A CONTRIBUTION TO THE FLORA OF THE LOWER COAL MEASURES OF THE PARISH OF HALIFAX, YORKSHIRE. BY WM. CASH, F.G.S., AND THOS. HICK, B.A., B.Sc., &c.

PERHAPS no branch of Palæontology presents greater difficulties to the geological student than that of Fossil Botany, and this is especially true of the fossils furnished by the Palæozoic rocks. The remains of plants are so fragmentary and disconnected, that it is very rarely that the portions of such as are found, in even tolerable abundance, can with certainty be placed in their true relations to each other; besides this, most of the fossils are simply casts or impressions, and exhibit no traces whatever of structure; added to these is the fact that those organs, such as flowers, seeds, fruits, &c., which are of the greatest classifactory importance, are the very ones which in nine hundred and ninety-nine cases in a thousand are *not* found fossilised; hence some idea may be gathered of the difficult task which lies before the botanist who attempts from these fragmentary relics of an ancient flora to reconstruct for us its long-hidden vegetable forms.

During the past ten years or so much has been done towards elucidating the structure and affinities of the plants which flourished in the Carboniferous age. In England, a fresh impulse has been given to the study of the plants of the Coal period, by the diligent and careful researches of such distinguished naturalists as Mr. Carruthers, Mr. Binney, and notably Professor Williamson, of whom we may say that he is *facile princeps*. The specimens of Carboniferous plants, so wonderfully preserved as to show structure even in its minutest details, which have enabled fossil botanists to push forward their researches much further than at one time seemed likely or even possible, have been chiefly collected (in England at least) in two localities, namely, near

Oldham in Lancashire, and in the parish of Halifax in Yorkshire. In the former place the intelligent and painstaking labours of Messrs. Aitken, Butterworth, Earnshaw, and Nield have produced a rich harvest, whilst in the latter district Messrs. Binns and Spencer have largely collected for several years. We propose in the following paper to restrict our remarks to the plants which have been collected in the Halifax district.

GEOLOGICAL POSITION.

The bed of coal in which the plant remains (having minute structure preserved) are found, is known as the "Halifax Hard Bed Coal," which lies in the lower portion of the Ganister Beds, between the Elland Flagstones and the Rough Rock or uppermost member of the Millstone Grit series.

The following is the order of superposition:—

	Ft.	In.		Ft.	In.
Elland Flagstone,	130	0	to	210	0
Shales, &c.,	50	0	,,	120	0
80 Yards Band Coal,	0	6	,,	—	
80 Yards Band Rock,	—		,,	20	0
Shales, &c.,	45	0	,,	120	0
48 Yards Band Coal,	0	6	,,	1	2
Shales, &c.,	35	0	,,	—	
36 Yards Band Coal,	0	7	,,	1	8
Fire-clay,	1	6	,,	4	0
36 Yards Band Rock,	—		,,	15	0
Shales, &c.,	90	0	,,	100	0
Halifax Hard Bed Coal,	2	3	,,	—	
Fire-clay,	2	0	,,	6	0
Shales, &c.,	25	0	,,	30	0
Middle Band Coal,	0	6	,,	0	10
Middle Band Rock,	—		,,	12	0
Shales, &c.,	35	0	,,	60	0
Halifax Soft Bed Coal,	1	6	,,	—	
Soft Bed Flags,	—		,,	110	0
Measures,	30	0	,,	80	0
Shales, &c.,	0	6	,,	—	
Fire-clay,	1	0	,,	—	
Rough Rock (Millstone Grit),	Base.				

PHYSICAL CONDITIONS.

The fossil plant remains showing structure are in this district, so far as our knowledge and experience goes, entirely restricted to the Halifax Hard Seam. This bed consists of an earthy coal of very inferior quality, which in many parts is so thickly studded with nodules, varying in size from that of a nut to that of a man's head, or larger, as to render it unworkable. These "coal balls," as the nodules are locally called, are composed chiefly of carbonate of lime; and when broken up are found to contain stems, rootlets, and branchlets of plants, and sometimes cones, spores, and other organs of fructification are found. It is to be remarked that these nodules are not evenly distributed through the seam, but occur in large groups, whilst considerable areas are free from them. The average thickness of the "Halifax Hard Coal Bed" is about two feet. The roof consists of a thin stratum of black shale, some four inches or so thick, and this is often composed almost entirely of the flattened valves of what is accepted as a marine bivalve mollusc, the *Aviculopecten papyraceus*, Gold. Above this thin layer is a bed of shale, averaging a thickness of about five feet, and in this bed are numerous calcareous nodules, often coated over or even impregnated with iron pyrites. These are locally known as "brass lumps" and "baum pots," and when broken up are found to contain fossils, sometimes of vegetable origin, sometimes fish remains, but most commonly shells of the *marine* genera *Aviculopecten*, *Posidonia*, *Orthoceras*, *Goniatites*, *Nautilus*, &c., &c.—a characteristic shell being *Goniatites Listeri*. At the base of the coal seam is found a hard, compact fireclay, known as Ganister. It is penetrated in various directions with the roots and rootlets (Stigmaria) of the plants which once grew upon it, and whose compressed and altered remains constitute the mass of the immediately overlying coal.

