 88).

Age of the flora. — As far as we know, *Hyenia* is one of the most characteristic Middle Devonian genera (as regards its distribution, see Høeg 1942, p. 87), and even if the new species from Tristein is rather different from the type, it is a plant which, to judge by its organization, at once suggests the Middle Devonian. The psilophyte occurring more or less in the same beds might belong to the upper parts of the Lower Devonian; but it may also have come from somewhere up in the Middle Devonian, and probably that will be the correct age of the beds.

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EXPLANATION OF PLATES

The specimens, when nothing else is stated, belong to the Paleontological Museum of the University, Oslo. The photographs are not retouched.

Plate I.

Fig. 1. *Hyenia sphenophylloides* Nathr., from the Gjegnalund Glacier, Nordfjord. Belongs to the Riksmuseum, Stockholm. Nat. size. — Figs. 2—4. *Hostimella*, from Ørlandet: Døsvik. PA 1271, 1275, 1266. Nat. size.

Plate II.

Ørlandet: Døsvik.

Fig. 1. *Psilophyton rectissimum* n. sp., holotype. PA 1269. Nat. size. — Fig. 2. Part of same. $\times 4$. — Fig. 3. Same species, branching axis. PA 1267. Nat. size. — Fig. 4. Same species. PA 1267. $\times 4$. — Fig. 5. *Hostimella*. PA 1276. Nat. size. — Fig. 6. Sporangium of a psilophyte. PA 1272. Nat. size. — Fig. 7. Same. $\times 4$.

Plate III.

Psilophyton sp., from Tristein. Coarse axes. PA 1298. Nat. size.

Plate IV.

Psilophyton sp., from Tristein. PA 1209. Nat. size.

Plate V.

Tristein.

Fig. 1. *Psilophyton* sp. PA 1236. Nat. size. — Fig. 2. Same species. PA 1281 a. Nat. size. — Fig. 3. Same species. PA 1295. $\times 3$.

Plate VI.

Tristein.

Fig. 1. *Hyenia ramosa* n. sp., holotype. PA 1193. Nat. size. — Fig. 2. Detail of same. $\times 2$. — Fig. 3. Same species. PA 1219. Nat. size. — Fig. 4. Same species. Nat. size.











