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WEST YORKSHIRE.

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AN ACCOUNT OF ITS

GEOLOGY, PHYSICAL GEOGRAPHY, CLIMATOLOGY, AND BOTANY.

Part I.

GEOLOGY.

BY

JAMES W. DAVIS, F.G.S., F.L.S.,
Honorary Secretary of the Yorkshire Geological and Polytechnic Society,
President of the Halifax Geological Society.

Part II.

PHYSICAL GEOGRAPHY AND BOTANICAL TOPOGRAPHY.

BY

JAMES W. DAVIS

AND

F. ARNOLD LEES, F.L.S., M.R.C.S., L.R.C.P., LOND.
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With Maps and Plates.

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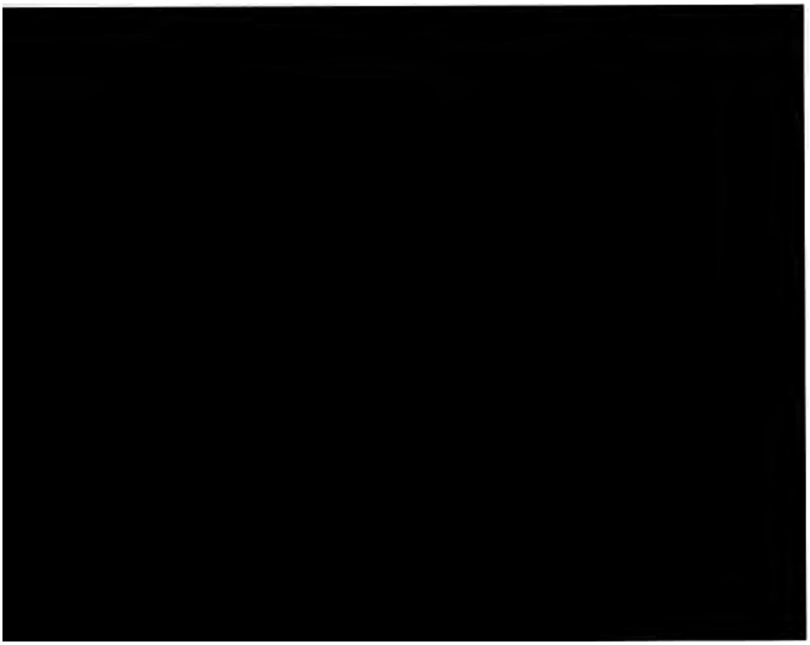

TO

JOHN GILBERT BAKER,

WHOSE "NORTH YORKSHIRE" SUGGESTED THE PRESENT WORK,

AND FURNISHED

THE MODEL UPON WHICH TO MOULD IT;

AND TO

W. WILLIAMSON NEWBOULD,

AS A MEANS OF CONNECTING HIS NAME

WITH A RIDING AND A WORK THAT ALIKE OWE MUCH

TO HIS PROFOUND BOTANICAL RESEARCH,

IN TOKEN OF APPRECIATION AND INDEBTEDNESS,

THIS BOOK IS INSCRIBED

BY THE AUTHORS.

PREFACE

TO THE SECOND EDITION.

IN issuing a Second Edition of 'WEST YORKSHIRE,' the Authors have much pleasure in taking the opportunity to thank their friends for the kind appreciation manifested towards the First Edition.

There will be no material alteration in any part of the work. The character of the subject renders small changes unnecessary, and, unless the whole was greatly enlarged, unadvisable.

It has been a source of satisfaction to find that our efforts should have been considered worthy of almost unanimous approval on the part of those gentlemen who have reviewed the work for the scientific and general press. It is also gratifying to know that two of the Addresses delivered by Sectional Presidents, at the recent meeting of the British Association at Sheffield, were founded to a considerable extent on the subject-matter of 'WEST YORKSHIRE.'

CHEVINEDGE, HALIFAX,

November, 1879.

PREFACE.

IN offering the first portion of "West Yorkshire" to the subscribers, the authors would apologize for the delay which has occurred in its publication. Originally intended to be issued in one volume, the subject-matter so accumulated in their hands, that it soon became evident that the work would largely exceed the limits first contemplated, and that the time for its preparation must be considerably extended. They trust that its enlargement will be a sufficient compensation to the subscribers for the patience with which they have awaited its appearance.

The objects of the work as enlarged are as follows:—to give a tolerably full account of the geology of the Riding; to describe its salient physical features, and, intercurrently, to outline the sample *florulas* grouped around them; to sketch the climate of the Riding, and show the limits imposed by its various factors upon the range of the integers of its Flora; to connect the facts concerning soils and subjacent rocks that are interdependent in respect of their behaviour under disintegration, and with regard to their effect on the horizontal distribution of plants, indicating the rôle of each separate set of conditions in determining the Flora; and lastly, to furnish a Flora somewhat more comprehensive and instructive than the usual bald list of species with their localities.

In the present volume are included the sections on Geology and Physical Geography, and the distribution of plants according to drainage districts. The Climatology, the 'Flora' proper, and their connections are reserved for a second volume.

The Geological part of the work is based to some extent on the results of the Geological Survey; and these and all other available sources of information have been unhesitatingly utilised. The accompanying map will, it is hoped, be of service to practical geologists, the more so that it embraces districts for which the survey maps are not yet published.

The authors have much pleasure in acknowledging their indebtedness to numerous kind friends for much [redacted] whose most unselfishly rendered help the Flora could never have been written), W. Fowler, Gerard E. Smith, and R. A. Gatty; Drs. H. F. Parsons, B. Carrington, H. Payne, and J. S. Wesley; and Messrs. T. Abbot, W. Todd, A. Carr, T. Emmett, T. Stansfield, T. Hardy, Geo. Webster, are especially worthy of thanks; but beyond theirs, not a little help has been given of a nature, like anonymous alms, precluding allotment of credit by name.

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WEST YORKSHIRE.

Part I.

GEOLOGY.

13

CHAPTER I.

INTRODUCTION.

IT is proposed to give a general outline of the geological structure of West Yorkshire, with some account of the great system of faults and anticlinals of the Craven and Pennine districts, and the influence they have had in forming the general contour of the country. The boundaries of the Riding will also be indicated.

The classified list of formations represented in the West Riding will then be given, followed by as detailed a description of each as the small compass of the work will allow.

The north-west corner of the Riding is occupied by a series of high mountains composed of Silurian sandstones, shales, slates, and limestones. These are brought to a sudden termination by the great Pennine Fault on the east, and abut against the Carboniferous Limestone and Yoredale rocks of Baugh Fell and the hills east of Dent Valley; but on the west they are continuous with the mountainous parts of Westmoreland, and present features of much nearer relationship with the latter than with the neighbouring districts of Yorkshire. The Silurian rocks differ little in character through their vast thickness, and cause scarcely any variation in the physical characters of the district. They are usually much contorted, and give rise to rounded mountain-land. The position of the great valleys by which they are intersected is greatly due to the lines of weakness caused by the faults, the rocks in the valleys being precisely similar to those occupying the hills above, and exhibiting no features rendering them more liable to erosion.

The system of drainage being thus determined, the denuding agents, water and ice, have been concentrated in the areas contiguous to the faults, wearing them down still deeper, and giving the hills their peculiar rounded character. Thus the courses of the rivers Lune, Rawthey, and Dee, with many of their tributaries, coincide with the lines of fault, which are known to run in a somewhat parallel direction to their course, though often hid by beds of river deposit, or by the older morainic matter left by the glaciers. The high hills of Barbon, Middleton, and Holme Fells owe their abrupt eastern termination to the great fault which decided the course of the River Dee. The deep hollows and combes which run down the western and northern slopes are due to the erosion of the softer beds of shales and sandstones by a glacier which descended Ravenstonedale, and passed over these hills on its way south-west to the Irish Sea : the rock surfaces on feet over their precipitous cliffs, passes along the highest point of the Calf and Windy Scarth (2000 ft.) westwards to the Valley of the Lune. This stream, with its beautiful accessories of wood and fell, forms the dividing line between Yorkshire and Westmoreland until its junction with the Rawthey is reached. The boundary then again ascends to the high ground composing the ridge of hills called Holme Fells, passes along their summit for four or five miles, then crosses Barkin Beck to the Yoredale Hills capped with the Millstone Grit of Colne Hill (2253 ft.), and the county stone on Graygarth Fells (2060 ft.), which is the point that separates Yorkshire, Westmoreland, and Lancashire. From this summit, the boundary line descends in a south-westerly direction, and crosses the patch of Permian Conglomerate near Ireby, brought by the great fault in apposition with the Mountain Limestone; continues across the Black Burton Coalfield to the River Greta, and southward to the Wenning near Low Bentham. It pursues a somewhat devious course along the summit of drainage in Bolland Forest, of which Burnmoor (1319 ft.), Bolton Head Fell (1784 ft.), and Wolf Crag (1731 ft.), are the highest points. Thence descending to the Yoredale shales of the Trough of Bolland, and turning westwards from Whitewell, the boundary is formed by the River Hodder to its confluence with the Ribble. The Millstone Grit district of Bolland consists as usual of extensive moorlands, covered with scrubby heath and bilberry bushes. In the thick beds of peat the roots of trees or their recumbent stems have been found, evidence of the former existence of forests in a situation where, at present, it appears impossible to grow trees of any kind. This is an instance of a local change in climate or circumstances of which no satisfactory explanation has been given.

The Ribble, from its confluence with the Hodder, northwards to Grindleton, constitutes the division between Lancashire and Yorkshire. For two or three miles it passes through a patch of Permian strata brought down by a fault against the Carboniferous Limestone of Clitheroe. The scenery to the west of the river in the wooded dells and terraces of the Limestone is very beautiful. Ings Beck forms the boundary eastwards to its source on Rimmington Moor, thence on the Millstone Grits of Burn Moor to the Forest of Pendle, and pursuing an east-north-easterly course near the line of the Kinderscout Grit escarpment of Tonbridge, along the Yoredale Grits of Kelbrook Wood (1175 ft.) to Ayneslack, where it turns to the south-east, and, crossing the Kinderscout and Third series of grit rocks, continues over the Rough Rock of Combe Hill (1337 ft.) to the opposite ridge of Crow Hill (1501 ft.), and along Jackson's Ridge on Boulsworth Moor.

These inequalities of the surface are mainly due to a system of great faults and anticlinals running in a

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the limestones and shales are found to be contorted and bent on themselves, occasionally at very sharp angles. That so hard and brittle a substance should be thus folded without being broken, indicates a long-continued and gentle lateral pressure, and this being clearly due to the powerful action producing the fault, it follows that the latter was also the result of a force prolonged over an indefinite period. The result produced by the Pennine faults in the northern part of the Riding has been to bring up the Silurian Slates and Grits of Howgill Fells to a level with the Yoredale Rocks and Millstone Grits of Swarthfell and Bowfell, whilst in the valleys, the Coniston Grits and the Mountain Limestone are found in contact with each other. A few miles southward, the Burton and Ingleton Coalfield, with all the underlying Millstone Grit, Yoredale and Carboniferous Limestone rocks are depressed to an equality with the Silurian Shales and Grits beneath the Limestone of Ingleborough. From Clapham, the line of fault makes a sweep round Austwick to Feizer, and thence along the magnificent escarpment of Giggleswick to Settle. On the southern side of the Scar, the rocks are Millstone Grit, and may be seen exposed in sections near Giggleswick. The accompanying sketch will explain their relationship. (Pl. VI., Fig. 19.)

The limestone scar behind Settle is a continuation of the fault; and, still proceeding eastwards, the grand series of scars of Attermire and Langcliffe, perhaps the finest along the whole line of dislocations, extend towards Malham. They form dry hills to the left of the road, whilst on the right are wet surfaces of Millstone Grit, the road being near the line of fault. The fault then passes between Kirkby Fell and Ryeloaf Hill, and across to the valley of the Aire, forming the well-known and highly interesting escarpments of Malham Cove and Gordale Scar,—the latter unequalled for wild grandeur in the country. The limestone has been cut back by the stream, forming precipitous cliffs on each side 300 feet in height. Below the limestone, the Silurian grits may be seen in the gorge, whilst to the south the grit rocks of Carboniferous age flank the cliffs. From Gordale the dislocation proceeds to the south of the village of Skythorne.

A northern branch of the fault proceeds across Malham Moor, near the Tarn: the exact line of the fault is much obscured by drift deposits. There is a throw of several hundred feet. The beds of limestone on the south are nearly horizontal, with a very slight dip towards the southern branch of the fault. From Malham Tarn it proceeds across the Moor to Kilnsey, where evidence of the upheaval may be seen in Kilnsey Crag, and it is probably continued eastward under Grassington.

The anticlinals of Bolland and Skipton districts constitute a rich agricultural tract, which, especially in the neighbourhood of Gisburn, is well wooded. The valleys are Yoredale Shales and Grits, and inserted in these are

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capped with grits. A natural section may be seen in the bank of the river opposite the Abbey, showing the shales dipping N.W.; further down the river the shales may be seen dipping in an opposite direction. Between these two points the contorted limestone can be traced through Beamsley as far as Blubberhouses. The mass of Yoredale Shales and Grits stretching from Pannal to Harrogate may be a part of the same great system of anticlinals, and the ridge can be seen passing through Knaresborough and sinking under the Permian Limestone to the east, the latter lying horizontally above the contorted Carboniferous beds. Near the western extremity of the Riding there are also beds of Permian or Triassic age resting on the denuded edges of Carboniferous rocks; and as several thousand feet of strata have been washed away in that locality, there must have been a break of very long duration between the close of the Carboniferous age and the commencement of the Permian. The Carboniferous rocks of the latest age are broken through by the faults and anticlinals, so that, reasoning from these data, the age of the Craven faults and the accompanying phenomena is fixed between the end of the Carboniferous and the beginning of the Permian formation, during the period of denudation existing between the two eras.

A second great system of faults, the Pennine anticlinals, form a long chain of hills, reaching a distance of more than fifty miles from near Skipton in a north and south direction to Staffordshire. This anticlinal has divided the Lancashire and Yorkshire coalfields, which originally formed one continuous area, into two parts. This upheaval is of much later date than the one already described, and probably took place near the conclusion of the Permian period or at the commencement of the Triassic. The Pennine anticlinal passes along the western part of Yorkshire, through Compstall, Dishley, and along the anticlinal axis of Saltersford Valley, onward to Leek in Staffordshire, where it passes under undisturbed beds of new red sandstone which lie in the centre of an old Palæozoic trough. Southward it reappears, passing along the vertical beds of Whitley rock, and ultimately forms a juncture with another fault which traverses both Carboniferous and Triassic rocks. Parallel with, or converging to, the anticlinal axis, along its whole course, are several minor faults. An important one in these is the Red Rock Fault, which throws the Permian sandstone against Carboniferous rocks. It reaches from Bridbury and Poynton in Cheshire, southward, for several miles. This fault is certainly of later date than the Permian formation, and if the Red Rock Fault is coeval with the Anticlinal Fault, it follows that the Anticlinal Fault is also of later date than the Permian.

The south-west boundary of the Riding is formed by a well-defined series of high moorlands, ranging generally in a southerly direction. These high moorlands are the [redacted] along Widdop Moor, Gorple Stones, Black Hambleton (1574 ft.), and Bride Stones (1434 ft.)

At Todmorden the range of hills is broken through by the River Calder for a width of about two miles. Crossing this valley, the boundary reascends to Langfield Moor, and, passing between White Holme Moss and Turlay Holes Edge, continues to Blackstone Edge, forming a magnificent wall of rock, 1553 ft. in height, overlooking the comparatively low and level districts of Littleborough, Rochdale, Oldham, and Manchester. From Stokes-in-the-Moss (1356 ft.) the boundary makes a slight deviation to the west, and passes along the edge of the Lancashire coalfield to a short distance west of Oldham. The Pennine Fault, or the backbone of England, as it has been named, runs about two miles east, down the beautiful valley of the Tame, throwing up the Yoredale Rocks in the valley in an anticlinal. The higher ground on each side consists of the Millstone Grits forming table-lands which support and gradually give place to the Ganister and Middle Coal Measures of Yorkshire and Lancashire respectively. The two coalfields, as already observed, have been separated by the Pennine disturbances having been originally deposited in one continuous bed.

Several smaller faults from the east and west converge near Marlow and Buckden Pikes, and thence pass southward, throwing the Millstone Grit against the Yoredale Shales. The escarpments which bound the valleys are often formed by cliffs of grit which present a very fine appearance when seen from below. These cliffs, when traced further on the moors, give rise to waterfalls and cascades. After heavy rains, the water rushes along these courses with great violence, carrying down large pieces of stone with sand and pebbles, leaving evidence in the valleys of the denuding power of water.

The masses of rock which form the crests of the ridges are also worn by atmospheric agencies into most peculiar and fantastic shapes. This is in a great measure owing to the different degrees of hardness, and the power of withstanding the action of rain, wind, and frost. Examples may be seen in the numerous rocking stones scattered about: the "Pots and Pans" near Greenfield, "Bridestones" near Todmorden, and many others. These, like many other phenomena not easily explained, have been erroneously attributed to the Druids.

From the River Tame, the West Riding is separated from Cheshire by extensive moorlands, wholly given up to grouse or sheep. The boundary runs over Blindstone and Featherbed Mosses in an easterly direction; then bending north round Slidens Moss, it keeps along the south-western edge of Holme Moss and Withern Edge, which are composed of the upper beds of the Third Millstone Grit series. From Dead Edge End the direction is southerly, and crosses the Kinderscout grit of Featherbed Moor. Here the River Derwent takes its rise, and its course southward forms the dividing line between the two counties

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the Druids. At the junction of the Abbey Brook with the Derwent, the boundary of the county deviates eastward across Howden Moor to the magnificent escarpment of Derwent Edge. At Back Tor it attains a height of 1773 feet, and its course is marked by stones of strange forms surmounting a cliff of grit rock. Below this, the underlying shales form a steep slope to the Yoredale grit of the moors below.