CHEMICAL COMPOSITION OF THE COAL BALLS.

We have not yet subjected examples from the Coal Balls to a quantitative chemical analysis, but a qualitative examination gives the following constituents:—

Carbonate of Lime, Carbonate of Magnesia,	70 per cent.
Oxide of Iron, Sulphide of Iron, Sulphate of Soda, Sulphate of Potash, Silica,	30 per cent.

PROCESS OF FOSSILISATION.

A consideration of the conditions under which the "coal balls" are found, leads us to concur with Mr. Binney, when he says, "So far as my experience extends, the occurrence of nodules in the coal is always associated with that of fossil shells in the roof, and therefore may probably be owing to the presence of mineral matter held in solution in water, and precipitated upon, or aggregated around, certain centres in the mass of vegetable matter now forming coal, before the bituminisation of such vegetables took place. No doubt such nodules contain a fair sample of the plants of which the seams of coal in which they are found were formed; and their calcification was most probably due to the abundance of shells afterwards accumulated in the soft mud, and then decomposed, and now forming the shale overlying the coal.

At present little is known of the process by which animal and vegetable bodies are decomposed, and the particles of which they were formed removed and exactly replaced by mineral matter. All observers have been struck with the wonderful perfection of the process by which the most microscopic parts of minute vessels and cells have been

preserved in form; but no author could satisfactorily account for it, until the wonderful discoveries in *Dialysis*, by the late Professor Graham, F.R.S., showed us how crystalloids, such as carbonate of lime, could percolate through animal and vegetable membranes. It is probably by the laws of *Dialysis* that we shall be enabled to find out the process of the calcification of the specimens which occur in nodules from the Halifax Hard Seam.

LOCALITIES.

There are four pits in the Halifax district where plant remains from the Halifax Hard Seam have been collected. Two of those, Bank Top Pit and Sunny Bank Pit, are in Southowram; one at Elland, near Halifax; and the other, Sugden Pit, near Bradshaw. And here we would offer our hearty acknowledgments to our friend, Mr. James Binns, of Halifax, who has long worked hard in this field of research, and indeed has discovered most of the novelties which this district has yielded. Though one of those whose only college has been the university of Nature, and who, like Hugh Miller, has matriculated in a stone quarry, yet his fine powers of observation, trained by long and patient practical study of recent plants in the field, have enabled him to detect the analogies between fossil and existing forms; and, joined to this, he has a rare manipulative skill in preparing sections of fossil plants for the microscope (a by no means easy task), which gives promise, we trust, of still further contributions from his hands to the fossil flora of the Halifax district.

GENERA, ETC., OF PLANTS FOUND IN THE HALIFAX HARD BED.

It is no part of our purpose in the present communication to enter upon any description of the structure of the Halifax fossil coal plants, but rather to furnish a list of the forms

that have been found up to the present time. The fossils may be roughly grouped as follows:—

1. Stems, &c.
2. Organs of Fructification.
3. Undetermined Forms.
4. Fungi.

I.—Stems.

Calamites.

Without bark,	Bank Top Pit	Southowram.
do.	Sunny Bank Pit	
do.	. . . . .	Elland.
With bark, preserved,		
rare, ...	Sugden Pit, .	Bradshaw.

The Calamitean stems are usually decorticated. Professor Williamson mantains that the imaginary restoration of Calamites with straight stem and verticils of extremely slender twigs is a mistake, for in his Ninth Memoir on the Organisation of the Fossil Plants of the Coal Measures, we find him writing, "That such was the case with very young Calamitean stems is more than probable; but my specimens seem to show that many of the twigs of each verticil were arrested at an early stage of their development, whilst the few that were not so arrested did not differ materially in their external appearance from the branches of an ordinary Pinus."

Astromyelon.

Stems.—Sunny Bank Pit, Southowram; and Elland.

The peculiar stellate form exhibited by the pith when seen in transverse section is very characteristic. In transverse sections there is considerable resemblance between this genus and Calamites, but unlike the latter, Astromyelon had a branching unarticulated stem.

Asterophyllites.

Specimens of this genus, the central vascular axis of which in transverse section display the well-marked triangular structure with truncated angles, have been found by Mr. Binns at Bank Top Pit, Southowram.

Lepidodendron.

Two species of Lepidodendra occur in the Halifax Hard Bed—the L. Selaginoides (= Sigillaria vasculare) and the L. Harcourtii. They are both found at Bank Top Pit, Sunny Bank Pit, Sugden Pit, and at Elland.

Sigillaria.

