MINDRE MEDDELELSER

PETRIFIED WOOD FROM A TERTIARY COAL SEAM IN SPITSBERGEN

As it is well-known, iron carbonate (siderite) is a quite common mineral in many coal-seams and the adjacent rock, occurring as concretions or even separate layers, usually also containing some clay and coal substance (blackband). Concretions of iron carbonate in coal may contain plant fragments showing no signs of compression, proving that the mineral was precipitated not long after the vegetation material (peat) had accumulated (Potonié 1920, p. 78). Iron carbonate, along with carbonates of calcium and magnesium, may also occur as fossilisation material in the woody stems and twigs sometimes found in the coal-seams, usually near the hanging wall. Such have also been found in Spitsbergen, viz. near the hanging wall of the coal-seam in Mine No. 2 of the *Store Norske Spitsbergen Kulkompani A/S* in Longyearbyen at the Adventfjord. The finding point is northeast of the main adit, some 2 kilometres from the mine entrance. The samples were collected by G. Aasgaard in 1930 and E. Sverdrup in 1933, and kindly placed at my disposal. They consist of 2 pieces of coal with fossilised "twigs"; one smaller stem or twig; and the fourth sample is part of a rather big stem. The last one is in the collections of the Geological Institute of *Norges tekniske Høiskole* in Trondheim, and the other specimens are in the collections of *Norges Svalbard- og Ishavs-undersøkelser*.

The Tertiary coal-seam is in Mine No. 2 almost exclusively developed as ordinary coal. Above the seam follow sandstones and conglomerates having a thickness of about 15 metres, then a coal-seam, again followed by sandstones. In these sandstones have been found marine mussels. They have also been found in the beds between the mentioned seams. Thus Sverdrup in the summer

1933 found a specimen on the south side of Endalen (first valley south of Longyeardalen). The fossil occurred few metres above the coal, and above the conglomerate which here lies on the coal. J. P. J. Ravn of Copenhagen has kindly examined the mussel and refers it to the species *Meretrix pyriformis* Ravn (Cf. Ravn 1922, Pl. II). The find is of importance as it shows that, after the peat layer had been formed, the area was invaded by the sea. Sea-water, perhaps brackish, may then be assumed to have penetrated down to the layer of buried vegetation.

The specimens of coal with fossil twigs[1] consist of dull coal (durite), with thin layers of bright coal (vitrite). In the durite is also seen layers consisting of mineral matter, chiefly carbonate of iron. Just above this layer, on the surface of the specimens, occur a number of fossilised twigs, mostly as imprints, as some were lost when the specimens were collected in the mine. The twigs are somewhat flattened, the shorter diameter of the elliptical section varying from 1 to 5 millimetres. The specimen of a thicker branch, or small stem, has an elliptical section (2.5 × 5 cm) and a rounded rather irregular surface. The big stem is also somewhat flattened. Its length is 56 cm; in the one end the section measures 17 × 6 cm, and in the other 12 × 4 cm. The surface is even, with a tendency to longitudinal striation. There are also some figures which may be interpreted as scars of twigs. The stem contains coal disseminated, and when treated with cold, diluted HCl, a slight effervescence shows the presence of some calcite. In thin section is seen that nearly the whole mass consists of iron carbonate, usually occurring as more or less round, oolitic grains (diameter 0.1 0.2 mm) with a radial structure, but frequently are the grains so intergrown that the result is a more or less compact mass of carbonate. Between the grains, often arranged longitudinally, is seen some coaly matter, which in places exhibits indubitable cell structures, and there is thus no doubt about the whole being petrified wood. There is a subordinate occurrence of calcite on tiny cracks, and as small grains between the iron carbonate. This calcite is clearly of secondary origin. Particularly in the outer part of the small stem there is much pyrites. A chemical analysis of a sample of the big stem has been carried out for me by C. Schreuder of the University Chemical Laboratory A:

[1] They may also represent rootlets.

Insoluble	2	per cent.
Coal substance	10	—
FeO	45	—
CaO	6.5	—
MgO	1	—
CO_2	35.2	—
	99.7	

Along with the ferrous carbonate will also be precipitated some of the isomorphous carbonates of calcium and magnesium, but most of the calcium will, according to the thin section, be present as calcite. The specific gravity of the rock is 3.0.