Passing Strines Edge, the boundary continues along the western edge of Hallam Moor,—an escarpment of Third grits, which forms a very striking feature in the scenery of the district. The peculiar character of this grit is well shown on Crow Chine and Stanage Edge. Its vertical joints cause masses of the rock to split off and fall down the slope of shale below, which is thus thickly strewn with large rectangular blocks. This may be accounted for by the underlying shales being removed by the action of rain and the atmosphere: the rock, thus deprived of its support, breaks off along the joints, and rolls down the flank of the hill below, which in time becomes covered by these disintegrated masses.

The division between Derbyshire and Yorkshire runs next under a ridge of the flag rocks composing the Second grits, which are here well developed, and quarried at several places along Brown Edge, Ringinglow, and Thirlow Bridge. The River Sheaf afterwards serves to separate the two counties as far as Lower Heeley, about two miles south of Sheffield. The boundary then turns to the south-east, along Moors Brook, to its source near Gleadless, when the Shire Brook conducts it eastward to its confluence with the River Rother. This distance is over the Coal Measures, a tract of undulating country somewhat similar in character to the Millstone Grits further west, but lacking much of their boldness and fine mural escarpments. The River Rother and the stream rising on the Permian Limestone on the east of the coalfield, and passing through Norwood, conducts to the most southern part of the Riding, whence its boundary pursues a course northward through Shireoaks to Harworth, along the rich agricultural or park-like district of the Permian Limestone.

The country throughout the district already described forms an elevated plateau of moorlands, intersected by rich grassy valleys. The higher portions are covered by heather and bilberry bushes where the surface is formed on grit rocks; and where limestone prevails, grassy mountain pastures are generally found. The deep valleys in the grit country usually have a stream at the bottom. They are well cultivated, and are studded with towns or hamlets. The moors generally terminate westward in an abrupt gritstone escarpment, below which is a slope of shale. Those edges are often wholly or partially hidden by a thick growth of wood, mainly stunted oak, sycamore, and birch trees, with a close undergrowth of hazel and [redacted]

The rocks forming the Pennine anticlinal dip gradually to the east, giving place to the upper beds of the Millstone Grit series. The Third Series of grit rocks forms a succession of sloping terraces very similar to the Kinderscout grit; in many localities it is very bold in outline, and has rugged escarpments. Its surface usually forms moorlands, but where it descends to a moderate height above sea level it has been enclosed and cultivated. The broad belt of Third grits dips under the shales supporting the Flag and Rough rocks. The latter in the south-western part of the Riding, with some portion of the Lower Coal Measures, are brought against the Ganister Coal series by faults. North of these faults the Millstone Grit and Coal Measures ascend in conformable and undisturbed order. The Rough Rock presents a remarkably even and extensive slope, with a general dip of about one in twenty to the N.E. in the southern part of the Riding; further north the dip is influenced by the Pennine and Craven anticlinals, having a direction first easterly, and then south-easterly, until in the northern part of the district, ranging from Bingley to Shadwell, the strike becomes east and west, and the superincumbent Coal Measures rest on the Rough Rock, with a general dip to the south. It will thus be seen that the grit rocks form a basin-shaped hollow in which are deposited the Coal Measures of South Yorkshire; that this form is due to the upheavals of the older rocks in Derbyshire, between Lancashire and Yorkshire, and in the Craven district; and, as will be explained hereafter, the whole series dip unconformably beneath the Permian limestone escarpment running north and south across the county.

The principal surface characteristic of the Lower Coal Measures is the bold outline of the hills formed by the Elland flagstone and the Grenoside sandstone. These rocks are about 600 to 800 feet above the Rough Rock; the intermediate beds being composed of uniformly soft clays, shales, and coals, form a sloping hillside unbroken by any marked features. The thin beds of sandstone which occasionally occur are too small to influence the general evenness of the hillside. The Greenmoor and Grenoside rocks attain a height of about 1200 feet on Whitley Edge, Hartcliffe, Wood Royd Hill, and elsewhere. Castle Hill, near Huddersfield, is about 900 feet, being composed of these flags. From these summits the ground falls with the dip slope of the rock, forming a widespread incline passing beneath the outcrop of the Penistone flagrock. North-west of Huddersfield the Ganister series rests on the rough rock, surmounted by the Elland flagstone in a regular series, and in the neighbourhood of Halifax it attains an elevation of 900 to 1000 feet above sea level. It pursues a tolerably straight course across the country, except when broken through by the Calder and Colne, or by faults. On the escarpment on the west side of the ridge the different beds forming the Ganister series may be [redacted] sequence the country occupied by them does not present striking features, but is of a gently undulating nature, with considerable variety of hill and dale.

From the north-western part of the Riding occupied by the Silurian rocks, the boundary extends eastward over Swarth Fell (2237 ft.), and along the summit of drainage to Widdale Fells (2203 ft.) in a southerly direction, and then again eastward along Cam Fell, Dodd Fell (2183 ft.), and the mountainous land north of Langstrothdale Chase to Kidstones Fell (1812 ft.), where it turns south to Buckden Pike (2302 ft.) and Great Whernside (2245 ft.). The River Nidd takes its rise on the latter hill, and, running eastward, the chain of hills on its northern side, Little Whernside, Ackleside Moor, Great Haw Hill (1786 ft.), Brown Ridge, and Fountain Earth Moor (1450 ft.), form the summit of drainage between Nidderdale on the one side, and Coverdale and the tributaries of the River Burn on the other. All these ranges of hills consist of Yoredale shales and limestones, with a base, not always seen, of Carboniferous Limestone, and having usually a thick covering of Millstone Grit rock, with occasionally one or two beds of inferior coal. This is also the character of the mountains to the south. Wharnside (2414 ft.), Ingleborough (2373 ft.), Penyghent (2231 ft.), Fountains (2191 ft.), and Coska Fells, are constituted of Yoredale rocks, with a capping of Millstone Grit which increases in thickness eastward, and on Penyghent has workable beds of coal above it. The base of the mountains of this district is the thick massive Carboniferous Limestone which extends in a great tableland from the line of the Pennine Fault on the west, forming extensive scars along the flanks of the mountains as far as Upper Wharfedale, where it dips under the superincumbent strata, reappearing again in the deep valley of the Nidd near Lofthouse. The Limestone extends southward to the Craven Fault, which throws down the Millstone Grit rocks to the level of the Carboniferous Limestone. In the Craven district the limestone reappears in a series of anticlinals. In the valley of the Wharfe, between Burnsall and Appletreewick, the limestone is seen ; it extends eastward to Nursa Knot, and the outlier of Greenhow Hill as an anticlinal ridge.

The boundary line pursues a direction east, with a little north, across the bleak gritstone moors of Mashamshire Chase to the River Ure at Grewelthorpe. These moorlands are composed of grit rocks of the Third Series, which occupy a very extensive area. They are higher in the series than the grit rock which caps the hills westward, and also that of Wharfedale, Nidderdale, and Greenhow Hill, which are the equivalents of the Kinderscout grit of the country further south. The Third Grits from the bold craggy escarpment of Birmham and Guy's Cliff, on the west and eastward, reach to the Magnesian Limestone escarpment under which they disappear, having a general dip to

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its course is along the great, comparatively flat plain of which York is the centre.

Extending across the entire length of the West Riding is the belt of Magnesian Limestone. It has an average height of 200 to 300 feet above the sea-level. Its western edge forms a well-marked escarpment above the Millstone Grits and Coal Measures. It dips gently eastward, with a slightly undulating slope under the Bunter Sandstone. Its composition changes very much in different localities, from a hard, blue, close-grained limestone to a soft yellow rubbly one. Its thickness also varies considerably, having been extensively denuded since its deposition ; as, for instance, a few miles north of Knaresborough, where the limestone has been entirely removed, exposing the Millstone Grits beneath, and also in the same district the red marl rests immediately above the grits, the limestone below the marl having entirely disappeared. Along the western extremity there are many outliers of the limestone which have been separated from the main mass by denuding agencies. At Barsneb, Nidd Rock, Bilton, Collingham, Thorner, and other places further south, these isolated patches may be seen. The limestone, wherever present, is extensively quarried for agricultural and building purposes. It makes a beautiful building stone when fine-grained and a good colour, but it is not very durable in large towns, or where the atmosphere contains a large percentage of carbonic acid. The latter, by its action on the carbonate of lime, causes the stone to become friable, and easily weathered. In the country, however, where the atmosphere is pure, it forms a good stone, and is very durable, many old buildings in Yorkshire having been built of this stone, and being still in a good state of preservation.

Above the Lower Limestone is the Middle Marl and the Upper Limestone. The latter usually forms a second escarpment, running tolerably parallel to the one already described. The first appearance in the north, except a small patch near Knaresborough, is to the east of Wetherby; from thence, southwards, both limestones are persistent as far as the county boundary. It is generally thinly bedded, hard, and fossiliferous, and contains little magnesia. It is extensively quarried, and burnt into lime.

The Middle Marl consists of red or variegated marls, having occasionally beds of gypsum, which were formerly used for making Plaster of Paris. The marls are rarely more than 50 feet thick, often much less, or totally absent. Where they cannot be seen, their presence is generally indicated by the red and wet soil, and the springs thrown out near their top. The various members of the Permian formation do not appear to be quite conformable to each other; they are very variable in thickness, and have been denuded prior to the deposition of the rock above in nearly all cases. Instances also occur of pebbles and fragments of the lower limestone being incorporated into been found the remains of animals now extinct in this part of the world, as elephant, rhinoceros, and reindeer. More recent than the Gravels are Warp Clays, which consist of finely laminated unctuous clays with beds of sand. They have been deposited by successive tidal overflowings of the sea on the flat lands extending from the mouth of the Humber northward; also eastward and southward in the valleys of its tributaries—the Aire and the Don. The richness and value of the land, wherever Glacial or Estuarine Deposits predominate, is usually greatly increased for agricultural purposes, and presents an undulating, park-like appearance.

Extending from the Permian Limestone to the boundary of the Riding is a long, nearly level plain, with slight undulations, but rarely rising higher than 75 feet above the sea level. Northward and southward it reaches into the North Riding and the plains of Lincolnshire respectively, whilst eastward it extends beyond the Ouse, in the East Riding, to the foot of the Hambledon Hills and the Chalk wolds. This large tract is occupied almost entirely by the Bunter Sandstone of Triassic age, above which, and in great measure hiding it from sight, are enormous deposits of Drift and Boulder Clay. The Bunter Sandstone is usually a brick-red colour, porous and very soft; occasionally it becomes hard enough to be used as a building stone, and has been quarried for this purpose at Aldborough and near Ripon. It is not used, however, at the present time. On account of the thick deposits of Drift which everywhere cover the surface in the vale of York, the knowledge of the Bunter Sandstone is very limited. Occasionally it rises to the surface as small hills, as in the localities mentioned above, and at Brayton Barf and Hambleton Hough, near Selby. In other instances it is exposed in railway cuttings or at the base of gravel-pits, as near Cattal Station, and those of Hensall and Heck, near Snaith. In pits, examples may be seen at Hunsingore, Healaugh, Bilborough, and Pollington. The only other source of information accessible is from a few borings and wells that have been sunk in search of coal or water. These have proved that the sandstone is of great thickness. A well at York was sunk to a depth of 483 feet in the red sandstone; at Selby 330 feet were penetrated, and at Goole 1029 feet, the upper part probably being through the Keuper sandstone. The middle member of the series, the Muschelkalk, as represented in Germany, appears to be absent in Yorkshire.

CHAPTER II.

SILURIAN PERIOD.

THE Fossiliferous Strata of the British Isles have been divided, for purposes of classification and comparison, into the following groups :—

Post Tertiary.
Tertiary.
Cretaceous.
Oolitic.
Liassic.
Triassic.
Permian.
Carboniferous.
Devonian.
Silurian.
Cambrian.
Laurentian.

Of these, the Post Tertiary, Triassic, Permian, Carboniferous, Devonian (?), and Silurian are represented in the West Riding of Yorkshire. If the whole of the county be taken, we have all the great divisions well represented, except the two last, the Cambrian and Laurentian, thus presenting in so small an area a more glorious epitome of the strata composing the earth's crust than can be found in any other locality of similar, or even much larger, extent in the world.

It is proposed to consider each of the formations represented in the West Riding of Yorkshire separately, beginning with the earliest in point of time.

SILURIAN SYSTEM.

The Silurian rocks in the West Riding of Yorkshire consist of a great thickness of slates, flagstones, and limestones, which may be divided into two principal sections, the Upper and Lower, the one resting unconformably on the other. The Green Slates, Coniston Limestone, and a small thickness of strongly cleaved slates above the limestone, which pass gradually into it, will be considered as Lower Silurians; whilst the Conglomerate, which rests in many places unconformably on the limestones or slates, and consists of coarse angular or rolled fragments which appear to be derived from the grit of the Green Slate series and the Coniston Limestone, is regarded as the base of the Upper Silurians—the latter group including the Horton flagstones and the slates and grits of Howgill Fells. This classification is based on, and is essentially the

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represented by the Welsh series, ranging from the Caradoc to the Ludlow rocks.

The West Riding series, which may be considered as a part of the Westmoreland group, in both its physical and geological aspects, is comprehended in the Green Slate and Upper group; they are arranged in the following order:—

I. Lower Silurians.	1. Green Slates and Porphyries.	
	2. Coniston Limestone and Shale . . .	*a.* Coniston limestone.
		b. Strongly cleaved slates.
II. Upper Silurians.	1. Coniston Flags . .	*a.* Conglomerate.
		b. Mudstone slate.
		c. Tough grits and flags.
		d. Horton flags.
	2. Coniston Grits . .	*a.* Tough grits and flags.
		b. Sandy slates.
	3. Bannisdale Slates.	

I. LOWER SILURIANS.

1. *Green Slates and Porphyries.*

Bluish-green fissile slate, with alternations of flaggy beds, showing transverse cleavage. No fossils have been found in this district, but further north fossils have been found which establish its identity with the Caradoc sandstone of Wales.

Localities: Ingleton Beck, Horton, etc.

2. *Coniston Limestone and Shale.*

a. A dark-blue, close-grained, more or less calcareous slate and shale, passing into a hard blue crystalline limestone. It contains numerous fossils, which are distributed with tolerable equality wherever the limestone is found. The following are those ordinarily observed:—

Halysites catenularia.
Heliolites.
Petræia æquisulcata.
Favosites fibrosa.
F. (two other species).
Encrinites.
Cystideans.
Phyllopod crustacean.
Calymene Blumenbachii (var. brevi-capitata).
Cheirurus bimucronatus.
Cybele verucosa.
Illænus.
Lichas.
Phacops conophthalmus.
Remopleurides.
Atrypa marginalis.

Leptæna quinquecostata
L. sericea.
L. transversalis.
L. (small sp.)
Lingula (two sp.?)
Orthis Actoniæ.
O. biforata.
O. calligramma.
O. elegantula.
O. flabellulum.
O. porcata.
O. vespertillis.
O. (species ?).
Strophomena depressa.
Murchisonia.
Lituites (?).
Orthoceras.

b. Strongly cleaved slates. May be divided into two parts: in the upper the altered grits, like ash-beds, occur, the lower being flaggy slates with concretions.

The following fossils have been found:—

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II. UPPER SILURIANS.

1. *Coniston Flags.*

a. Consists principally of coarse irregular conglomerates made up of rolled and angular fragments, which appear to be derived from the Coniston limestone and from the grits and fine conglomerates of the green slates of the lower group. It is never found in conjunction with the lower series, except in immediate connection with a fault. Its thickness is not more than 10 feet. The only fossils found are Favosites alveolaris (?) and F. fibrosa.

Localities: Crummack Valley, and Austwick Beck Head.

b. A soft mudstone, splitting by cleavage and joints into small rhomboidal slates passing upwards into a roughly cleaved sandy slate. No fossils found.

Localities: under Moughton Scar, and Wharf near Austwick.

c. Tough grits, with subordinate beds of flags, always found resting on the previous beds with a uniform character, about 1000 feet thick. They have as yet yielded no fossils.

d. Flags with thin beds of grit. These, known as the Horton or Coniston flags, are very generally and extensively quarried. The beds are about 2000 feet thick. Fossils are uncommon, with the exception of orthoceratites and graptolites. The following occur :—

Favosites fibrosa.
Actinocrinus pulcher.
Graptolites Ludensis.
G. sp.
Pterinea tenuistriata (?).
Cardiola interrupta.
Lituites giganteus.
Orthoceras primævum.
O. subundulatum.
O. sp. (ventricosum ?).
Worm tracks, etc.

2. *Coniston Grits.*

a. Tough grit with a few flaggy or slaty beds. These are the highest beds seen in the Horton district. They are largely developed on Howgill and Casterton Fells, at the latter place being 1200 feet thick. In Horton or Casterton districts no fossils have been found, but at Helmside, near Dent, there are some flaggy beds, probably near the top of this series, which have supplied the following list :—

Cliona.	Pterinea tenuistriata.
Spirorbis Lewisii.	Cardiola interrupta.
Ceratiocaris Murchisoni.	Orthoceras Ludense.
C. robustus.	O. bullatum.
Graptolites Ludensis.	O. angulatum.
G. sp.	O. (three other species).

b. Sandy slates of Howgill and Casterton Fells, and of Middleton. They reach a thickness of more than 3000 feet. The following fossils are found in them :—

Petræia.	Graptolites.
Encrinites.	Pterinea tenuistriata.

