ON THE OCCURRENCE OF THE NODULAR CONCRETIONS (COAL BALLS) IN THE LOWER COAL MEASURES¹.—During the last fourteen or fifteen years that I have worked amongst fossil coal plants, I have been struck with the diversity of ways in which the different genera and species of plants occur in the different calcified nodular masses which we find so plentiful in the several localities where they are found embedded in the coal.

At the meeting at Bradford in 1900 there was a joint discussion between the Geological and Botanical Sections as to whether the plants which entered into the composition of the different coal seams grew *in situ* or not, and from that discussion I gathered that the opinions were evenly balanced. Consequently, from that time to the present I have taken a very great interest in the position in which I have found the nodules embedded in the coal seam. As we all know, there is only one seam of coal in which we find these nodular concretions, and which is given different names in the different districts where it is worked. In the Yorkshire district it has the name of the Halifax Hard Bed; in Oldham, the Upper Foot Mine; Bacup, the Mountain and Union Mine; Todmorden, which includes Dulesgate, the Union Mine; Sheffield, the Gannister Mine; and so on. But, where it is found, in nearly all cases the roof contains similar concretions, with this exception—that the fossil remains contained therein are of marine origin, while those found in the coal underneath are always of vegetable origin. Sometimes, but not very often, we may find a stray stem in the nodular concretions from the roof, such as *Dadoxylon*, *Calamites*, *Lepidodendron Harcourtii*; and the best specimens of *Rachiopteris Grayii* that have ever been found in the English Coal Measures I found in one of these nodules from the roof.

It is not my intention to enter into the chemical composition of these concretions, only so far as to state that in most cases they consist of calcium carbonate and iron pyrites in varying proportions; and in a few places we find that there is a mixture of silica with the carbonate of lime. I have obtained from three localities portions of the seam with these concretions of various sizes embedded in the coal. Some of the pieces I have obtained have been over two feet long and one foot in diameter. I have cut these in various directions to show

¹ Abstract of paper read before Section K of the British Association, Belfast, 1902.

the plant tissues—how they ran, whether one nodule was coincident with its neighbour (that is, if the tissues in the one nodule ran on into the next), and if the tissues of one nodule ran parallel with those of a succeeding nodule either higher or lower in the seam. In that object I have been very successful, as the specimens will show.

During these investigations it has been gradually forced on me that, at least in this case, these plant remains have not grown on the spot where we now find them, and for the following reasons:—In one nodule out of a number which were joined together by the surrounding coal we have a portion of a transverse section of *Stigmaria*, about one-half the whole section; and in the nodule adjoining to the right there is no portion of this *Stigmaria* whatever, but a fragment of a longitudinal section of *Amyelon radicans* and Stigmarian rootlets. In the one to the right above it there is still no part of it, and in the one to the left we have no part of it either. It is so with the various masses I have examined. Some we have which have contained nothing but Stigmarian rootlets; their neighbours would contain *Lyginodendron*, *Rachiopteris bibractensis*, and so on, in short pieces; another, Stigmarian rootlets, with a short piece of *Lepidodendron fuliginosum*, which could not be seen from the outside of the nodule, but was totally enveloped by the rootlets; and so on.

If these plants had grown on the spot where we now find them, and been petrified, we should have certainly found, where we had an abundance of nodules, that these stems would have been continued from nodule to nodule; but that is not so. What we find is a quantity of fragments of short pieces of stems, &c., some with the cortex, some without, some split in fragments, and so on. The natural conclusion is that the various portions of plants have been carried into their present position after being broken in fragments, and before petrification, or they have been carried from a parent bed after petrification.

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