the Kellaways series, I noticed that Phillips, in his "Geology of Yorkshire,"¹ in a list of "Fossils from the Kellaways Rock," refers to a "coracoid bone? of a saurian animal," and this is the only record of any kind that I have been able to find. I thought it possible that the specimen referred to by Phillips might be in the York Museum. On communicating with Mr. Platnauer, the Curator, however, on the matter, he states — "Phillips' 'Undetermined Coracoid' from the Kellaways is not in our Museum. Indeed, our collections have no vertebrate remains from the Kellaways Rock at all."

It should be mentioned that whilst at Scarborough recently I noticed two lumps of hard ferruginous rock in the Museum grounds, the matrix and general appearance of which very much resembled that of the Kellaways Rock, which is exposed in several places in the neighbourhood. Each piece on its broken face exhibited the section of a huge bone, somewhat resembling the paddle-bones from Mill Hill, just described. A portion of an articular surface also protruded from one of the pieces. Of course it is possible that these two Scarborough blocks were found together in the Kellaways Rock, and it is not even improbable that they represent the specimens referred to by Phillips. In the absence of labels or other information, however, we are left in the dark on these points, but it seems desirable that the specimens should be recorded.

III.—COAL PLANTS. INCONTROVERTIBLE EVIDENCE OF GROWTH *IN SITU*.

By W. S. GRESLEY, F.G.S., F.G.S.A.

THE fossils to which this communication relates were described and the deductions drawn from their mode of occurrence in a paper I submitted to the Geological Society of London in 1896, but as that paper was not printed *in extenso* (see Q.J.G.S., vol. liii, p. 245), with the Editor's kind permission the gist of it appears as follows.

I am not aware that entirely satisfactory evidence showing that any of the coal-forming plants² grew exactly where they occur to-day as fossils, has as yet been produced. What authenticated cases of demonstrated growth-in-place coal-forming plants have been admitted by reliable or competent workers and teachers in this connection? While many instances of tree stumps with root-processes and other forms of vegetation more or less in contact with beds of coal have been cited in many countries, in no case do they seem to have contributed coal to the seam, or been found to be composed of but little else than material foreign to coal (stone, pyrites, clay, shale, etc.). Many trustworthy observers have pointed out the danger in taking it for granted that erect fossil stumps met

¹ 1829 edition, p. 142.

² The term 'coal-forming' used in this paper means entering more or less extensively into, or contributing, material of a coal-like aspect and chemical composition, practically the same as the coal-bed in which occurring, with which to help to pile up or add thickness to the seam.

with in or upon (very rarely *in*) a coal-bed grew where they now are; but if a case of growth in place in coal has been or can be established, notwithstanding the substance of the fossil is rock or shale, nobody will dispute that the tree or the plant, whatever it was, did contribute some coaly material to the coal-bed in which it flourished. Be this as it may, the object of this paper is to record the occurrence of forms or fossils composed of coal in actual contact with beds of coal, that unquestionably were plants that grew absolutely *in situ*, and thus to establish the fact that some coal-seams, and typical ones too, are partly, at any rate, composed of vegetal remains that have lived and died exactly on the spots now occupied by them. I also want to make it quite evident that the forms to which special reference is here made grew under water.

FIG. 1.—Section of Coal and Clay-slate.

The coal-seam A, Fig. 1 (the uppermost few inches of which appear), is about 6 feet thick: it is overlain by a layer of black, tough shale (called 'bone'), B, which is about 2 inches thick. Over this 'bone' comes 10 to 11 inches of mottled fireclay, C, and the clay is followed by strata of coal and shale for several feet. These alternations of Coal-measures (Carboniferous), with trifling local differences, obtain for a very large portion of the area of the seam, which is the 'Pittsburg' bed in S.W. Pennsylvania.

An examination of the horizon A-A'—the top of the seam of coal proper—reveals the phenomenon of the bright, brittle, pitch-like coal laminæ, sending out, or more properly, having developed, upward swellings, expansions, and horn-like processes D, not only into the black shale B, but also into the clay C, and in those two strata dividing, branching, curving, and expanding in a peculiar but uniformly characteristic manner. This phenomenon is a very common one; and since these coaly forms extend very much farther horizontally than vertically, and possess their limbs, lobes, expansions, branches, leaves, or whatever their parts or processes should be called, in ever varying shape, position, and trend, any section or exposure of them shows change and difference in form. In some places they appear in great profusion, in others are scattered or of less development and therefore less conspicuous. As to chemical composition and physical aspect, these strange meandering forms in the top of the coal-seam differ but little, if at all, from the black brittle

laminæ lower down in the seam, where the forking and curving phenomena are very much less in evidence. Occasionally one notices suggestions of a core or centre in these fossils—a little clay or pyrites, for instance—but the majority of them are composed of compact, bright, brittle, apparently structureless coal. The exteriors, when the fossils enter the clay, are always filmed with clay, but seem quite devoid of markings—are very smooth. A noticeable feature of the terminals or extremities of the leaves or processes is a tendency to thicken or become slightly bulbous there. Complete pockets of clay are sometimes seen in them. When embedded in the coal-seam they cannot be separated from the matrix. The longest individual measured over 12 feet; the thickest part of any one, about 4 inches,—and all compact coal. Rarely one reaches to the base of the coal above the fireclay C; and here and there specimens seem wholly in the latter stratum. From an examination of a very large number of these forms, extending over many years of my professional work (that of a mining engineer), underground in coal-mines and in clay-mines, as well as in open-cast workings in coal and fireclay districts, my conclusion is that in *form* or *shape* these fossils resemble, more than anything else I know of, the fronds of the Elk-horn fern. Fish teeth, scales, etc., have been found in contact with these coaly forms.