[redacted]

the lower beds: in the upper beds have been found at Crossdale Beck Houses:—

Cliona prisca.	Orthis, sp.
Actinocrinus, sp.	Rhynchonella navicula, *Sow.*
Beyrichia Klædeni, *M'Coy.*	R. nucula, *Sow.*
Calymene Blumenbachii, var. *Brong.*	Pterinea tenuistriata, *M'Coy.*
	Orthonota undata, *Sow.*
Phacops Downingiæ, *Murch.*	Murchisonia, sp.
Ceratiocaris, sp.	Turbo Corallii, *Sow.*
Discina, sp.	Bellerophon expansus, *Sow.*
Lingula cornea (?), *Sow.*	

From the above lists of fossils it will be seen that all the upper series are characterized by such fossils as Cardiola interrupta and Graptolites Ludensis; that they rest unconformably on the lower series characterized by Orthis Actoniæ and Trinucleus. This arrangement confirms the determination of Professor Sedgwick, that, on both the mineral structure and the character of the fossils, the Coniston flags must be regarded as the base of the Upper Silurians, and the Coniston limestone as the upper bed of the Lower series.

The Silurian rocks occur in greatest profusion in the north-western part of the Riding—Howgill Fells, north of Sedbergh, and the mountains west of Dent, being composed of Coniston grits. They are thrown abruptly on their eastern side against the Mountain Limestone by the great Pennine series of faults. The lowest beds seen are those of Coniston Limestone and Shales, the equivalents of the upper part of the Bala Limestone of Wales. They occur on the east side of Helm Gill, which is the line of a great fault separating the limestone from the shales and grits on the opposite side of the watercourse, and beneath the moorland above Helm Gill, near Dent. The limestone is exposed where the course of the stream has been lowered for the purpose of draining the land adjoining. The beds consist of dark-blue limestone and shale, and dip rapidly to the S.W., so that on descending the Gill they are hid by the overlying shales and grits. They are highly fossiliferous, near twenty species in the list on p. 26 being from this locality.

In the Lake district, the Stockdale Shales form the base of the Upper Silurians. They occur as a thin band lying above the Coniston Limestone, and consist, in the lower part, of dark shales, with pale or purple-coloured shales above. The Pale Slates occur in Hebblethwaite Gill, near Sedbergh, being brought up by a fault against the Coniston Grits. Next in the series are Coniston Flags and Grits, which fill up a large area. They are the equivalents of the Denbighshire Flags and Grits of the Wenlock series. The Flags are seen at Helm Knot, near Dent, in a small quarry on the north side of the hill, with fossil Orthoceratites and Graptolites. They dip rapidly to the S.W., and are again seen in the bed of the River Lee, in several places between Dent and Sedbergh. They [redacted] interstratified slates and flags in the lower parts. Resting on these are thick beds of a coarse grit, in which are traces of fossil, Chonetes and Spirifer. The flaggy beds again occur, containing in the upper part Orthoceras and Graptolites. This series in Casterton Fell is 1200 feet thick. It is succeeded by about 3000 feet of dark-grey shivery sandstone, with subordinate beds of tough grit or greywacke. These rocks pass in gentle undulations across Dent Valley; and on the opposite side the lowest beds of the series are exhibited in good sections in the water-course behind Helmside; they consist of compact blue grit, with beds of shale containing veins of quartz. The beds in the upper part of the Gill above the waterfalls are somewhat different in character, and when weathered present a concretionary appearance, and turn a brown colour on the surface.

The Riggs, south of Sedbergh, are formed by an anticlinal of these grits, and are exposed in many sections. From the River Rawthey to the boundary of the West Riding, the high mountains composing Howgill Fells are entirely Coniston Grits, which present the usual character of tough greywacke, or gritstone, with roughly cleaved shaly sandstone and slate. The lower part, with subordinate flaggy beds, graduates insensibly down into the Coniston Flags, and in the upper part the shaly sandstones pass up still more gradually into the striped sandstone and flags of the Bannisdale Slate Series. Fossils are generally not uncommon, especially in the lower beds of Howgill Fells. At Cautley Crag, where a magnificent natural section is exposed, Cardiola interrupta is abundant; Pterinea tenuistriata and Orthoceras subundulatum are also plentiful. About 1200 feet above the base of the Coniston Grits, on the hill-sides immediately behind Sedbergh is a band of coarse sandstone, 20 feet thick, which is very fossiliferous ; it may be traced from Winder to Hobdale Beck ; it is also found on the Riggs at Crags Hill Wood. The following fossils have been found in this sandstone :—

Phacops, sp.
Chonetes lata, *V. Buch.*
Orthoceras, sp.
Belerophon, sp.
Orthis elegantula.
Rhynchonella nucula, *Sow.*
R. navicula, *Sow.*
Spirifera crispa, *Hising.*
S. elevata, *Dalm.*
Cardiola interrupta, *Sow.*
Holopella gregaria, *Sow.*
Beyrichia Klœdeni, *M'Coy.*
Tentaculites tenuis, *Sow.*
Cornulites serpularius, *Sebloth.*
Halysites catenularius, *Linn.*
Favosites aspera, *D'Orb.*
Cyathocrinus, sp.
Petræia, sp.
Monticulipora, sp.
A small Bryozoon, sp.

A comparison of this list of fossils with those usually found in the Coniston Grits on p. 28 shows that there is here a fauna quite distinct from the beds above and below. The Chonetes lata and the Rhynchonellæ are characteristic of the Ludlow rocks ; this is the more remarkable as several thousand feet of strata intervene between this bed and the [redacted] of concretionary nodules ; in some cases, where exposed, they have weathered out, leaving cavities. The rocks may also be seen in several natural sections on the banks of the Lune, and in the bed of the stream passing through the village of Howgill. In a quarry east of Castley Knots, and in the bed of the stream near Crossdale Beck Houses, several species of fossils have been obtained, as already enumerated.

Lower down the Lune the upper beds are exposed, consisting of thin-bedded sandstone and laminated shale, which form the passage beds into the massive sandstones of Kirkby Moor and Benson Knot.

In the dales drained by the Wenning, the slate rocks occupy a large area, and are exposed in all the deep valleys occupied by the Ingleton Beck, Thornton Beck, the stream running through Clapham, at Wharf above Anstwick, and in several other situations. The series consists in these neighbourhoods of alternations of calcareous, greenish or grey slates, hard, gritty flagstones and sandstones, and a kind of dolomitic limestone. The limestone is in all probability the equivalent of the Coniston limestone ; and the slates and sandstones occupy a relative position similar to the Chloritic slates of Cumberland and Westmoreland, underlying the Coniston limestone.

The sections of these rocks presented on each side the gorge cut by the Thornton Beck are interesting, and may be studied with advantage. Proceeding towards Thornton Force from Ingleton, the bed of the stream is cut through a considerable thickness of Scar Limestone, which is quarried and burnt on the east side of the stream. It has a dip of 15° to the S.W., which higher up is increased to 30° in the same direction, and immediately afterwards presents a dislocated and contorted appearance, becomes tilted up at an acute angle, and its place is occupied by a brownish earthy limestone with numerous cavities filled with crystals of carbonate of lime. It is intersected by two dykes composed chiefly of red felspar and black mica, and by numerous veins of quartz ; the upper part assumes a dolomitic appearance, and is interpolated with two or three beds of flagstone and shale. The limestone contains a few fossils of the Silurian type,—one or two species of Orthis and Stenopora.

Underlying the calcareous beds are a number of coarse flagstones and slates, with an irregular intermixture of calcareous concretions. These gradually merge into a fine greenish-blue slate which is sufficiently fissile to have been extensively worked. The quarry is not now worked, the slate being spoiled by joints and fractures, but a similar slate in the Ingleton Beck is worked extensively. The slates alternate with flaggy beds and a hard gritty rock locally termed calliard, all showing transverse cleavage planes. The presence of these alternating beds leaves no room for doubt as to the planes of stratification of the slates, sometimes a difficult matter to decide. In this instance they are nearly vertical, showing a slight dip to the S.S.W., [redacted] to the Mountain Limestone series. The slates present the appearance of having been worn down to a smooth horizontal surface before the Scar Limestone was deposited above them.

At Dowgill Beck, a short distance from Horton, in Ribblesdale, underlying the Scar Limestone which forms the base of Penyghent, are a series of slate rocks forming the bed of the stream. They present the usual highly inclined appearance, having a dip varying from 50° to 70° to S.E., and showing evidence of a small anticlinal axis. The beds nearest the source of the stream are composed of a greenish-blue slate; above these stratagraphically, but further down the stream, are some grey calcareous slates containing numerous nodular concretions. The latter are not wanting in fossils, though they are only in a poor state of preservation; they identify the beds with the Coniston limestone of Westmoreland and the Bala limestone in Wales. A short distance further down the stream, the slates dip under the glacial deposits which fill the whole of the valley of the Ribble in this district. About a mile on the road to Settle, at Studfold, a quarry is worked for flagstones, of a bluish-grey colour; they are a little coarse, but can be got of very large size; they exhibit lines of cleavage, but, in working, these are not noticed, the planes of stratification, formed during their deposition, being followed in quarrying; some of the slabs are covered with broken Graptolites; small shells are also common, principally of the genera Orthis and Orthoceratites. The best sections for the study of the Horton flagstones, however, are on the opposite side of the valley, on Moughton Fell. The upper part of the Fell is composed of a bluff escarpment of Scar Limestone in nearly horizontal beds; under the limestone are seen the great undulating masses of Horton flagstones: these are got very extensively in a quarry immediately under the limestone, and a beautiful section is exhibited showing the latter lying unconformably on the upturned edges of the flagstones. It is obvious that the Silurian rocks, after their deposition, were contorted and elevated to their present inclination, and afterwards ground smooth by attrition and denudation at the bottom of the sea, until they formed a plain on which were gradually accumulated the great reefs and shell-beds of the Mountain Limestone. There is no intervening bed of boulders, as frequently happens at the junction of the two rocks: in this instance a period of quiet appears to have attended the growth of the coral beds and the deposition of the remains of the marine fauna.

In the northern flag quarry, which is at present worked, the rocks dip 38° to the S.E.; the plane of cleavage is well marked, having a strike to the S.E. and S.W., and dipping at an angle of about 80° to the S.W. A little to the north of the quarry a series of coarse slates and hard grey grits may be seen—the latter called by the quarrymen 'calliard' or 'galliard.' The flagstones are similar to those [redacted] been quarried at several places in the S.E. corner of the Fell. At one of these quarries the following section is exposed, viz.:—

1.	Thin bedded flagstone	20 ft.
2.	Black shale	4 "
3.	Flagstone, bluish calcareous grey, with nodular concretions	15 "
4.	Arenaceous shale	5 "
5.	Flagstone similar to No. 3	12 "
6.	Arenaceous shale	6 "

The nodular concretions in Nos. 3 and 5 are spherical, and many of them of considerable size, presenting a ferruginous appearance. In the same beds are many crystals of iron pyrites. The nodular or concretionary character of these calcareous flagstones may be well seen in a section exposed by a cutting for the new line of railway from Settle to Carlisle. The section is about 100 yards nearer Settle than the Dryrigg quarry, and exposes a thickness of about 60 feet of strata, which are full of the concretions; they average from 3 to 5 inches in diameter. Some have a blue calcareous appearance, the exterior part being brownish; others are ferruginous and earthy; whilst many cavities are left filled with a light porous rottenstone, exhibiting the fossil remains of corals, encrinites, etc. The matrix is a gritty, calcareous, grey flagstone, which presents a peculiar wavy and pebbly surface. In many places it has quite the appearance of a breccia; when broken, the enclosed pebbles also break straight with the remaining part of the stone, not separating from it.

Walking along the line of railway, several beds of grit, shale, and slate are passed through, which are all covered in the sections by beds of glaciated Boulder Clay. At a distance of about half a mile the beds change from the general southerly dip by a synclinal axis to the N.E. (Pl. I., Fig. 4.)

The flagstones continue to dip rapidly to the N.E. for a distance of fifty yards, when they are again hidden by a thick bed of Boulder Clay, which continues to the village of Stainforth.

The Silurian rocks extend eastwards at the base of the Mountain Limestone; they probably exist to the west of Malham Tarn, but are covered up by glacial drift. They may be seen, however, at the foot of Gordale Scar. The rock consists of a tough grey sandstone, with a dip to the S.S.W. They are not of great importance, except as indicating the extent of the Silurian rocks in this direction. There is no certain evidence of their extension further east, but it has been inferred that, beneath the crag of Mountain Limestone at Kilnsey, there may be, at a very slight depth below the surface, a bed of Silurian rocks. This inference receives support from the occurrence of Silurian boulders in the drift of Wharfedale, immediately [redacted]

CHAPTER III.

RED CONGLOMERATES.

THE Mountain Limestone from the valley of the Ribble to Ingleton is deposited unconformably on the Silurian rocks. Beneath Moughton Fell, nearly opposite Horton, the limestone is found separated from the slates beneath by a thickness of about fifteen or sixteen feet of a Conglomerate, which is composed of angular fragments of slate, grit, quartz, and shale. It appears to have filled a hollow in the slate rocks before the limestone was deposited horizontally above it. There are no fossils in the conglomerate, except such as are enclosed in the Silurian stones it contains. A similar bed of Red Conglomerate also exists in Dove Cote. A much larger section may be seen in the valley of the Rother, two miles N.E. of Sedbergh, where beds of coarse Red Conglomerate rest on the edges of the Conistone Grit, and do not pass into the Carboniferous Limestone. At Hebblethwaite Gill, near Sedbergh, this coarse Red Conglomerate is succeeded by shales, grits, and earthy limestones; and in these shales a second bed of red conglomerate occurs in every respect similar to the one below. The beds also occur at Kirby Lonsdale, Barbon, and other places in the valley of the Lune: near Kendal there are patches. Westward and northward the series attains a much greater thickness: near Ulleswater a number of hills, including Little and Greater Mell Fell, the latter 1760 feet high, are composed of thick bedded conglomerates without the intervention of limestones, but towards Penrith the limestone is found resting on them several hundred feet in thickness, followed by alternations of limestones, red sandstones, and shales, and above these is the main mass of the Scar Limestone. To the northward, in the direction of Brough and Kirby Stephen, the beds are greatly developed. At Ash Fell, near the latter place, they consist, in ascending order, of a considerable thickness of red conglomerates, shales, and sandstones, which form the base of the series; these gradually merge into impure limestones, green conglomerates, and chocolate and grey shales, above which is about 500 feet of limestone, without any intermixture of sandstone or shale; this is succeeded by an obliquely laminated soft red sandstone, with alternations of fossiliferous beds of shale and limestone: in the lower part there are layers of quartz pebbles, and above the sandstone is the Carboniferous Limestone, with thin beds of reddish shale and sandstone.

The whole series, exclusive of the latter bed of limestone, is about 1200 to 1300 feet thick.

[redacted]

From the description of the above sections we are led to consider the probable method of formation of the series of conglomerates and sandstones. They rest in each locality on the upturned edges of the Silurian rocks, consequently they were deposited unconformably, and a long period of time may be inferred to have elapsed between the deposition of the two. During this period the Silurian grits and slates were subjected to intense lateral pressure, causing them to assume the contorted forms and rapidly alternating inclinations which they present at the present time. The surfaces were next exposed to a great amount of abrasion and denudation by the action of the sea. It appears probable that the only lands above the sea at that time were the higher hills of Westmoreland and Cumberland, and that the waves beat against their slopes, around which the water-worn and rounded pebbles of these red beds were gradually accumulated, representing, to some extent, the waste of this old Silurian period. In some instances the *débris* filled up the hollows in the grits forming the bed of the sea, as at Moughton Scar. In others the boulders and sand would be formed into great banks, as in the neighbourhood of Ulleswater; whilst again, in the Sedbergh district, the coarser materials being deposited, the land appears to have been still further submerged, and the conglomerate was covered by successive deposits of sand and mud. Whilst these shore deposits were being accumulated near the land, the deeper and quieter waters to the eastward and northward were adapted to the growth of immense numbers of corals and other marine organisms, which were slowly but surely evolving the great masses of the Carboniferous Limestone. The land appears to have been still subsiding, for we find the limestone encroaching nearer the shore, and in many instances covering up the red conglomerates, the pebbles from the latter being incorporated in the lower bed of the limestone, and forming what are usually termed the basement beds of the series. At Ash Fell there are indications of several submergences and elevations, the conglomerates and limestone alternating with each other repeatedly. Speaking generally, the nearer the Cumbrian Hills are approached, the thicker are the beds of the Red Conglomerate, whilst away from the mountains the limestone is found overlapping or dovetailing into them, and assuming larger and more extensive proportions ; but there can be little doubt, in this district at any rate, that the two formations are coeval, and were forming at the same time.

CHAPTER IV.

CARBONIFEROUS PERIOD.

THE Carboniferous System in Yorkshire consists of an immense thickness of strata which have been deposited in their present relative positions when this country was at a much lower level than at present. At that time the only land above the water consisted of the groups of mountains of Westmoreland and Wales, which constituted islands; and around these, during successive and repeated alternations of submergence and elevation, the limestones shales, and sandstones were gradually accumulated. The system may be naturally divided into three or four principal groups, each characterized by the preponderance of certain lithological constituents, and by its mode of deposition. The lowest group rests on the upturned edges of the Silurian rocks, and in the northern part of the Riding consists entirely of thick-bedded homogeneous light-coloured limestones; whilst further south, in the Craven district, the thick limestones are much contorted and laminated, assume a dark colour, and have intermingled with them dark laminated beds of shale. These thick beds of limestone, composed of the fossil remains of corals, encrinites, and molluscs, indicate a very long period of comparatively quiet and uninterrupted deep-sea conditions.

Whilst the lowest group is characterized by limestones, the next is principally composed of shales with numerous intercalations of thin beds of limestone and sandstone. Its fossil contents do not differ greatly from the lower limestones, and its varied beds appear to have been formed during a series of oscillations of the sea bottom, at times deep and at others shallow. When deep, the limestones and shales were probably deposited; and when shallow, the sandstones would be the result. This division was named, by the late Professor Phillips, the Yoredale Series, from its large development in the Yore- or Wensley-dale.