Though fragments of this plant are common, portions of the stem, with adherent bark, being found at all the four pits already enumerated, we are not able to record as yet the occurrence of a whole stem, large or small.

Respecting the two genera, Lepidodendron and Sigillaria, Professor Williamson is of the opinion that "all the phenomena tend to confirm his previous conclusions that they belong to the same type of vegetation; that they are equally Cryptogamic plants, but that the Sigillariæ represent, so far as their vegetative organs are concerned, the highest modification to which the Lycopodiaceous type has ever attained."

(*Farularia* has been found, but we are not able to say from which pit.)

Stigmaria.

Under this name are probably confounded the roots and rootlets of more than one plant; they are found at all the pits. In studying the microscopical sections of fossil organisms from the Halifax Hard Bed, it is specially requisite to be well acquainted with the structure of these rootlets, as they are found penetrating other organisms in every conceivable direction, and are calculated to seriously mislead a superficial observer.

Lyginodendron.

The stems and bark of this genus, which rejoices in the synonyms of Dadoxylon and Dictyoxylon, has been found at Sunny Bank and Bank Top Pits, at Sugden Pit, and at Elland. The species is L. Oldhamium. In transverse section the stem exhibits a circle of plates of fibrous tissue, arranged somewhat like the Roman figures on the face of a church clock.

Diplyoxylon. Bank Top Pit and Elland.

Kaloxylon Hookeri.

A single specimen of this singular form has been found by Mr. Binns in the Halifax Hard Bed.

Fern Stems.

Professor Williamson has adopted the plan of referring the fern stems of the Coal Measures provisionally to the genus *Rachiopteris*; thus, "by adopting this plan we avoid burdening science with a number of meaningless genera, based upon characters which have little, if any, generic value, and which only possess even specific ones under peculiar limitations, such limitations arising from the variations which a single petiole exhibits according to the portion of it from which a section is made." Following this method, we have to record the following species from our locality :—

R. Oldhamia. Elland.
R. duplex.
R. Cylindrica. Elland.
(This peculiar form was first discovered by Mr. Binns.)
R. aspera.
R. (Zygopteris) Lacattii.

II.—Organs of Fructification.

Cardiocarpon. One or two examples have been found.

Lagenostoma ovoides. Elland.

Lepidostrobi of several types have been found, also detached *macrospores* and *microspores.* Of these, one form is supposed to be the fruit of plants of the Calamitean type, another is supposed to *Lepidodendroid.* Another remarkable one has been found, in which the mother cells of the spores are preserved.

Lepidostrobi and spores have been found at Sunny Bank, Bank Top, and Sugden Pits, and also at Elland.

Sporangia of Ferns.

The annulus and contained spores are in several cases wonderfully preserved.

Detached spores and spore-like bodies.

These have been found in considerable numbers, of various kinds, but have not yet been determined.

III.—Undetermined Organisms.

Oidospora anomala.

This name has been given by Professor Williamson to curious bodies discovered in the Halifax Hard Bed nodules by Mr. Binns. They may possibly be some new form of Sporocarp.

Sporocarpon tubulatum. Williamson.

These bodies of unknown affinity have been found in the nodules of the Halifax Hard Seam.

Stomata.

Professor Williamson, in his Ninth Memoir, says:—"Two fragments alone, both from the Halifax deposits, whence they were sent to me by Mr. Binns, seem to resemble objects figured by M. Grand 'Eury, "Flore Carbonifère du Department de la Loire, &c.," which belong to *Cordaites.* One of these

closely resembles the section of a leaf represented in Plate 18, fig. 1, of the work cited. The other is a fragment of epidermis, with numerous large and closely grouped *stomata*. The epidermal cells have disappeared, but the stomata are clear and distinct." We are happy to record that Mr. Binns has since discovered a very fine example of stomata, *with some of the epidermal cells preserved.*

Fungi.

We have one example of the mycelium of a fungus, which was also found by Mr. Binns.

ON AN ORTHOCERAS OF THE MILLSTONE GRIT. BY REV. J. STANLEY TUTE, B.A.

I HAVE met with an Orthoceras in a bed of black shale, immediately underlying the Cayton-Gill Beds, in the parish of Bishop Thornton, near Ripon, which presents several points of interest, apparently new. It occurs in a very fragmentary condition, associated with Posidonomya Becheri in abundance, some small fishes' teeth and scales, and a few flag-like vegetable remains.

The lower part of the fossil is about an inch and a half in length, consists of a number of meniscus-shaped portions, and tapers to a point, which is bent slightly to one side. Above this, which in the fossil is solid (Fig. 1, 2, 3 *a*), there is a hollow chamber (Fig. 1, 2, 3 *b*), the walls of which are very thin, and marked externally with parallel rings from one-sixteenth to one-tenth of an inch apart (Fig. 3 *b*). The walls of this chamber I have never yet found in a perfect state: but such portions, as I have met with, appear to show that the chamber expanded regularly until it was about an inch in width.