I have also examined some coal samples from a more southerly part of the same mine, and when treated with hot, dilute HCl a slight effervescence followed. The coals consequently contain some ferrous carbonate, possibly also a little dolomite. A small amount of carbonate (chiefly ferrous) seems then to be quite common in these coals. An analysis af ash from coals shipped from this mine 1923 shows 23.29 per cent. Fe_2O_3, 6.00 per cent. CaO, and 2.04 per cent. MgO (Rødland 1924, p. 26). A Swedish ash analysis certainly of coal from Sveagruvan, situated some 40 kilometres to the Southeast, but with seams belonging to the same coal horizon — shows as much as 50.7 per cent. Fe_2O_3; 7.1 per cent. CaO and 1.1 per cent MgO (Norlin 1927, p. 140). Characteristic is the red colour of the ash. In the coal these ash constituents will then to a large extent occur as carbonates. Small amounts will, of course, be present as constituents of other minerals. An analysis of ash of the also Tertiary Kings Bay coals shows a much higher content of CaO: an average of 6 ash analyses gives 15.7 per cent. CaO, and 16.1 per cent Fe_2O_3 (Rødland 1924, p. 26). But these coals contain much calcite deposited on tiny cracks and fissures (Horn 1928, p. 42).

Turning now again to the petrified wood, the mineralisation process must have taken place quite early, as the stems are only slightly compressed. Water carrying small amounts of Fe, Ca and Mg salts have percolated through the mass of vegetation (peat), and minerals have been precipitated in some of the wooden stems. The precipitation has started more or less simultaneously at numerous points whereby is caused an oolite-like structure. During this process the cellular tissue was almost completely destroyed. One must assume

that it is the CO_2 content of the water, furnished by the decomposition of the plant debris, which has caused the iron to become precipitated as carbonate and not as hydroxide.

Similar occurrences have been described by Gothan, Stutzer and others. According to their descriptions, the ferrous carbonate seems to have been precipitated as more typical oolites, these also having a larger size. The "Oolithhölzer" described by Gothan occur in Tertiary brown coals near Cologne (Gothan 1911, p. 528). Stutzer (1933, p. 1141) describes oolitic wood from Chinese Jurassic and Cretaceous coals: "Die Oolithe haben 1 1.5 mm Durchmesser und liegen in einer kohligen Grundmasse, die im Dünnschliff Holzgefüge aufweist". This type of fossilised wood is then also to be found in the Spitsbergen Tertiary coals, and must be expected to occur, with more or less well developed oolite structure, in coals from other formations as well.

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Gunnar Horn.

ADDITIONAL REMARKS ON THE PRESENCE OF A FLOATING ORGAN IN *DICTYONEMA FLABELLIFORME* (EICHW.)

Dr. A. HEINTZ has very kindly drawn my attention to the interesting specimens of the graptolite *Dictyonema flabelliforme* (EICHW.) described below, which he had noticed in one of the Paleontological Museum collections used in connection with the lectures.

In a previous paper[1] I described a well-preserved basal organ in one specimen of this species. From the structures observed and the condition in other graptolites, I arrived at the conclusion that the basal organ evidently represented a vesicular body of the type found among the floating organs of planktonic organisms. A planktonic or epiplanktonic mode of life is expressed in the wide horisontal distribution of *D. flabelliforme*. The species has been found in Europe, East America and even in British Columbia[2]. In my earlier paper I had overlooked a recent publication by BULMAN[3] on some basal structures in a few British specimens from one locality. The structures described by BULMAN deviate considerably from the Norwegian in having an irregular basal disc with root-like extensions. Since the sicula was visible inside the disc the latter proved to be a secondary formation. BULMAN suggested that the graptolite was attached by the disc and the root-like extensions, and had a pendent position.

The basal organs of the Norwegian specimens figured and described below, correspond rather closely to the one I have previously

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[1] "A floating organ in Dictyonema". Norsk geol. tidsskr. *13*, 1933, pp. 102—112.