The third division is composed of thick massive beds of grit rock, with shales between each. Limestones are rarely met with, though not altogether absent. There is a great dearth of the remains of animal life, and only in the case of an occasional calcareous shale do we obtain evidence on this head, that the deposit is, to a small extent, a marine one. The shales are usually in thick beds, ferruginous, and devoid of fossil remains. The grit rocks contain only the silicified impressions of the remains of plants. These evidences all point to a shore or estuary [redacted]

These circumstances lead us to the inference that the upper division of the Carboniferous Series was in part formed on dry land, whilst the shales and sandstones were probably of fresh-water or estuarine origin.

The whole of the Carboniferous System may be thus divided into three large natural series, as follows :—

I. Marine deposits	1. Limestones	Mountain Limestone.
	2. Shales .	Yoredale Series.
II. Shore deposit, with marine intercalations		Millstone Grits.
III. Fresh-water or estuary deposit .		Coal Measures.

These divisions must not be taken in any arbitrary sense. It is extremely difficult, or quite impossible, in many instances, to draw a line that shall separate one group of strata from another ; and they can merely be accepted as the best classification applicable to elucidate a series of local phenomena. The correlation of the members of the same group, in different parts of the Riding, always difficult to determine, can rarely be accomplished with any great degree of certainty, and the variations in the character of any series of rocks, in the course of even a few miles, are sufficiently puzzling to convince any one that hard-and-fast lines are not to be thought of.

I. Marine Deposits.

1. *Limestone Group.*

The Mountain Limestone group, in Yorkshire, may be divided into two large areas,—a northern one, in which the great Scar Limestone is surmounted by a variable series of limestone, flagstone, shale, and coal, upwards of a thousand feet in thickness ; and a southern area, in which the series is much less complicated, the group above the Lower Limestone consisting of black laminated limestones and shales. This division separates roughly the Mountain Limestone series north and south of the Craven Fault, and east and west of Kettlewell and Wharfedale, but the constituents of the groups are far from uniform over great areas. Important variations occur in distances of one or two miles, and the southern series is found to pass gradually to the northern one, by the increased thickness and subdivision of the strata. If the northern boundary from Kettlewell Dale to Wensley Dale be followed, it will be seen that the thin ends of several wedges of sedimentary strata are interpolated in the upper part of the limestone, producing a most complicated intermixture of gritstone, shale, coal, and thin limestones. From Malham to Bell Busk and Eshton there is a thick mass of impure laminated limestone, and at Skipton, a mass of thin bedded limestone is overlaid by three or four thicker beds of limestone, which are separated by equally thick beds of calcareous shale, [redacted] plateau, on which the horizontal beds of Ingleborough, Penyghent, Wharnside, and many other high hills, are superimposed. Its western and southern boundaries keep generally to the line of the great Pennine and Craven Faults. The limestone forms the western base of Swarthfell and Bowfell, and passes southward, in a highly inclined position, abutting against the slate rocks of Howgill Fells. It crosses Garsdale, and passing under Rysel, reaches Dent Dale, and may be followed for a considerable distance towards the source of the river. Still pursuing a narrow course southwards, the limestone forms great escarpments between the Silurian rocks on the west, thrown up by the Pennine Fault, and on the east the alternate shales, gritstones, and thin limestones forming Culm Crag and the County Stone. Passing round Graygarth Fell, the escarpment turns to the east, and forms the grand and precipitous series of scars in Ingleton Fells and Kingsdale, fills the valley of Ingleton Dale, and sweeping round the base of Ingleborough, stretches out so as to present the appearance of great fissured pavements of limestone rock, bordering the valleys in which are the villages of Clapham and Wharf. In the latter the limestone makes a large curve to the north, the Silurian rocks occupying the lower part of the valley, and forming the base of Moughton Fell: above the upturned edges of these, the limestone forms continuous level scars to Ribblesdale, where the slates have again made a deep indentation. Two or three miles above Horton, the limestone fills the whole valley, and continuing down its eastern boundary forms the great surface from which rise Penyghent, Coska, and Fountains Fell. From Stainforth, where the limestone is extensively quarried, it stretches in lofty escarpments, parallel to the Ribble, to Settle. A number of smaller patches may be seen separated from the main mass at Austwick, Feizer Hills, and the fine scar of Giggleswick.

From Settle, the limestone turns to the north round Ryeloaf, to Malham, where its escarpment forms the picturesque Cove and the terrific scars of Gordale. Thence it covers the wide plateau of Hard Flask, reaches up Littondale almost to its source, and fills the valley of the Wharfe up to Kettlewell, Buckden, and Greater and Lesser Whernside.

Throughout this large area the limestone consists of one vast series of calcareous beds, almost without division by shales or sandstones. It is 500 to 1000 feet thick, and is mostly of a light grey or blue colour. Much of it is crinoidal; some compact. An appearance of prismatic structure is often caused by the numerous vertical fissures, more especially in the thicker masses. The lower bed of the limestone, where it forms a junction with the Silurian rocks or the conglomerate beds of red sandstone, is often found to contain a great number of rounded fragments broken from the rocks beneath. These were washed and

[redacted]

below it. Many other instances might be given. Generally, large boulders lie near the base of the limestone, whilst the beds higher up contain smaller and fewer pebbles, until the conglomeratic character finally disappears in the common structure. These beds may generally be distinguished by the absence of the vertical fissures of the upper masses, and the presence of horizontal laminæ and cracks.

Amongst the characteristic features of the scar limestone, as already observed, are the great fissures and cracks, which were probably formed during the consolidation of the rocks, and which often indicate natural joints of very considerable extent. Many of these subterranean passages are occupied by torrents of water, which, being collected on the hill-sides, disappear in openings in the limestone plateau, often called "pot-holes," and after pursuing a devious course, in some instances two or three miles in length, reappear at a lower level, or at the base of the cliff, in copious streams. Numerous instances of such phenomena might be cited as occurring on the slopes of Ingleborough, Penyghent, and in other localities. The stream which emerges in Clapdale is swallowed four hundred feet higher up by Gaping Ghyll, a terrific chasm on the limestone plateau of Ingleborough. The River Aire, in its passage from Malham Tarn, sinks into a cleft in the limestone, and emerges at the foot of the precipitous Cove; and the River Nidd follows a subterraneous course above Pateley Bridge. The ebbing and flowing well under Giggleswick Scar is an instance of a different character.

Numbers of the pot-holes do not form channels for water, but have probably fallen in over chasms existing below the surface. They are often in lines, of great regularity, in the form of inverted cones, their sides grown over with grass, sometimes with an open chasm of immense depth at their apex (as at Alumpot, above the village of Selside), but in the majority of cases the shelving sides converge to a point without exhibiting an orifice.

Many caves and caverns also exist in the limestone. Some are partly open to the surface, as Weathercote Cave, in which is a magnificent fall of water, 75 feet high, and the Victoria Cave, near Settle, of which more will be said further on. Others are only to be seen by passing a narrow horizontal or vertical entrance. Ingleborough Cave, a short distance above the village of Clapham, is one of the finest and most remarkable in the district. It was formerly the watercourse of the stream from Gaping Ghyll Hole, its narrow passages and large chambers being often nearly filled up with pebbly and sandy sediment. It has been explored to the distance of nearly half a mile from the entrance. At the further extremity the rush of waters can be heard, which, having been diverted into another channel, make their exit at a lower level, a few yards to the right of the opening of the cave. The

[redacted]

been modified in form by the action of running water, and the slow infiltration of water holding in solution minute quantities of carbonate of lime, which may either have been borne away or redeposited elsewhere. Along lines of fault or dislocation of strata, the limestone is often changed in character, becoming a brown or yellowish drab dolomitic rock: it assumes a semi-crystalline appearance, and is generally filled with nodules and veins of quartz or calcareous spar. Its peculiar character does not appear to be dependent on igneous action, not being found in proximity to the Whin-sill in Teesdale; but it appears to be definitely connected with the lines of fault. Good examples of its occurrence may be seen at the junction of the slate rocks with the mountain limestone in Kingsdale below the quarries; in the rearing beds of Pendle; and in the neighbourhood of Kettlewell it is a source of annoyance to the miners, by diverting the course of the veins of lead. It is very heavy, and varies very much in thickness—from a few feet to a hundred.

At Stainforth, the Settle and Carlisle Railway cuts through a series of branches of the Great Craven Fault, the effect of the fault being to lower the Scar Limestone on the south side to a level with the Silurian rocks which crop out on the north. The principal fault, and the one first seen in the cutting, is about 50 feet in width, and is filled in by loose fragments of limestone and other contiguous rocks, along with clay, and a great amount of quartz. The quartz is also forced into the beds forming the sides of the fault. On the north side the strata dip about 10° to the south, and are composed of the following series:—

	ft.	in.
Blue limestone	10	0
Shale		5
Dark-blue or black limestone . .	1	0

	ft.	in.
Shale		4
Limestone	1	0
Shale		4
Limestone		10
Shale		3
Limestone	4	0
Shale		8
Limestone	1	0
Blue limestone	12	0
Brown cherty or dun limestone . .	12	0
Blue limestone	10	0

On the south side of the fault is a thickness of 12 feet of blue limestone, and above that a similar thickness of a fine brown-drab cherty-looking limestone, massive, and of very close texture, containing veins and nodules of quartz. About half a mile to the south are two smaller faults in the Carboniferous Limestone. The strata between the two cannot be connected, being covered by accumulations of glacial deposits.

The mountain limestone in the district south of the great Craven Fault occupies a large area, extending to the Millstone Grit escarpment, which forms the boundary [redacted]

The limestone is forced up into long ridges by a series of anticlinals, whose chief direction is W.S.W. to E.N.E., diminishing in importance northwards. The principal anticlinals are those which extend from Clitheroe to Skipton, and from Chipping to Slaidburn. Besides these there are several of less extent. The Clitheroe anticlinal may be traced through Mitton, under the Triassic rocks south-west of Clitheroe. At the latter place limestone is very extensively quarried, and the course of the ridge is clear past Chatburn to Downham; it then becomes obscured by faults, but its course probably lies near Gisburn, and thence by Marton to Skipton. At Marton Scar the limestone is exposed for about three-quarters of a mile, forming parallel ridges of bare rock, having the scarped sides to the west. They appear to form the summit of the anticlinal, dipping in opposite directions at the north and south end of the ridge. At Skipton Rock the limestone is quarried on each side the tilted mass, exposing rocks dipping north and south at very rapid angles. Thence the anticlinal passes through Bolton to Blubberhouses, where limestone is wrought by adits. It may in all probability be continued to a much greater distance eastwards.

The second great anticlinal runs in a north-easterly direction from Chipping and Whitewell, in the valley of the Hodder, across to Slaidburn, and may be continuous with the anticlinal which is formed under Malham. Besides these more important systems, there are several minor ones, extending in nearly parallel lines. The Sykes Anticlinal does not form a distinct trough, as do the others; but where the higher ground has been washed away by the streams which cross its axis, the limestone rocks are exposed. This may be seen at Sykes, Brennands, and in Croasdale Beck, above the House of

Croasdale. From the latter place it continues across the Hodder Valley to Fair Hill. It is then lost beneath the grits, but may possibly emerge somewhere in the neighbourhood of Settle.

Two smaller anticlinals occur south-west of that at Skipton, one reaching from Barnoldswick past Thornton, and the second occupying the Lothersdale Valley, the limestone being largely wrought at Raygill and Downshaw.

The anticlinals usually form valleys; the synclinals form high ground between them, and are usually composed of Yoredale shales, with grit rock on the top. Between the two great anticlinals of Clitheroe and Slaidburn are the Millstone Grit Fells of Longridge, Waddington, Bradford, and Champion. South of the Clitheroe anticlinal is the Pendle Range, and between the Thornton and Lothersdale anticlinals are the moors of Elslack. Having given a rough outline of the chief characteristics of this southern part of the mountain limestone series, each district will now be described at greater length separately.

The mountain limestone of the district south of the [redacted] shales. The water bearing the mud appears to have been prevalent southwards; whilst to the north, during a continued period, the limestone was quietly deposited in deeper waters. The horizon taken as the upper limits of the Carboniferous limestone is a purely arbitrary one, and merely separates the lower part, in which the limestone predominates over the shales, from the upper, in which the shales occupy a very much greater thickness than the limestones. It is very probable that the dividing lines in different localities may be at a much higher or lower level with respect to each other, there being so many bendings and variations in the strata, that their identity or correlation is in many instances only a matter of conjecture. A further cause of difficulty is found in the thick deposits of drift which envelope the greater part of the country. North of Sawley, the Glacial Drift completely covers the limestone; and it is only in the valley of the Ribble, which here runs in a deep ravine, and a few tributary streams, that the rocks are exposed. The drift rises into a series of rounded hillocks, and only rarely is the limestone exposed, either in the form of rounded hills, or as terraces following the outcrop of the various beds.

The great mass of the limestone on which Gisburn stands is well exhibited at Wybersey Hill in Bolton Park. Thence the upper boundary runs along the west side of the river in an east-north-easterly direction, for the most part covered by drift, but exhibiting sections in the several tributary brooks. It extends to Gisburn Park, and thence to Paythorne and Nappa, whence it curves round with a northerly dip to join the south side of the anticlinal.

The principal anticlinal runs from Gisburn southwards to Downham Bridge. Thence it extends through Chatburn to Clitheroe. A great fault, extending from Sawley eastwards to Barnoldswick, throws down the Yoredale shales against the limestone ; south of this, a second series of faults bring up the limestone again at Rimington, and at the old lead mines of Skeleron ; from this point the anticlinal extends in a south-westerly direction past Twiston Lane, Downham, Bold Venture Limeworks, and Ridding Hey, to Horrocksford Quarries. On the Yorkshire side of the Ribble the limestone extends from north of West Bradford, through Waddington, to Waddow Hall. Near the latter place a large fault throws down the limestone to the southward, and the Permian Sandstone is found abutting against the Carboniferous Limestone. In the Clitheroe district the limestone is very extensively quarried, and is considered of very excellent quality. It may be divided into two distinct parts. The lower consists of evenly bedded, black, bituminous limestone, which sometimes contains beds of black calcareous shale. It usually forms a straight and well-marked ridge. Above the black limestone is a band of shales, which may be seen in a quarry on the north side of Twiston Lane, between Downham and Twiston Mill. The shales contain [redacted] walks. This deposit (here about forty feet thick) appears to be only a local one; for though similar beds are found at Worsaw and Whitewell, they do not present the same characteristic phenomena.

At Withgill, near Bashall, a distance of two miles south-west of Clitheroe, a boss of limestone is protruded, from which the overlying shales dip in every direction. It is a greyish-white colour, and appears to be a detached mass of the upper bright-coloured limestone of Clitheroe. It abounds with fossils which may be easily extracted in good preservation. Cubical crystals of fluor spar occur in a mineral vein to be seen on the west side of the old quarry.

Between this and the Ingleton district are many minor foldings, but none are of sufficient importance to call for special notice.

In all the cases described it may be noted that the anticlinals form troughs or valleys, and are composed of the most ancient rocks, whilst the synclinals stand out as bold hills, frequently more than 1000 feet in height, consisting of the most recent formations, and usually capped by a hard bed of grit, the sides of the hills being composed of the different beds of the Craven shales, with occasionally slight escarpments of Yoredale limestone. (See Fig. 5, Pl. II.)

Nearly parallel with the Skipton and Gisburne anticlinal ridges of limestone is the Slaidburn anticlinal, which extends along a considerable extent of country in the valley of the Hodder. The two systems are separated by the high moorlands of Harrop and Bradford Fells, and Browsholme Moor, composed of the Yoredale shales with thin limestones, and capped by a thick grit, considered as the Upper Yoredale Grit by the Geological Survey, but which may with propriety be considered as the lowest bed of the Millstone Grit series. It was so named by Professor

Phillips, along with its equivalents forming the summits of the Moors south-west of Barnoldswick, and those of Elslack and Carlton, as well as the summit of Pendle Hill. To avoid confusion with the Memoirs published by the Geological Survey, these grits will be considered as Yoredale grits, but it will be well for the student to remember their synonymy with the Millstone Grit beds of the early geologists.

The limestone occupies the valley of the Hodder from near its source to the point where it turns eastward to flow into the Ribble, and forming for that distance the boundary of the county. It has been uplifted in a north-easterly and south-westerly direction, the rocks dipping rapidly to the north-west and south-east. The anticlinal is continued southwards, and forms a second district, in the centre of which is Chipping. The limestone of the Chipping district is brought to a sudden termination by faults at Whitewell, the grits of Birket and Hodder Bank Fells being brought down into juxta-position with it. At Knowlemere Manor the limestone again appears,

[redacted]

coloured, very massive, and very much resembling the great Scar Limestone further north; it is probably higher in the series, however, than the limestone of the Slaidburn anticlinal, and may be a member of the Yoredale series.

The Sykes anticlinal is formed by a third parallel folding of the strata westwards from Slaidburn. It does not make a continuous valley as in the case of the other two, but brings up the lower rocks of mountain limestone in the valleys that cross it, as at Sykes Brennard and Croasdale. Thence the course of the anticlinal probably continues through Fair Hill. Its course is somewhat indistinct afterwards under the Grit rocks, but it is probably the same as that which thrusts up the limestone on the south side of Stockdale, near Ryeloaf and Settle. The limestone at Sykes is cherty, and has beds of calcareous spar interposed; in the summit of the anticlinal ridge of the limestone is a sparry lead vein, ranging in a nearly N.N.E. direction.