Viewed or regarded as veins, or in a purely stratigraphical and physical light, wholly apart from botanical considerations, these forms or shapes of coaly material, since they intersect the beds B and C, would be regarded as having been formed there or placed there *since* those beds were deposited. But as those forms are presumed to be of vegetable origin, fossil plants or parts of plants which evidently contributed coal to the seams A–A', two explanations of their origin are possible, viz.: (1) That they are the drifted and buried remnants of shrunk-up parts of trees, etc.; and (2) that they are plants which grew and died where they now are. If the former,

FIG. 2.

then they became buried before the coal A was fully accumulated, and therefore before B and before C were deposited; if the latter, then we ought to find some tangible proof of the fact in connection with them. That there is this proof is the burden of this paper—of my argument. When these forms or fossils are strongly in evidence and protrude stout processes up into the clay C, two things are

noticeable: one is that the black shale or 'bone' bed is, as it were, ploughed up and overturned along the sides of the coaly intruders (see Fig. 2); and the other is that ruptured masses of the 'bone' are seen to lie upon the backs and tops of the more prominent expansions (see D, Fig. 2), making it perfectly plain that these plants, in pushing their way upwards, carried patches or strips of the layer B with them in the water (they must have been under water) or slime in which they were growing. I fail to see how one could wish for a more striking demonstration of expansive or upward growth of plants *absolutely in place of growth* than such as this figure is typical of. What other explanation, I ask, will be satisfactory?

But if we would attempt to account for this phenomenon by supposing the forms were in place before the bone layer was deposited, its deposition would have been a horizontal, even, or unbroken one, and the projecting (? woody) processes, such as D, Fig. 2, would have stood up through or been left bare of it, as suggested in Fig. 1. But we are not left to conjecture upon this point. Look at the conditions or the phenomenon sketched in Fig. 3,

FIG. 3.

for clearly here we have one of these forms, D, actually arrested as it were in the act of rupturing the bone layer B. That that stratum was undergoing lateral stretching, amounting to tearing it asunder at E and F, as well as crumpling or thrusting it aside at G, when overwhelmed or when solidification took place, and that the cause of the rending and twisting was the lateral thrust from the extension towards G of the form, or coal-plant growth, D, is to my mind perfectly clear, admitting of no other explanation when taken in conjunction with the phenomena illustrated in Figs. 1 and 2, besides other facts to be noted.

Having these forms of coaly material interlaminated or interstratified with the body of the coal-seam in a descending direction, and inseparably connected stratigraphically and physically in the opposite direction with the beds immediately overlying the coal-seam, to draw a hard and fast line between the coal-bed and the clay above it is impossible. The conclusion, then, is, that growth *in situ*, for a part at least, of the seam of coal, must be granted, even by those who would prefer what we call the 'drift theory.' Another

point that seems to admit of no question is this: that since these coaly forms grew in place, that 'place' cannot have been other than under water, for the reason that the black slime, the stratum B, must have been an aquatic deposit: so that our 'coaly forms' were denizens of mud and presumably of water too.

Other facts may be cited in this connection. The underclay or 'seat earth' of the No. 2 coal-bed in Illinois—a seam far-reaching in extent and of wonderfully uniform thickness and character as regards floor, coal, and roof—in very many places is penetrated by 'coaly forms' possessing the same facies and characteristics as those we have been considering in the 'Pittsburg' seam. If the reader will look at Figs. 1, 2, and 3 upside down, and disregard the bed B, the general aspect of these forms, in vertical sections, will appear. In other words, they are *grown* to the coal-bed, and protrude twisty and horny sheets of compact bright coal in every variety of shape and direction into the underclay; thus making it evident that they were formed exactly where they are now, and that some of the laminations of the coal-bed also, as plants or parts of plants, lived and died in place of growth. The characteristic markings of *Stigmaria* have also been observed in this underclay, but so totally different are the two fossils or objects and their state of preservation, that to get confused in tracing them is impossible. Here, then, also we cannot escape the inference that these coaly forms were plants of aquatic habitat; and although admitting some shrinkage or reduction in bulk to have taken place during conversion from vegetal matter into brittle material resembling coal, it is evident that comparatively little shrinkage did obtain.

Besides the above localities that have produced this kind of coal-bed formation phenomena, the author has discovered very similar fossils in contact with three or four coal-beds in the Leicestershire and South Derbyshire Coalfield; in fact, it was in the mines in this district that they first attracted his attention.

Doubtless similar forms exist in other regions, and the discovery and study of them will yet furnish valuable facts in this line. I am fully aware that if the palæobotanist and microscopist were to pass judgment on my observations and conclusions, they would say the case was 'not proven'; but my contention or claim is this: that no matter what the anatomy and internal organization of these forms was and may yet be found to show, the stratigraphical evidence is clearly pronounced, unmistakable, and altogether in favour of my contention. Further, I hold this: that *science* does not demand a demonstration—a knowledge—of the anatomical structure of an extinct plant or animal to prove or claim the existence or discovery of a new species or genus when *the shape or form* (cast or mould, etc.) of such make it evident that something new has turned up. But *time* will show whether or not I have come upon something new or important in this interesting question of coal-bed formation. If I have made my claim good, it is for those who may refuse to accept it to show that these fossils did not have the attributes and environment herein described or suggested.