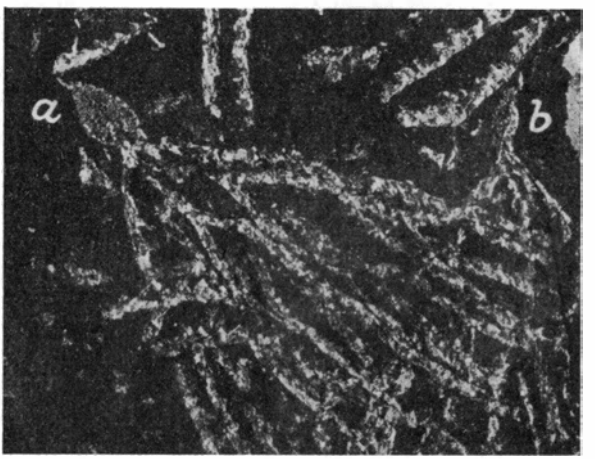
[2] R. RUEDEMANN: "A graptolite from the Chushina formation". Am. Journ. Sci. *20*, October, 1930, pp. 308—311.

[3] Remarks on the attachment of Dictyonema flabelliforme (ECIHW.). Geol. Mag. *66*, pp. 492—495, November, 1929.

described, and like this, suggest a bladder-like floating organ rather than root-like structures. The fossils occur in typical black alum shale, and are labelled: "Oslo by" (City of Oslo).

Description of the material. The text-figure shows the two rhabdosomes with their respective basal organs (a and b).

No. 57557 a has a vasiform rhabdosome with a length, including the basal organ, of 13 mm and a largest width of 10 mm. The number of stipes is difficult to determine, but seems to be 6 7 to each 10 mm. Only a few dissepements are preserved. The distance between neighbouring hydrotecs amounts to 0,6 mm. The first mentioned characteristic corresponds to *Dictyonema flabelliforme forma typica* according to the classification proposed by BULMAN.[1]



Dictyonema flabelliforme (EICHW.). 5 ×
Two specimens showing basal organs. From the Dictyonema-shale, Oslo.
Untouched photograph of specimen embedded in alcohol. No. 57 557 *a* and *b* of the Paleontological Museum Collection.

The basal organ consists of a thin film with a very distinct, continuous outline. The leaf-like disc is almost symmetrically arranged on each side of the sicula which is visible inside. The outline of the disc is equally curved on either side and the two sides converge in front forming a point. The thin glistening fragment near the point does not belong to the specimen, but evidently represents a dissepement of the adjacent single stipe. The disc extends as far as to the initial part of the rhabdosome.

No. 57557 b resembles the specimen described, but is not so well preserved. The presence of the basal organ is shown in the considerable width of the apical portion of the sicula. Only the left side is preserved. The sicula is not well defined.

[1] Monograph British Dendroid Graptolites (Paleontograph. Soc.), pt. I, 1927, p. 27.

Conclusion. The specimens described occur on one and the same surface of one piece of scale. The presence of the basal organs seems to be due to an exceptionally fortunate preservation and the organs might therefore have been present in many of the ordinary specimens showing the sicula only. This is especially probable after the demonstration in British and Norwegian species of an unaltered sicula within the observed basal organ.

The basal organs described in the present article resemble those of the same species described and figured from Canada by HAHN (refigured in my above-cited paper, textfig. 2 c), with the exception that the Canadian have a well-developed stem between the disc and the rhabdosome. The even outline of the basal disc does not in these cases favour the assumption of the structure being an organ of attachment. The structures found in American and Norwegian specimens indicate strongly that the basal organ represents a floating organ, probably a gas-filled bladder of the type described in younger graptolites by RUEDEMANN. As LAPWORTH and BULMAN among others, have pointed out, there seems to have been a considerable individual variation in the development of the basal structures, and although several, or probably many, of the *Dictyonema*-specimens possessed a bladder-shaped floating organ, others might perhaps have been attached to floating seaweed either by a basal disc with root-like extensions, or by a short nema only.

Paleontological Museum, Oslo.

Leif Størmer.