In the valley of Lothersdale the limestone is again forced to the surface, and is remarkably well exhibited in the Raygill and Dowshaw Delves. The limestone is a light bluish-grey colour; it is very hard and fine grained, and is quarried to a large extent for the repair of roads, being conveyed to all parts of the Riding for that purpose. It forms an anticlinal ridge with a strike N.E. and S.W., the rocks dipping mainly E.S.E. from 25° to 50°, or N.W. at near the same angles; and, as usually happens when limestone is bent over at sharp angles, the beds are divided into thin laminations. Parallel to the lines of stratification are many bands of dark chert. Above the mountain limestone, on each side the valley, are the shales, with alternations of Argillaceous limestones, succeeded by the Yoredale limestones, quarried at Park Head Quarry, on the summit of the anticlinal, and at Cliff Edge and

Hawshaw Delf on each side. There can be little doubt that this isolated patch of limestone, which is several hundred feet thick, is the equivalent of that quarried at Thornton and Skipton, and very likely they are all continuous beneath the surface.

In the quarry at Raygill are several veins of sulphate of barytes and calc spar. They range across the anticlinal axis, and vary much in size and thickness, occasionally attaining a thickness of five or six feet. They have a dip towards the south, parallel to a throw which passes Raygill Clough, and near Dowshaw Delf. The limestone beds on both sides of the veins are disturbed and altered in character. The barytes has long been worked, and one of the veins has been followed below the surface to a great depth.

In the quarry at Raygill is an old cave (Pl. II., Fig. 6), now filled up with sand and clay, containing bones of mammoth and several other animals long since extinct in this country. The bones are in a matrix of sandy loam, cemented fast together; they are mostly in a broken and [redacted] exposures are rarely seen, the only sections being in quarries at South Field House and at Langber. At Fence End Quarries, an immense face of rock is exposed (Pl. III., Fig. 7). The limestone is dark coloured, in regular thin laminations, almost without the intervention of shale. The dip is very great, being from 50° to 70° S.E. Resting on the carboniferous limestone are shales with thin limestones, which are black, and above these are layers of sandy limestone, containing abundance of fossil corals, encrinites, and brachiapods. Several faults pass through the ridge, one of which is exposed in the quarry, running in a direction the opposite to the strike of the beds.

The anticlinal system is continuous across the valley of the Aire to Skipton Rock, where an immense mass of the limestone is exposed in artificial section. The ridge of which it forms a part may be seen occupying the valley, and extending five or six miles eastward to Bolton Bridge, between hills, surmounted by grit rock, on Embsay moors to the north, and to the south, the moors of Skipton. The intermediate valleys and the slopes of the hills are occupied by members of the Yoredale series, which dip away from the limestone ridge in the centre to the N.W. and S.E. respectively. The limestone is dark grey or black, usually compact, but sometimes semi-crystalline. It is thin-bedded, with intercalations of thin black shales, which are fine grained and laminated, containing numerous fossil encrinites, producta, bryozoa, and others in good preservation.

At the western end of the quarry, the dip ranges from 35° to 60° W.N.W. Eastward the centre of the anticlinal is approached, and the dip becomes 80° N.N.E. The beds being nearly vertical. The limestone abounds in sparry veins which run in a transverse direction to the lines of stratification. Several faults or slips are exposed, which have left glistening smooth surfaces of rock named by the quarrymen Slickensides. By the percolation of water bearing carbonate of lime held in suspension by excess of carbonic acid, between the two surfaces of the rock, a thin film has been in many cases deposited, which gives the face of the rock a peculiarly ice-like appearance, from which, no doubt, the name has been derived. The illustration (Pl. III., Fig. 8) is from a slickenside in these quarries.

In this instance the rocks all dip in the same direction, to the north-west, but it will be noticed that the limestone on the right of the line marking the slickenside have been somewhat distorted by the grinding action of the opposite face of rock.

There is also a large quarry on the southern slope of the ridge, in which beds of the same dark, compact, laminated limestone are exposed, dipping rapidly to the south-east, that is, in the contrary direction to those described above, proving that they form part of the opposite bend of the anticlinal axis. Interbedded with

[redacted]

dipping from it respectively 40° N.W., and 30° S.E., whilst just inside the quarry they are again tilted up, forming a trough (Pl. III., Fig. 9). All the beds of limestone are continuous and unbroken through the bendings. In another quarry a little nearer Draughton, on the south side of the road, the beds are dipping 70° N.W. But perhaps the finest exhibition of contorted limestone to be seen in the whole course of the anticlinal ridge is in a quarry behind the Matchless Inn at Draughton, a name which will apply very well to the rocks also. Here the beds, in a distance of twenty-five or thirty yards, are bent without breaking, so as to form two sharp anticlinals with corresponding troughs.

The limestone is similar in composition to the Skipton Rock—dark grey, thinly laminated, and in many instances semi-crystalline. Its contorted beds form a range of low hills, reaching to Bolton Bridge, which may be distinguished by their rounded form and green grassy surface. A mile west of Bolton Bridge there is a large quarry in Hambleton Rock (Pl. IV., Fig. 10), exposing vertical beds of black limestone, alternating with beds of shale of greater or less thickness, and full of ramifying quartz veins. The shales are grey and micaceous, and very distinctly laminated. They have a dip to the N.W. on the eastern side of the quarry, and form a synclinal trough. On the opposite side of the road the limestone forms a ridge which has been quarried. It has a dip of about 45° to the N.W. From this point the course of the anticlinal can be traced to the east; but the limestone does not again appear at the surface.

The following is a list of the fossils found in the Carboniferous Limestone of the West Riding:—

I. CEPHALOPODA.

Nautilus dorsalis, *Phil.*	Bolland.
bistrialis, *Phil.*	Bolland.
biangulatus, *Sby.*	Bolland.
globatus, *Sby.*	Bolland.
? goniolobus, *Phil.*	Bolland.
tetragonus, *Phil.*	Bolland.
subsulcatus, *Phil.*	Bolland.
ingens, *Mart.*	Coniston, near Gargrave.
sp?	Chatburn.
cyclostomus, *Phil.*	Bolland.
cariniferous, *Sow.*	Bolland.
Goniatites cyclolobus, *Phil.*	Bolland.
carina, *Phil.*	Bolland.
micronotus, *Phil.*	Bolland.
intercostalis, *Phil.*	Bolland.
nitidus, *Phil.*	Bank of Ribble.
mixolobus, *Phil.*	Bolland.
rotiformis, *Phil.*	Bolland.
truncatus, *Phil.*	Bolland.
vesica, *Phil.*	Bolland.
vittiger, *Phil.*	Bolland.
foraminosus, *Phil.*	Bolland.
bilinquis, *Salt.*	Clitheroe, Waddow Hall,

[redacted]

reticulatum, *Phil.*	Bolland.
sp?	Chatburn, Worston, Twiston.
dentaloideum, *Phil.*	Bolland.
Poterioceras fusiforme, *Sby.*	Bolland.

II. GASTEROPODA.

Natica ampliata, *Phil.*	Bolland.
lirata, *Phil.*	Bolland.
elliptica, *Phil.*	Bolland.
planispira, *Phil.*	Bolland.
variata, *Phil.*	Bolland.
plicistria, *Phil.*	Bolland, Withgill, Salt Hill, Clitheroe.
elongata, *Phil.*	Bolland.
tabulata, *Phil.*	Bolland, Clitheroe.
Loxonema sinuosa, *Phil.*	
constricta, *Sby.*	Bolland.
sulculosa, *Phil.*	Bolland.
scalaroidea, *Phil.*	Bolland.
tumida, *Phil.*	Bolland.
Macrocheilus parallelus, *Phil.*	Bolland.
acutus, *Phil.*	Bolland.
curvilineus, *Phil.*	Bolland.
rectilineus, *Phil.*	Bolland, Clitheroe.
imbricatus, *Sby.*	Bolland, Clitheroe, Twiston.
sigmalineus, *Phil.*	Bolland.
globularis, *Phil.*	Bolland.
Turritella suturalis, *Phil.*	Bolland.
Turbo tiara, *Phil.*	Bolland.
semisulcatus, *Phil.*	Bolland.
biserialis, *Phil.*	Bolland.
Trochus Yvanii, *Lev.*	Bolland.
Euomphalus Catillus, *Sby.*	Bolland, Withgill, Downham, Great Dunnow, Slaidburn.
calyx, *Phil.*	Bolland, Waddow Hall.
bifrons, *Phil.*	Bolland.
pugilis, *Phil.*	Bolland.

pentangulatus, *Sby.* . . .	Bolland.
pileopsideus, *Phil.* . . .	Bolland.
pentagonalis, *Phil* . . .	Bolland.
tabulatus, *Phil.* . . .	Clitheroe, Bolland.
sp?	Bolland.
cristatus, *Phil.*	Bolland.
Bellerophon costatus, *Sby.* . .	Bolland, Salt Hill, theroe.
tangentialis, *Phil.* . . .	Bolland, Coplow, \ ston, Clitheroe.
hiulcus, *Sby.*	Bolland, Chatburn, (low.
tenuifascia, *Sby.* . . .	Bolland, Salthill.
cornu-arietis, *Sby.* . . .	
Urii, *Flem.*	Bolland.
Woodwardii, *Sow.* . . .	Bolland.
Porcellia Woodwardii, *Sby.* . .	Waddow Hall, Bolla
Murchisonia angulata, *Phil.* . .	
fusiformis, *Phil.* . . .	Bolland.
vittata, *Phil*	Bolland.
Cirrus acutus, *Sby.*	Bolland.
Pleurotomaria atomaria, *Phil.* .	Bolland.
abdita, *Phil.*	Bolland.
acuta, *Phil.*	Bolland.
carniata, *Sby.*	Bolland.

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suturalis (Eulima), *Phil.* . .	
undulata, *Phil.*	Bolland.
tornatilis, *Phil.*	Bolland.
vittata, *Phil.*	Bolland.
rotundata, *Sby.*	Bolland.
tumida, *Phil.*	Bolland.
Patellas cutiformis *Phil.* . . .	Bolland.
sinuosa, *Phil.*	Bolland.
mucronata, *Phil.* . . .	Bolland.
curvata, *Phil.*	Bolland.
retrorsa, *Phil.*	Bolland.
lateralis, *Phil.*	Bolland.
Platyschisma glabrata, *Phil.* . .	Bolland.
helicoides, *Phil.* . . .	Bolland.
oroidea, *Phil.*	Bolland, Coplow, Clitheroe.
Phanerotinus cristatus, *Phil.* .	Bolland.
Dentalium ingens, *De Kon.* . .	Bolland.
Actinoceras giganteum, *Sby.* . .	Bolland, Twiston.
Discites cariniferus, *Sby.* . .	Worston, Clitheroe.
tetragonus, *Phil.* . . .	Bolland.
sp?	Chatburn, Twiston, Worston, Clitheroe.

III. BRACHIOPODA.

Terebratula hastata, *Sby.* . .	Clitheroe, Bolland, Coplow, Twiston, Slaidburn.
sacculus, *Mart.*	Bolland, Clitheroe, Greenhow Hill.
pentaëdra, *Phil.* . . .	Bolland.
sp?	Withgill.
Spirifera bisulcata, *Sby.* . .	Bolland, Slaidburn.
attenuata, *Sow.*	Bolland.
convoluta, *Phil.* . . .	Clitheroe, Bolland, Withgill, Slaidburn, Twiston.
cuspidata, *Mart.* . . .	Chatburn, Bolland, Clitheroe, Settle.

crassa, *De Kon.*	Slaidburn.
distans, *Sby.*	Bolland, Withgill, C theroe.
crenistria, *Phil.*	Bolland.
duplicicostata, *Phil.*	Clitheroe, Bolland.
humerosa, *Phil.*	Greenhow Hill.
glabra, *Mart.*	Chatburn, Coplow, B land, Twiston, Wit gill, Clitheroe.
fusiformis, *Phil.*	Bolland.
insulpta, *Phil.*	Bolland.
globularis, *Phil.*	
senilis, *Phil.*	Bolland.
integricosta, *Phil.*	Bolland.
septosa, *Phil.*	Head of Ribblesdale.
lineata, *Mart.*	Bolland, Chatburn, Worston, Twiston.
resupinata, *Mart.*	Bolland, Greenhow H
oralis, *Phil.*	Withgill, Bolland.
linguifera, *Phil.*	Bolland.
planata, *Phil.*	Bolland.
octoplicata, *Sow.*	Pateley Bridge.
pinguis, *Sow.*	Coplow, Twiston, B land, Clitheroe.
symmetrica, *Phil.*	Bolland.

[redacted]

Roysii, *Lev.*	Coplow, Withgill, Twiston, Slaidburn, Bolland, Clitheroe.
sp?	Chatburn, Worston, Clitheroe, Slaidburn.
globularis, *Phil.*	Bolland.
Retzia radialis, *Phil.*	
Speriferina cristata, *Eth.*	Clitheroe.
insculpta, *Phil.*	Chatburn, Bolland.
Streptorhynchus, crenistria, *Phil.*	Chatburn, Withgill, Clitheroe, Salt Hill, Slaidburn, Great Dunnow, Bolland.
Rhynchonella acuminata, *Mart.*	Twiston, Clitheroe, Bolland.
acuminata var. mesogonia, *Eth.*	Chatburn, Coplow, Withgill.
cordiformis, *Sby.*	Withgill, Downham.
flexistria, *Phil.*	Twiston, Clitheroe, Bolland.
pluerodon, *Phil.*	Waddow Hall, Chatburn, Coplow, Worston, Twiston, Slaidburn, Bolland, Clitheroe.
pugnus, *Mart.*	Chatburn, Withgill, Twiston, Bolland, Clitheroe.
proava, *Phil.*	Bolland.
reniformis, *Sby.*	Bolland, Chatburn, Salt Hill, Clitheroe.
Strophomena analoga, *Phil.*	Slaidburn, Waddow Hall, Twiston, Bolland, Withgill.
Productus mesolobus, *Phil.*	Coplow, Slaidburn, Clitheroe, Bolland.
margaritaceous ? *Phil.*	Bolland.
concinnus, *Sow.*	Bolland.
muricatus, *Phil.*	Twiston.
punctatus, *Mart.*	Twiston, Withgill, Bolland, Clitheroe, Settle.
pustulosus, *Phil.*	Chatburn, Withgill, Cop-

	low, Twiston, Clitheroe, Bolland.
semireticulatus, *Mart.* . .	Withgill, Chatburn, Salt Hill, Worston, Twiston, Slaidburn, Bolland, Clitheroe.
scabriculus, *Mart.* . . .	Chatburn, Bolland, Clitheroe, Withgill, Twiston, Slaidburn.
spinulosus, *Sby.*	Chatburn, Clitheroe, Bolland.
striatus, *Fisch.*	Twiston, Bolland.
antiquata, *Sby.* . . .	Bolland.
quincuncialis, *Phil.* . . .	Bolland.
sublævis, *De Kon.* . . .	Slaidburn, Bolland.
undatus, *Def.*	Twiston, Clitheroe.
aculeatus, *Mart.* . . .	Twiston, Clitheroe.
arenarius ?	Clitheroe.
Cora, *D'Orb.*	Withgill, Twiston, Bolland, Clitheroe.
costatus, *Sby.*	Bolland.
fimbriatus, *Sby.* . . .	Clitheroe, Bolland, Greenhow Hill.
analoga, *Phil.*	Bolland.
giganteus, *Mart.* . . .	Chatburn, Bolland,

[redacted]

Meristella tumida, *Dalm* . .	Bolland.
Crania *sp?*	Withgill.
Camarophoria crumena, *Mart.* .	Clitheroe.
globuina, *Phil.*	Bolland.
Lingula sqamiformis, *Phil.* . .	Bolland.

IV. CONCHIFERA.

Avicula cycloptera, *Phil.* . . .	Bolland.
lunulata, *Phil.*	Bolland.
squamosa, *Phil.*	Bolland.
laminosa, *Phil.*	Bolland.
lœvigata, *M'Coy.* . . .	Withgill.
Aviculopecten circularis, *De Kon.* .	Chatburn.
concentricus, *M'Coy.* . . .	Downham.
margaritoides, *M'Coy.* . .	Withgill.
hemisphericus, *Phil.* . . .	Twiston, Bolland.
tessellatus, *Phil.*	Bolland, Clitheroe.
ellipticus, *Phil.*	Bolland.
dissimilis, *Flem.*	Bolland.
arenosus, *Phil.*	Bolland.
interstitialis, *Phil.* . . .	Bolland.
papyraceus, *Sby.*	Bolland, near Harrogate.
granosus, *Sby.*	Bolland.
radiatus, *Phil.*	Bolland.
sp?	Slaidburn.
Posidonomya Becheri, *Gold.* . .	Clitheroe.
vetusta, *Sby.*	Bolland.
Pinna costata, *Phil.* . . .	Bolland, Slaidburn.
flabelliformis, *Mart.* . . .	Bolland.
flexicostata, *M'Coy.* . . .	Clitheroe.
sp?	Chatburn, Blue Butts, Slaidburn.
Gervillia lunulata? *Phil.* . .	Bolland.
squamosa, *Phil.*	Bolland.
laminosa, *Phil.*	Bolland.
Modiola elongata, *Phil.* . . .	Bolland.
squamifera, *Phil.* . . .	Bolland.
granulosa, *Phil.*	Bolland.
Myalina lamellosa, *De Kon.* . .	Withgill.
sp?	

Cucullæa obtusa, *Phil.*	
arguta, *Phil.*	
sp. allied to M'Coyanum, *Eth.*	Withgill, Dunnow : Slaidburn.
Arca *sp ?*	
Pullastra elliptica, *Phil.*	Twiston.
Conocardium minax, *Phil.*	Bolland, Twiston.
rostratum, *Mart.*	Bolland.
trigonalis, *Phil.*	Bolland, Withgill.
Koninckii, *Baily.*	Clitheroe.
sp ?	Bolland.
Ctenodonta cuneata, *Phil.*	Bolland.
attenuata,	Bolland.
gibbosa, *Flem.*	Bolland.
undulata, *Phil.*	Bolland.
claviformis, *Phil.*	Bolland.
luciniformis, *Phil.*	Bolland.
tumida, *Phil.*	
Cypricardia glabrata, *Phil.*	
parallela, *Phil.*	
rhombea, *Phil.*	Bolland, Withgill.
Lutraria prisca, *M'Coy.*	Withgill.
Sanguinolites augustatus, *Phil.*	Bolland.
Myacites tumidus, *Phil.*	Bolland.

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pileus, *Phil.*	Bolland.
oblonga, *Phil.*	Bolland.
imbricata, *Phil.*	Bolland.
sulcata, *Phil.*	Bolland.
sp?	Chatburn, Withgill, Clitheroe.

V. ECHINODERMATA.

Archæocidaris triserialis, *M'Coy.* .	Racecourse, Clitheroe.
Urei, *Flem.*	
sp. spines and plates. . . .	Waddow Hall, Coplow, Clitheroe.
Palæchinus gigas *M'Coy.* . .	Clitheroe.
sp. plate.	Waddow Hall, Coplow, Worston, Clitheroe.
Codonaster acutus, *M'Coy.* . .	

VI. CRINOIDEA.

Actinocrinus atlas, *M'Coy.* . .	Clitheroe, Coplow.
bursa, *Phil.*	Bolland, Clitheroe.
Gilbertsoni, *Mill.* . . .	Clitheroe, Bolland.
globosus, *Phil.*	Bolland.
dactylus, *Mill.*	Bolland, Broughton.
mammillaris, *Phil.* . . .	Bolland.
polydactylus, *Mill.* . . .	Clitheroe, Bolland.
tessilatus, *Phil.*	Clitheroe.
triacontadactylus, *Mill.* . .	Clitheroe, Bolland, Waddow Hall, Downham, Twiston.
sp?	Clitheroe, Bolton-on-Bowland.
Cladocrinus *sp.*	Coplow, Clitheroe.
Cyathocrinus calcaratus. *Phil.* .	Bolland.
conicus, *Phil.*	Bolland, Clitheroe.
distortus, *Phil.*	Bolland.
mammillaris, *Phil.* . . .	Bolland, Waddow Hall.
ornatus, *Phil.*	Clitheroe, Bolland.
Dichocrinus elongatus, *Phil.* . .	Bolland.
Euryocrinus concavus, *Phil.* . .	Bolland.
Forbesiocrinus nobilis, *De Kon.* .	Bolland.

Pentremites acutus, *Sby.*	Bolland.
angulatus, *Sby.*	Bolland, Worston, C theroe.
Derbiensis, „	Worston, Clitheroe.
ellipticus, „	Bolland.
inflatus, „	Bolland.
oblongus, „	Bolland.
pentagonalis, *Sby.*	Bolland.
orbicularis, „	Bolland, Clitheroe.
sp ?	Chatburn.
Platycrinus contractus, *Phil.*	Bolland.
ellipticus, *Phil.*	Bolland.
gigas, *Phil.*	Bolland.
granulatus, *Müll.*	Bolland.
elongatus, *Gilb.*	Bolland.
laciniatus, *Phil.*	Bolland.
lævis, *Mill.*	
megastylus, *Phil.*	Clitheroe.
plicatus, *Gold.*	
tuberculatus, *Mill.*	Bolland.
rugosus, *Mill.*	Clitheroe, Bolland, Downham, Whitw
microstylus, *Phil.*	Bolland.
Poteriocrinus conicus, *Phil.*	Bolland.
impressus, *Phil.*	Whitwell.

[redacted]

gemmuliferous, *Phil.*	Bolland, Aldstone Moor.
raniceps, *Phil.*	Bolland.
globiceps, *Phil.*	Bolland.
Brachymetopus ouralicus, *Bern.*	Clitheroe, Coplow.
sp ?	Chatburn.
Entomoconchus scouleri, *M'Coy.*	Clitheroe, Chatburn, Coplow, Withgill, Twiston.
Griffithides globiceps, *Port.*	Bolland.
Phillipsia Derbiensis, *Mart.*	Clitheroe, Bolland.
Broagniartii, *Fisch.*	Bolland.
gemmulifera, *Phil.*	Bolland.
geminifera, *Phil.*	Bolland.
truncata, *Phil.*	Coplow, Clitheroe.

VIII. POLYZOA.

Ceriopora rhombifera, *Phil.*	Bolland.
Fenestella crassa, *M'Coy*	Slaidburn.
ejuncida, *M'Coy.*	Chatburn.
flabellata, *Phil.*	Bolland.
membranacea, *Phil.*	Bolland.
Morrisii, *M'Coy.*	Clitheroe.
plebeia, *M'Coy.*	Withgill, Slaidburn, Great Dunnow.
multiporata, *M'Coy.*	Slaidburn.
quadridecimalis, *M'Coy.*	Clitheroe.
sp ?	Downham, Wybersey, Slaidburn, Great Dunnow.
Glauconome pluma, *Phil.*	Clitheroe, Bolland.
Gorgonia ?	Bolland.
Polypora verrucosa. *M'Coy.*	Clitheroe.
Ptilopora flustriformis, *Phil.*	Bolland.
nodulosa, *Phil.*	Bolland.
undulata, *Phil.*	Bolland.
Retepora undata, *M'Coy.*	Slaidburn.

IX. ACTINOZOA.

Amplexus coralloides, *Sby.*	Bolland, Waddow Hall, Chatburn, Clitheroe, Twiston, Coplow.

Syringopora	geniculata, *Phil.*	Clitheroe.
	ramulosa, *Gold.*	Bolland.
	reticulata, *Gold.*	Chatburn.
Michelinia	megastoma, *Phil.*	Bolland.
Lithostrotion	ensifer, *M. Edw.*	
Lonsdaleia	floriforme, *Mart.*	Bolland.
Favosites	dentifera, *Phil.*	Bolland.
	incrustans, *Phil.*	Bolland.
	parasitica, *Phil.*	Bolland.
	(Michelinia), tenuisepta, *Phil.*	Bolland.
Cyathopsis	fungites, *Flemg.*	Bolland.
Cyathophyllum	regium, *Phil.*	Twiston.
	crenulare, *Phil.*	Clitheroe.
	sp?	Waddow Hall, Worston, Clitheroe.

II. Marine Deposits.

2. *Shales or Yoredale Series.*

The simple thick masses of the mountain limestone become changed in the upper part, as we approach its northern limits, by the interpolation of beds of sandstone, shale, and thin limestones. These, from their rapidly [redacted] the nature of the change from the lower limestone to the Yoredale series may be traced in the beds of the streams. The intermediate beds have increased to a thickness of over 250 feet, and consist of fine beds of limestone, with thin partings of shale, whilst immediately below the Kinderscout grit a mass of shale, 80 feet thick, occurs. On the opposite side of the mountain, that is, the north-west, between the grit and the shale, a bed of limestone, named Parkhead limestone, occurs, having already attained a thickness of 30 feet, and can be traced along both sides of Wharfedale, above Starbottom and Buckden. At Starbottom the Yoredale series is as follows:—

	ft.
Kinderscout Grit and Coal	100
Parkhead Limestone	30
Thin Micaceous Sandstone, Shale	80
Limestone	20
Grits and Shales	130
Thick Limestone	50
Thin Flagstone, Thick Shale	50
Limestone (middle), Thin Gritstone and plate Limestone	80
Parting, Limestone, Parting, Black Limestone	70
	——
Lower Scar Limestone	500

From these sections we learn that the great limestone series, which at Greenhow Hill forms one thick mass, becomes divided in its upper members towards the north, north-west, and west, by beds of shale and new beds of limestone, which are thin in the valley of the Nidd, at Grassington, and Kettlewell-in-Wharfedale, but quickly augment in thickness to the north-west. In Wensleydale, a few miles north of the boundary of the West Riding, they assume their most complex form, and have a total thickness of about a thousand feet. These beds were divided by Professor Phillips into three principal groups: 1. The Cam, or Upper Scar Limestone; 2. Hawes Flagstone group; and 3. The Black Limestone group; each subdivided into—

		ft.
I. CAM OR UPPER SCAR LIMESTONE GROUP.	*a.* Main Limestone . .	70
	b. Grits, Coal, and Shale .	80
	c. Underset Limestone . .	30
II. HAWES FLAGSTONE GROUP.	*d.* Laminated Grits . . Flagstone . . Shales . . . Impure productal limestone . . .	350
III. BLACK LIMESTONE GROUP.	*e.* Middle limestone . .	30
	f. Gritstones and Flags . .	150
	g. Simonside Limestone .	20
	h. Flags, Shales, and Grits .	100
	i. Hardrow Limestone . .	40
	k. Grits, Shale, and Ironstone	100
Lower Scar Limestone (exposed) . . .		240

[redacted]

In making the ascent of Garsdale, the Hardrow or Dent Limestone, the Simonside and Middle Limestone, with the intermediate beds of gritstones and shales, are respectively passed over. Above the Middle Limestone occurs a bed of coal. To the westward, on Bar Fell, the Upper Limestone, which produces the crinoidal marble of Garsdale, occurs as a single bed, 30 feet thick, with the Ingleborough Grit and the coal series of Penyghent superimposed. On Swarth Fell, which forms the boundary of the Riding, there are two escarpments of Upper Limestone, which, along with the intermediate shales and flagstones, is the same series that is found in Wensleydale. On Rysel Fell, flagstones are quarried below the Middle Limestone, which are characterized by having on their surface worm tracks and carbonaceous markings. Two seams of coal have been worked on Gragreth, one between the Main and Underset Limestones, at Cragside and Binksgreat Combe. It is from 8 to 13 inches in thickness. The second seam occurs below the Middle Limestone, and is probably the lowest band of coal in the Yoredale series. It is of very variable thickness, the beds ranging from 5 to 20 inches, the thicker being usually of good quality.

The section on Whernside exposes the following sequence, which is very similar to the typical section of Yoredale :—

I. UPPER SCAR LIMESTONE.	Main Limestone. Alternations of shale and grit with a bed of coal. Underset Limestone.
II. FLAGSTONE GROUP.	Alternating shale and grit. Hard cherty limestone. Grit, shale, and Flagstone. Middle Limestone. Flaggy rock and shale, with occasional thin limestones. Shale.

III. Black Limestone Group.	Simonside Limestone. Grits and Limestone. Dent or Hardrow Limestone. Gritstone and flags. Shale.

Lower Scar or Mountain Limestone.

Passing onwards to Ingleborough, the Yoredale series becomes reduced from a thickness of about 1,000 feet on Whernside to 700 feet. The series consists (in ascending order) of shales and laminated limestones, shales and laminated gritstones, about 500 feet in thickness, followed by 30 feet of crinoidal limestone, and above this, shales and grits surmounted by 300 feet of rough pebbly grit which constitutes the lowest member of the Millstone Grit series. The Yoredale Rocks also exhibit a diminution in thickness, from Weather Fell to the eastern slope of Cam Fell. The Underset Limestone on the former is 50 feet thick, with 40 feet of shale between it and the Main Limestone, whilst on the east of Cam Fell the two limestones are found joined into one bed of crinoidal limestone, similar to that of Ingleborough, having a great

[redacted]

		ft.
I.	Little limestone	8
	Shale	10
	Cam limestone	60
II.	Gritstones, flagstones, and shale	225
	Limestone	20
	Shale, with beds of limestone and sandstone	92
III.	Simonside limestone	20
	Shales and gritstones	62
	Hardrow limestone / Shales with limestones	40
	Mountain limestone occupying the valley between Penyghent and Fountains Fell.	

Section through the Yoredale strata at Providence Mine, near Kettlewell :—

	ft.
Millstone Grit, or "Bearing Beds"	
Shale	38
Limestone	5
Shale with thin limestones	15
Limestone with beds of shale	43
Top six-fathom limestone	35
Ten-fathom limestone	60
Shale	17
Eight-fathom limestone	47
Sandstone, "Dirt pot grit"	8
Shale	5
Blue grit and shale	15
Carboniferous limestone	

A comparison of these sections proves that the Yoredale series gradually thins off eastwards, and that, between Kettlewell and Rycloaf Hill, they disappear altogether. Westwards, however, they increase in thickness and importance, forming all the highest hills in the West Riding. Their base consists of Mountain Limestone, and they are usually capped by some of the lower members of the millstone grit rocks. To the south, the Yoredales, along with the Mountain Limestone, are abruptly broken off by the great Craven Fault, but are again brought to the surface by a series of anticlinals, ranging east and west from Bolton Abbey to the trough of Bolland, occupying a tract of undulating ground forming the rich grazing district of Craven.

The Yoredale series in the Craven district may be divided into five principal sections, viz.:—

Lower Millstone Grit (Upper Yoredale Grit).
Bowland Shales.
Yoredale Grits.
Yoredale Limestone.
Shales, with thin beds of limestone.

The lower strata gradually pass into the thin-bedded Mountain Limestone, the division between the two being very obscure. Near the base, the shales consist principally of thick alternations of arenaceous and argillaceous layers of hardened mud, with many thin bands of limestone, containing numerous organic remains. Higher in the series the proportion of limestone increases. Occa-

[redacted]

distinguished in the ravines running into the valley from the south, those on the north being obscured by drift. The strata consist of thick black shales, with bands of dark-grey limestone. Above the shales, on each side the valley, is the Yoredale Limestone (worked in a quarry at Cliff Edge). It is thin-bedded, dark blue or grey, and interlaminated with thin beds of hard shale. The dip is 30° to the N.E. Another quarry occurs on the opposite side of the valley at Hawkshaw Slack, and to the N.E. at the summit of the anticlinal is Park Head Quarry, (Pl. IV., fig. 11). Here the beds have been much worked for lime, and appear to be of a better quality than those previously mentioned. They are thin, and similar in colour and composition to the quarry at Cliff Edge, and contain numerous layers of black hard chert. In the S.E. part of this working a fault, running N.W., has broken up and contorted the beds. The dip to the N.W. is 25°, and to the S.S.E. from 10° to 15°.

A short distance to the north are one or two small quarries in the Yoredale Grits, where the rocks have attained a dip of 60° N.W. One of these exposures shows the junction of the grit with the Bowland shales. To the N.W. the hills forming Carlton and Thornton Moors, having an altitude of 1,274 feet, are composed of Upper Yoredale Rocks, capped by Millstone Grit, with the Bowland shales cropping out on its flanks. The shales may be seen in the streams between Carlton, Elslack and Earby, having below them the Yoredale Limestone, as on the S.E. border of the synclinal. Near Elslack, on the side of the road, the limestone is quarried for road metal. The limestone has a close texture, it is grey, thin-bedded, much contorted, contains numerous veins of quartz, and breaks with a hard, splintery fracture. Although some trilobites and a few species of brachiopods have been found, fossils are uncommon. The shales and limestone may be seen resting on the Mountain Limestone at Fence End Quarry, near Thornton; at Rain Hall Quarry, near Barnoldswick; and several other localities. At Fence End Quarry, the upper beds of the Mountain Limestone are separated by thin beds of shale (fig. 7 *a*), above which earthy black shales with bands of sandstone occur (fig. 7 *b*), 24 feet thick, followed by sandy limestones (fig. 7 *c*), with carbonaceous matter, having a very strong smell of petroleum, and containing great numbers of fossil Corals, Crinoids, Bryozoa, and Mollusca; above these are ferruginous shales, with layers of stone (fig. 7 *d*).

The shales, with their limestones, are well exposed in some small tributaries of the River Ribble, about a mile north of Gisburne, and further west. They may be seen near the junction of the Hamerton with the Hodder, in the neighbourhood of Slaidburn. The shales, with thin limestones, also occupy the bed of the River Hodder north of Longridge Fell. Here they contain layers of ironstone, and give rise to springs containing sulphuretted [redacted] along the breast of Pendle Hill; it consists in the lower part of black limestone with chert of the same colour. Higher, it is a compact brown Crystalline Limestone, with irregular fracture, and not unlike Carboniferous Limestone in appearance. It contains bands of white chert. This again gives place to a black limestone, with bands of shale and black chert. The whole series, with the beds of shale, is about 350 feet thick. They are succeeded by the Lower Yoredale Grit; it is usually fine-grained, and hard in the lower beds. The upper beds are more pebbly, occasionally assuming the coarseness of a conglomerate. In the Pendle series, the Lower Grit is divided into two parts, with a thick bed of shale between. In the Craven district, this grit is very inconstant, often being altogether absent. Still ascending, about 600 or 700 feet of shales, with intercalated harder beds of limestone and sandstone, are passed over. They form the steep slopes of most of the higher hills in the district, and were named by Professor Phillips the Bowland Shales. They are usually dark-coloured where not rendered brown or yellow by the action of iron, and contain numerous crushed specimens of mollusca and fish remains. A good horizon for the fish is in the upper part, a short distance below the base of the Lower Millstone Grit (Upper Yoredale Grit). The calcareous shales of the Bowland series gradually give place to sandy shales, and these to thick beds of grit. The grit forms the summit of the mountain. It is very variable in texture, commonly a white or rusty colour, and frequently containing large concretions of a deep brown shade, somewhat harder than the surrounding stone. This was described by Professor Phillips as an outlier of the Millstone Grit rocks, but in the Memoirs of the Geological Survey it is considered as the Upper Yoredale Grit. This name was given by Mr. Farey to rocks in Derbyshire, which are on or near the same horizon as the grits of Craven, and retained from respect to his great experience and judgment. In the present work we adhere to the classification of Professor Phillips, and the grit rocks capping the hills of Craven are called Lower Millstone Grits. They must be taken, however, as synonymous with the Upper Yoredale Grits of the Survey Memoirs. It appears probable that in future memoirs the geological surveyors may return to the nomenclature of the early geologists, the grit series gaining in simplicity to the N.E., and tending to prove more clearly that they constitute the base of the Millstone Grits.

The sections exposed on the slopes of Pendle may be taken as typical of the Yoredale Rocks in Craven. They form a more perfect series than is exhibited in Yorkshire, and will materially assist in understanding the contorted and somewhat broken patches in the West Riding, and for this season have been noticed.

The Lower Yoredale Grit is absent E. and W. of the [redacted] tween them. The sandstones are generally fine-grained, and hard, presenting an appearance not unlike the Galliard of the Lower Coal Measures. It is white, or stained by the oxides of iron, a pink or brown colour. The lower bed is extensively quarried along the ridge near Crag and Coal Pit Lane. It is a fine white grit, occasionally merging into a conglomerate. The sandstones have a dip ranging from 25° to 40° to the S.E.

The whole series of the Bowland Shales, between the Lower Yoredale Grit of the ridge already mentioned and the summit of the "Weets" is well exposed in a watercourse on the N.E. The following is the section, in descending order:—

	ft.
Lower Millstone Grit (Upper Yoredale Grit)	
Shales, with sandstones in upper part . .	50
Black shales, with thin bands of black limestone, dip, 25° S.E.	145
Slaty mudstone with layers of shale . . .	30
Shivery black shale containing iron, with harder bands of calcareous shale	80
Ferruginous sandy shale, dipping 30° S.E. . .	20
Shale, with soft dark brown mudstone . .	40
Black shale, with iron stains	20
Black limestone, with encrinites . . .	10
Shale, with beds of dark crystalline limestone, dip 15° S.E.	30
Sandstone, with iron—at base of the bed are chalybete springs	60
Black shale	100
Shale, with harder beds of black limestone .	80
Lower Yoredale Grit	

The above are the measured thicknesses of the rocks; but the actual thickness, on account of the rapid and somewhat variable dip, may be nearly 1,000 feet.

Between Weets and Barnoldswick the dip of the strata increases, and about a mile from the latter place it is 50°

S.E. Small quarries on the ridge of Lower Grit, near Field Edge and Springs, as well as the stream which runs lower down, show the junction of the grit and shales. Compact dark limestones are found near the grit, and considerably higher up are thin bands of gritty sandstones, the shales being generally black or dark grey, and often impregnated with iron. Fossil encrinites, bryozoa, and small shells occur in the limestones and in the more calcareous shales.

The Lower Millstone Grit (Upper Yoredale Grit) continues to form the summit of the Pendle anticlinal, in its extension N.W. to Burn Moor, White Moor, and Weets, to a short distance south of Barnoldswick, where it is cut off by the great fault which throws up the Lower Shales and Limestones against this rock at New Field Edge. From Weets to near Barnoldswick, the lower part of the rock forms a good escarpment, and at the former place its junction with the shales below may be seen, the base being interstratified with a number of beds of shale. The grit may be seen in several quarries, usually near the roadsides, which have been opened to obtain material for mak- [redacted] pinkish in colour, with beds of shale. The top is not exposed. The average dip is 30° to the S.E., and altogether not less than 1,400 feet are seen.

In the small quarries occurring on Burn Moor and White Moor, the dip is only from 8° to 15° S.E. A quarry east of Moor House shows beds of fine micaceous sandstone, and coarse grits, with partings of shale. Behind Higher Park are quarries in the grit rock, dipping 25° S.E., which are brought against the Lower Shale with limestones seen in the railway cutting near Barnoldswick Park. The fault thus brings the limestones on the north against sandstones more than 2,000 feet higher in the series. There are also large quarries at Park Close in this grit.

Flanking the Mountain Limestone of Skipton Rock on each side is a series of shales, arenaceous flags, and thin limestones. These occupy the valleys, and extend up the hill-sides to the base of the Millstone Grit rock, which forms their summit. A good section through the series has been cut in forming the tram-road from the quarries towards Skipton. The rocks have a general dip to the south of 35° to 60°. The section exposes a great thickness of black shales; above these are laminated arenaceous shales, containing small flakes of mica, fine brownish mudstones, and close-grained calcareous shales and limestones. The latter are hard, and contain many fossils, in some instances being entirely composed of water-rolled and fragmentary remains of encrinites, bryozoa, brachiopods, and corals. Most of the beds contain numerous veins of quartz, and several have a distinct smell of some mineral oil when newly broken. Teeth of fish are occasionally found in the thin limestones; they are, however, very rare. Above the shales is a bed of limestone about 50 feet thick, which dips to the south 38°.

Westwards from the rock, and near Skipton, is a small quarry, which shows a minor fold in the Yoredale Limestone. It forms a ridge at an acute angle, the dips being 50° N. and S. The lower beds are black laminated limestones, with crinoids; the upper part is composed of alternations of limestone and shale, veins of quartz being common throughout.

Near Studfold, opposite Draughton, is a small limestone quarry. The stone is got for the repair of the roads. The beds have a dip varying from 50° to 60° to the N.W.; they are very variable in texture, being crystalline, semi-crystalline, or compact, and are light grey in colour. Bands of black chert, one to two inches thick, similar to those found at Park Head and Elslack quarries, are not uncommon. The limestone contains fossil producta of a large size; orthis, terebratula, encrinites, and corals very frequently occur. This limestone forms a well-defined ridge, which extends from Embsay, under East Halton, towards Bolton Abbey. Above the limestone are shales, which may be seen in the beds of small

[redacted]

Bolton Abbey (Pl. V., fig. 12), the Yoredale Shales are seen dipping away from the anticlinal. They consist of dark-coloured ferruginous shales, with bands of stone. They are much contorted, but eventually dip at an angle of about 30° to the N.W. About half a mile from Bolton Bridge, the Addingham Road is cut through a mass of shales, which have also been rolled about a great deal (Pl. V., fig. 13). They are surmounted by a bed of brownish red grit rock, the whole having a general dip of 25° to the S.E. The axis of the anticlinal passes between these places, probably near Bolton Bridge, and continues under the moors of Beamsley, following pretty nearly the line of the high road to Blubberhouses. The hills on all sides are capped by the Kinderscout Grit, which is exposed in several quarries. It possesses its usual characteristics, coarse, massive quartzose rock, with plant remains. Beneath the grit rock the Yoredale Shales are exposed in several small streams running westwards. A short distance beyond the summit of drainage between Wharfedale and the valley of the Washburn, the high road passes into a gorge with precipitous escarpments of grit rock on each side, below which the hill-sides are strewn with huge masses, disintegrated from above. At the head of this gorge the Yoredale Limestone is worked beneath the surface by adits. In conjunction with the limestone there is a calcareous sandstone, containing numerous fossil remains of brachiopods. Beds of light-blue shale, and a thin seam of coal, have been found, and a vein containing lead has been passed through during the progress of the works.

Beyond Blubberhouses, the anticlinal is probably continued in an easterly direction to Knaresborough, where it sinks under the unconformable Permian Limestone. It has a course from S.W. to N.E., a few miles from Harrogate, bringing up the Yoredale Shales and Limestones, and throwing off the Millstone Grit rocks on each side. It is along this line that the greatest amount of denudation has taken place, and the lowest beds are exposed to view. The northern boundary of the Yoredale measures is formed by a fault which runs from Shaw Green through Harrogate to Bilton, and throws the Yoredale Rocks into juxtaposition with the Millstone Grits. The former consist of, near the base, a moderately thick bed of sandstone, above this are shales with bands of cherty limestone. The sandstone is largely quarried on How Hill; it is hard, whitish, and thin-bedded.

The limestone is an exceedingly hard silicious rock, containing great numbers of remains of encrinites. It is used as a roadstone, and quarried for this purpose at Shaw Green, Beckwith House, and at Low Harrogate. The sandstone may be seen near Shaw Green, in the bed of a small stream forming an anticlinal axis, the beds dipping to the W. and S.W. On each side of this, separated by shales, are the calcareous roadstones, and then thick masses of shale between the calcareous beds and the [redacted] dale Shales occupy the valley of the Calder from Todmorden two miles eastwards, and flank the hills on each side to the base of the Yoredale Grit. North of Todmorden the grit seems to be absent, and the Lower and Upper Shales form an undivided series. In the cloughs S.E. of the valley the Lower Shales may be seen to a height of 150 feet. They are generally much obscured by landslips. In the upper part they become hard, sandy, and micaceous, and in many places roll about a great deal. They gradually pass up into the Millstone Grit. The junction of the two may be well seen in the clough descending from the Lee. North of the River Calder, the railway cuttings give sections in these shales. Limestone nodules containing Goniatites and Orthoceras are found in the shales on the south side of the valley.

The Yoredale Grits are extremely variable in structure, from a rough, coarse, quartzose grit, scarcely distinguishable from the Kinderscout, to a fine-grained flagrock, and even to thin-bedded close tilestone. It is also extremely irregular in deposition, ranging from thick massive beds to lenticular masses scarcely distinguishable in the clay or shale; and occasionally it separates into two or more beds, divided by sandy shale. The whole is still more confused by the occurrence of several faults, notably the great Pennine anticlinal, which forms its western boundary, and is roughly parallel to the division of Yorkshire from Lancashire. Near its south-western extremity the grit is very thick, consisting of irregular beds of coarse, massive grit, which is largely quarried. To the east it is obscured by landslips, but it rapidly thins out, and from Kilnhurst along the west side of Lee, or Lumbutts Clough, it becomes very shaley, and all that can be seen of the rock are lines of detached masses embedded in shale and clay. On the east side of the clough the Yoredale Grit forms a bold escarpment along by Woodhouse, Haugh Stones, and again up Shaw Clough. The section in the latter is not so clear. In the bottom of the valley are Lower Shales much contorted. Above these is a grit dipping 10° S.E., which is succeeded by sandy shale and sandstone, and these again by thin sandstones and shale. A fault runs down Stoodley Clough, and on the opposite side the Kinderscout Grit abuts against the Yoredale Shales.

On the opposite bank of the Calder several sections may be seen where the railway has cut through the grit. Above Eastwood station the Yoredale Grit is a massive sandstone, with slight interbedding of shale. The lower part disappears under the bed of the Calder. In Ingham Clough, a short distance west, the massive grit has become divided and greatly reduced, and forms a series of grits, sandstones, and shales, in which there is quite as much shale as grit. The lowest bed is seen in the railway cutting on the east of the clough, with [redacted]

East of Dungeon Top are beds of grey sandy shales, with thin tiles, masses of shale, and beds of fine hard close-grained grit, all interbedded in a very irregular manner. Above Hollins, the shales in the upper part are very sandy, and include beds of grit rock gradually merging with the Kinderscout Grit. Sections in the railway cutting give blue shales with interbedded sandstones much contorted or rolling. On the opposite side of the valley, from the anticlinal to Lumbutts Clough, are several good sections. The beds consist of shales of grey or brown colour, and more or less arenaceous, interstratified with beds of fine-grained grit. Under the Kinderscout Grit, above Mankinholes, is a good section in the dark-blue shale, where the fault at Studley Pike crosses the escarpment.

On the S.E. side of Langfield Edge, from Withern Clough Head to St. John's, are exposed a series of shales interstratfied with thin grits and sandstones, all dipping under the Kinderscout above. The strata are much disturbed, and roll about in every direction.

In the Hebden Valley and Horsebridge Clough, the Upper Yoredale Shales are exposed beneath the Kinderscout Grit escarpments. In Walshaw Dean lenticular masses of rock are exposed. In Horsebridge Clough, near the bed of the stream, thin bands of limestone in nodular concretions occur, which are highly fossiliferous. The following characteristic fossils have been found in them:—

Goniatites	Listeri, *Mart.*
	obtusus, *Phil.*
	crenistria, *Phil.*
Posidonomya	Gibsoni, *Brown.*
	vetusta, *Low.*
Aviculopecten	rugosus, *Phil.*

The Yoredale Shales are continued up the stream to its junction with the Gorple Beck. The two streams then run for a short distance over Millstone Grit rock. The source of the Gorple is in the Yoredale Shales, with interbedded grits, which have a dip eastwards of 22°.

The larger branch of the Hebden descends from Widdop —a beautiful little valley surrounded by rugged escarpments of Kinder Grit weathered into fantastic forms and presenting quite a castellated appearance at the Chudders —whilst the slopes of the Yoredale Shales, which occupy the centre of the valley, are strewn with masses of rocks which have been disintegrated by the action of the weather. The Pennine anticlinal passes through the centre of the valley, and the Yoredale Rocks may be seen dipping from it in all directions with a general trend east and west. They consist mainly of sandy shale, with beds of harder sandstones and micaceous flagstones. Probably lenticular masses of rock occur in the shales, and it is possible that the coarse reddish grit wrought in the quarry near Lower Houses may belong to one of these occasional beds.

[redacted]

beds of Kinderscout Grit, and on all sides they may be seen forming rugged escarpments of rough pebbly grit much weathered, and disintegrated by atmospheric action leaving the more durable parts of the rock projecting from the surface of the hill in huge blocks, many of peculiar form. Scores of examples may be seen on the tops of the surrounding hills, and more especially may be noted the Pots and Pans, near Greenfield, which have received their name from the circular holes worn by the rain-water and pebbles, derived from the rock itself, on their upper surfaces. The Wimberry Stones on the hills opposite are also fine examples. The sides of the hills, beneath the escarpment, are strewn with rounded pebbles of quartz, the result of the gradual wasting of the rock above.

The Yoredale Rocks exposed in this district consist in descending order, of—

Kinderscout Grit.	
Shales	600 ft.
Fine-grained grits, often flaggy, gradually merging into	150 „
Flaggy sandstones and dark shales .	60 „

The Yoredale Grit may be traced on each side the anticlinal, forming undulating but continuous high ground in the middle of the valley. The shales on each side, above the grit, form a hollow until they rise under the Millstone Grits. In the southern part, the series is much broken by faults, several of which converge to a point near Warlow Pike, and indicate a great amount of disturbance. The Yoredale Grit is a soft, brownish sandstone, containing mica, and impregnated with iron. A good section of the grit, with the shales below it, on each side the fault, may be seen at the entrance to the Diggle Tunnel. The beds are there seen to dip 35° to 40° to the S.E., and have, intermingled with the grit, several layers of dark shale. In the cutting, a little to the S.W. of the station, the grit rocks are again exposed, but, in this instance, dip 70° to the west with a little north, so that between the two stations the summit of the anticlinal ridge rises, which consists of the lowest members exposed, the dark shales with flaggy sandstone (Pl. V., fig. 14).

The lowest beds of the Shale with Flaggy Sandstone exhibited are at Upper Mill, a short distance S.W. of Saddleworth, where the expanse of the lower shale is rather broader than elsewhere. The grit may be traced northward and southward from Diggle in the beds of streams which run across the valley. In the higher road from Diggle to the church at Saddleworth, the Yoredale Grit is exposed. It is first seen cropping up in the road with a dip of 70° W.N.W. About 150 yards distant it is again seen with a dip of 60° to the E.S.E., the intermediate parts of the path being over a raggy stone and shale. The gritstone is quarried at Saddleworth Fold, and beneath Alphin Brow. It is coarse, brown, and of very inferior quality, being only used for the

[redacted]

I. CEPHALOPODA.

Nautilus discus	Hodder Bridge.
sp.	Dinckley Hall, Beck above Little Mearley Hall.
cyclostomus, *Phil.*	High Greenwood, Todmorden, Crimsworth Dean.
tuberculatus, *Sow.*	High Greenwood, Crimsworth Dean.
subsulcatus, *Phil.*	High Greenwood, do.
transversalis	High Greenwood, do.
Orthoceras Steinhaurii, *Sby.*	Brock Hall, Ribble. Dinckley Hall, Ribble. Crimsworth Dean.
angulare, *Phil.*	Bolland, High Greenwood, Crimsworth Dean.
annulatum, *Sow.*	High Greenwood.
sulcatulum, *M'Coy.*	Harrowfield, Knowlmere.
Brownii	Todmorden, Crimsworth Dean.
sp?	Fellside, Slaidburn, Dinckley Hall, Ribble.
giganteum, *Sow.*	Flashby.
reticulatum	Crimsworth Dean, Todmorden.
cinctum	do.
giganteum	do.
ovale	do.
Breyuii	do.
arenatum	do.
obtusum	do.
acicularis	do.
Gibsoni	do.
microscopicum	do.
Phragmoceras, *sp.*	Beck above Little Mearley Hall.

Goniatites, *sp.*	Champion, Dinckley Hall, Ribble.
Henslowii, *Sby.*	Dinckley Hall.
sphæricus, *Mart.*	Harrowfield, Knowlmere.
obtusus, *Phil.*	Black Hall, Bolland.
striolatus, *Phil.*	High Greenwood, near Todmorden.
implicatus, *Phil.*	Black Hall.
reticulatus, *Phil.*	High Greenwood, Flashby, Crimsworth Dean.
excavatus, *Phil.*	Bolland, Flashby, Todmorden, Crimsworth Dean.
Gibsoni, *Phil.*	High Greenwood, Crimsworth.
vesica, *Phil.*	Black Hall in Bolland, Crimsworth, etc.
calyx, *Phil.*	High Greenwood, Black Hall, Crimsworth.
Gilbertsoni, *Phil.*	Hebden Bridge.
Looneyi, *Phil.*	High Greenwood, Crimsworth Dean.
paucilobus	do.
serpentinus, *Phil.*	Black Hall, Bolland,

[redacted]

Kenyoni	Flashby.
paradoxicum	do.
intermedius	do.
proteus	do.
minutissimus	do.

II. GASTEROPODA.

Natica plicistria, *Phil.*	
sp?	Ashnot, Knowlmere.
lævis	Crimsworth Dean, Todmorden.
Loxonema constricta, *Sby.*	Ashnot, Knowlmere.
Pleurotomaria tumida, *Phil.*	Holden, Wiswell, Clitheroe.
deformis	Todmorden, Crimsworth Dean.
Euomphalus catillus, *Sby.*	Ashnot.
sp?	Hodder Bridge, Champion.
Turritella tenuistria	Crimsworth Dean, Todmorden.
Turbo Greenwoodii	Todmorden, Crimsworth Dean.
Bellerophon complexa	do.
Cirrus minutissimus	do.
Gloreri	do.
Buccinum imbricatum	do.
curvilineum	do.
rectilineum	do.
minimum	do.
productum	do.
elegans	do.
bullatum	do.
Cerithium dimidiatum	do.
Melania reticulata	do.
turritelliforme	do.
trochiforme	do.
Gibsoni	do.
rugifera	do.
excavata	do.

Patella Greenwoodii . . .	Todmorden, Crimsworth Dean.
Pileopsis minutus	do.
Serpula parvus	do.

III. BRACHIOPODA.

Spirifera bisulcata, *Sby.* . . .	Brock Hall, Ribble.
glabra, *Mart.*	Ashnot, Brock Hall, Ribble.
lineata, *Mart.*	Ashnot.
striata, *Mart.*	Ashnot.
resupinata, *Gib.*	High Greenwood, Todmorden.
Streptorhynchus crenistria, *Phil.* .	Brock Hall, Ribble.
Athyris Roysii, *Lev.* . . .	Ashnot.
Rhynchonella acuminata var. mesogonia, *Eth.*	Ashnot, Knowlmere.
pleurodon, *Phil.*	Ashnot.
pugnus, *Mart.*	Ashnot.
Productus semireticulatus, *Mart.* .	Ashnot, Knowlmere, Brock Hall, Ribble.
mesolobus, *Phil.*	Ashnot.
margaritaceous, *Phil.* . . .	Ashnot.
Martini, *Sby.*	High Greenwood, Har-

[redacted]

convexa	Crimsworth Dean, Todmorden.
Aviculopecten hemispherieus, *Phil.*	Ashnot.
papyraceous, *Sow.* . . .	Harrogate, Bolland.
Julius	Crimsworth Dean, Todmorden.
substriatus	do.
obliquatus	do.
latissimus	do.
Posidonomya Gibsoni, *Brown.* .	Champion.
sp ?	Beck, above Little Mearley Hall.
Pinna costata, *Phil.*	Dinckley Hall, Ribble, Beck above Little Mearley Hall.
Inoceramus vetustus, *Sow.* . .	Flashby, Todmorden, Crimsworth Dean.
lævis	Todmorden, Crimsworth Dean.
tumidus	do.
radiatus	do.
Gibsoni	do.
scariosus	do.
elongatus	do.
Pterinea, *sp ?*	Dinckley Hall, Ribble, Champion, Fellside, Slaidburn.
Gervillia lunulata, *Phil.* . . .	Ashnot, Knowlmere.
obtusa	Crimsworth Dean, Todmorden.
Cypricardia obtusum . . .	do.
Pallustra minima	do.
Modiola elongata	do.
rostrata	do.
minuta	do.
orbiculata	do.
Longthorni	do.
Mytilus lingualis	do.
variabilis	do.
Bellona	do.
Ctenodonta cuneata, *Phil.* . .	Ashnot.

attenuata	Forest Becks.
Lucina dubia	Todmorden, Crimsworth Dean.
orbicula	do.
lævis	do.
Metoptoma trilobata, *Phil.* . .	Ashnot, Knowlmere.
Nucula cuneata	Crimsworth Dean, Todmorden.
lævis	do.
variabilis	do.

V. CRINOIDEA.

Actinocrinus triacontadactylus, *Mill.*	Harrowfield, Knowlmere.
Poteriocrinus, *sp ?*	Primrose Print Works.
Entomoconchus couleri, *M'Coy.* .	Ashnot.
Brachymetopus, *sp ?* . . .	Worsaw End House.
Phillipsia gemmulifera, *Phil.* . .	Forest Becks.
truncata, *Phil.*	Ashnot.
sp ?	Worsaw End House.
Zaphrentis, *sp ?*	Worsaw End House.

III. Shore Deposits with Marine Intercalations.

[redacted]

coarsest, thickest, and most massive of the whole series, and form extremely good horizons whereon to place the boundary lines of the formation, being easily traced by the bold features they present in the landscape. Between the two there exists a thick series of sandstones, shales, and thin beds of coal. In Derbyshire, the Kinderscout Grit constitutes the high plateau of the Peak, and receives its name from the precipitous ridge on the west side of that mountain. It is there divided into two thick beds of grit, with an intermediate mass of shales. Above this grit is a varying thickness of shales, with occasionally a bed of stone in the lower part. These attain a thickness of 500 to 600 feet. Resting on them is the Third Grit, which is 200 to 300 feet thick. In its upper part it is a coarse red grit, becoming finer grained lower down, and at the bottom consisting of flagstones. Between the Third Grit and the First, or Rough Rock, are a number of flagstones and shales, with usually a bed of coal near the surface of the former. This series, called the Second Grits, or Flagrocks, and in Lancashire the Haslingdon Flags, has an extremely diversified structure. It usually consists of two or three groups of Flagrocks, with intermediate shales, the Lower Flagrock sometimes having above it a thin band of coal and Ganister Rock. The whole are from 150 to 450 feet in thickness, exclusive of the shales which separate the Flag group from the Rough Rock above and the Third Grit below, each averaging 200 feet. The Rough Rock is about 80 to 90 feet thick, the whole series being about 2,400 feet.

The Millstone Grit series in the West Riding occupy a larger area than any other formation, extending from the borders of Derbyshire and Cheshire along the course of the Pennine Chain to the neighbourhood of Skipton, and still northward to Great Whernside; westward from

Skipton they form the summit of most of the high hills above the Mountain Limestone and Yoredale Rocks, whilst eastward they occupy the northern part of the Riding to its junction with the Permian Limestone; following the escarpment of the latter southwards, they dip under the Lower Coal Measures in a line roughly reaching from a few miles north of Leeds to Bingley, from whence the Coal Series may be traced, resting on the Rough Rock southwards into Derbyshire.

The Kinderscout Rock in the southern part of the district consists of two beds separated by shale. In the neighbourhood of Harrogate there are three beds of grit, which, with the intermediate shales, are nearly 1,400 feet thick. Again, further north, the grits assume a more homogeneous character.

The Third Grits, in proceeding northwards, in place of one thick bed, are divided by shales into three, four, or five beds with different characters to the Derbyshire Grits, containing two or three beds of coal, and distinct bands of fossiliferous shale. The Flagstone group, on the contrary, [redacted]

1. *The Kinderscout or Fourth Grit.*

The Kinderscout Grit along the Pennine Ridge, in the south-west part of the Riding, consists of a very coarse, massive gritstone, or conglomerate, forming the high hills of Harrop, Diggle, and Millstone Edges, overlooking the Saddleworth Valley. It is divided into two or three beds, with intermediate shales, and attains a thickness of near 700 feet. The series is well shown on the roadside from Diggle to Huddersfield, where it crosses Diggle Edge. Three beds of grit are passed over, with two beds of shale between. On one of these the Stanedge Reservoir is situated. The rocks are traversed by plains of current bedding, dipping W.S.W., and often contain pebbles of quartz from one to two inches diameter. It is extensively quarried on both sides the Saddleworth Valley. In a quarry near Greenfield the beds are nearly vertical, being thrown up by a branch of the Pennine Fault, and at Mossley, near the boundary of the Riding, the beds are 700 feet thick, the base not being exposed. The lower part of the valley is composed of Yoredale Shales and Sandstones tilted up by a fault, forming an anticlinal, and running nearly due north and south down the valley. The fault may be seen at the northern end of the valley, throwing off the beds with a rapid dip to the west, causing the Millstone Grits to disappear in a short distance under the Lancashire Coal-field. To the eastward, the Kinderscout Grits are nearly horizontal, and rise into flat moorlands to a height of nearly 2,000 feet above the level of the sea. Further eastward the beds begin to dip more rapidly, and with the higher grits also disappear beneath the Coal Measures.

The Kinderscout Grit extends northward along the summit of the Pennine Chain, forming the boundary of

Yorkshire along Blackstone Edge, Blake Moor, Turley Holes Edge, and Langfield Edge, where it forms a series of bold escarpments overlooking the valley of the Calder at Todmorden. These moors extend over a large tract of country, and present a series of wild moorlands covered with heather and bilberry bushes, beneath which exists a great thickness of peat. The streams cut through this to the solid material below, and form a slightly undulating surface, given up to the sportsman, and occasionally sheep, the average height being from 1,100 to 1,350 feet above sea-level. In the opposite direction, the grit spreads out into an extensive plateau, mural ridges of which extend from Black Hambledon, under Stansfield Moor, along the side of the Calder Valley. Turning to the north at Hebden Bridge, its wooded crags may be seen on each side of the deeply indented, picturesque valley of the Hebden. Occasionally it is weathered away, and forms rocking-stones perched on the edge of the ridge.

The eastern boundary of the Kinderscout Grit dips gently under the shales and grits of the third series, [redacted]

Lindley, average a height of about 1,000 feet; the latter, east of the Washburn, reaching to Rigton, where it constitutes the bold ridge of Alms Cliff. Northwards, the moors of Beamsley, Blubberhouses, and those S.W. of Pateley Bridge, are all of this rock. Near Blubberhouses, the anticlinal which extends from Clitheroe eastwards through Skipton and Bolton has caused a split in the grit rocks at Kex Gill, forming rugged escarpments on each side, with blocks perched in huge masses, or strewn along the sides of the gorge (Pl. VI., figs. 15, 16).

On Kex Gill Moor there are several quarries in the grit rock, which present the usual characters: thick, massive, quartzose grit, in places very ferruginous, and containing numerous remains of the plants, Lepidodendron and Sigillaria. In the valley of the Washburn, at Thurscross and Hanging Moor, the Kinder Grit is seen dipping to the east beneath the shales, calliards, and coals of the Third Grit series. Continuing to the head of the Washburn Valley, at Greenhow Hill, the Grit is found to have diminished in thickness, and to consist of three beds, with thin partings of shale, and a bed of coal a foot thick, the whole being only separated from the Carboniferous Limestone by about a dozen feet of shale and thin limestone, representing the Yoredale series. Above the Kinder, or "bearing grit," is a thickness of 400 to 500 feet of shales and sandstones topped by the Third Grits of Brimham and Plumpton.

In Wharfedale, the Kinder Grit may be seen at "the Strid" in Bolton Woods, and between the Wharfe and Aire dales stretches over Embsay Moors to Flashby and Rylstone Fells and the Weets. It also forms the summit of Brown Hill, and on the southern side of the Craven Fault exists in great extent in the district from Settle and Giggleswick, to the Ingleton coal-field, which it underlies, and extends southwards, through the Millstone Grit districts of Bolland Knots, and Burn Moor.

Stretching from Harrogate, in a south-westerly direction, an anticlinal throws up the Yoredale strata, and dipping from it, the Kinderscout Grits crop out on all sides. The formation consists of two principal grits, coarse, massive, thick-bedded, and frequently containing quartz pebbles; an intermediate bed of sandstone is of much less importance; it is thin-bedded and flaggy in its upper part, getting thicker and coarser lower down. Between the flagstone and the Upper and Lower Grits are beds of shale of great thickness. The whole series is probably not less than 1,400 feet thick. The Upper Bed of grit rock is quarried at Hookstone Wood, and several other places near Harrogate, for building-stone. There are several quarries near Pannal, with a general dip to the S.E. of 15°, and a little further to the south the upper bed of grit rises to a height of 700 feet above the sea level, forming the bold hill called Great Alms Cliff.

The Kinderscout Grit of the southern parts of the

[redacted]

this grit forms the summit, resting on the Main Limestone. The face towards the north-west presents a fine precipitous slope of gritstone, which gives the mountain a bold and striking appearance. The grit series above the Yoredale Rocks on Penyghent give the following section :—

	ft.	in.
Sandstones and Shales	60	0
Gritstone	18	0
Shale	35	0
Grit	46	0
Shale	10	0
Grit	10	0
Shale	12	0
Coal Smut	0	6
Grit	17	0
Coal	1 0 to 2	0
Grit—"Bearing Grit"	75	0
Shale	30	0
Bearing Grit	57	0
Shale	10	0
Main Limestone	100	0

The next section is from the Providence mine near Kettlewell, a few miles further east :—

	ft.	in.
Shales, with thin Sandstones	30	0
Coal and Shale	5	0
Gritstone	30	0
Shales and plates	12	0
Grit	13	0
Shales, and thin Sandstones	22	0
Coal	2	0
Shales	25	0
"Bearing Grit"	90	0

The Third Grits.

Above the Kinderscout Grits are a number of beds of gritstone, flagstone, shale, and thin seams of coal, very variable in mineral characters. The most persistent bed in this district is the uppermost one, a massive, coarse, usually red grit, which, from its peculiar jointing, forms bold escarpments often extending for miles in an unbroken wall of rock, and presenting one of the most noticeable features in the scenery of a Millstone Grit country; it is due to the undermining action of the weather on the shales beneath, causing the rectangular masses of the grit to lose their support and break off along the joints, and the face of the cliff is thus kept square and straight. Examples of these escarpments occur in many of the deep valleys and cloughs in which the Don and the Calder take their rise, as in Ramsden Clough, the Valley of the Rybourne, Luddenden, and others. The Third Grits also form the bold escarpment which ranges from Harewood to Collingham, where the rock is cut through by the Wharfe, and [redacted] along the crest of the Pennine Chain, attaining a height of near 2,000 feet. Northwards it occupies much lower ground, is of a more decidedly red colour, and, from its uneven hardness, exhibits a decided tendency to weather into all kinds of grotesque and peculiar forms. Examples of this action may be seen near Spofforth and Plumpton, where, on a slope immediately below the escarpment of the Magnesian Limestone, are a number of detached pillars and masses of rock, some rising 15 or 20 feet above the level of the surrounding ground, whilst others, protected by soil, barely protrude, their surfaces presenting curious perforations due to atmospheric action. In Plumpton Park the rocks are still more decomposed, and being surrounded by an artificial lake, present a most picturesque appearance. The celebrated Brimham Rocks are denuded from the same bed of grit. The proportion of red felspar in the rocks is very great, and it is mainly to the decomposition of this mineral that the formation of these peculiar rocky structures is due. In their lower beds they are often conglomeratic from the abundance of quartz-pebbles. On a smaller scale examples frequently occur further south in the form of detached blocks and rocking-stones.

The red and purplish-red Plumpton Grits have been described at various times as Permian, or the equivalents of the Rothliegende of the Germans, and were named by Prof. Sedgwick, "Lower Red Sandstone." This opinion was shared by Prof. Phillips and Sir R. Murchison. Since the survey of the district by the Geological Surveyors there can be no doubt that they are members of the Millstone Grit series. This subject will receive full consideration in the description of the Permian Rocks.

Below the uppermost bed of the Third Grits, usually characterised by its red colour, and by having a bed of coal above it, there are a number of grits and shales which are very diverse in character, but, in the greater part of the West Riding, may be divided into four groups of grit rock with intermediate shales. Under the red grit is a bed of shale from 50 to 80 feet thick, then a rough, thick-bedded sandstone, shales, and an arenaceous flaggy bed, with worm tracks, more shales, and a rock, which in the north is usually calcareous and full of fossils; a grey shale followed by a thick-bedded pebbly grit, with beds of coal and shale; beneath all these are thick shales from 100 to 400 feet thick, which overlie the Kinderscout Grit.

RAMSDEN CLOUGH, NEAR HOLMFIRTH.		WEST OF HALIFAX.		SPOFFORTH AND RIPON.	
Flagrock and Shale.	feet.	*Flagrock and Shale.*	feet.		feet.
1. Red Grits to finer Sandstone	85	1. Warley Moor Grit { Red Grit, Shale, White Grit }	80	1. Plumpton Grit { Red grit, Shale, Red grit }	150
2. Shales and 3. Grits	75	2. Shale, with coal and fossiliferous bed	80	2. Shale	50
		3. Soft Sandstone, Shale, Thick-bedded Grit	100	3. Follifoot Rock	75
4. Shales and Flag-		4. Shale and Flagstones		4. Arenaceous shales	

[redacted]

The accompanying sections represent the relative positions and thicknesses of the series in the different parts of the district, viz., at Ramsden Clough, near the southern extremity of the county; in the neighbourhood of Halifax; at Spofforth, and near Ripon.

A good section of the whole of the Third Grit series is exhibited in Ramsden Clough, down which runs one of the sources of the Holme. The uppermost bed of the Third Grits, which forms the level ridge bounding Holme Moss, Black Moss, Withern Edge, and Ramsden Edge, is cut through by the channel of the stream. Above this grit is a thickness of about 100 feet of shales, surmounted by the flagstones of the Second Grit series of Snailsden Pike End and Cook's Study, whilst low down in the valley are found the members of the Kinderscout Grits. The whole series is about 550 feet thick, exclusive of the shales beneath the flagstones (Pl. vii., fig. 19).

The escarpment round the upper part of the clough is composed of a massive, well-jointed, thick sandstone, in many places having a red colour, but turning by exposure to a fine white colour. It is 85 feet thick, and gradually, towards the bottom, becomes thinner-bedded, with beds of shale intermingled, and eventually changes entirely to shale. Below the shale are 25 feet of a flaggy grit rock, which when weathered presents a peculiar rounded appearance. Still descending, 45 feet of shale are passed over, very fine-grained and ferruginous. It is in small fragments, and is readily disintegrated, and falls down the slope in showers. This is followed by another bed of rock, over the face of which the water makes a pretty cascade. It is 20 to 30 feet thick, harder, and not so flaggy as the one above. Shales, with thin beds of raggy sandstone, form the bed of the stream for a depth of 250 feet, where the Kinderscout Grit is seen. The line of its outcrop may be traced round the valley to the village of Holme on the hill-side opposite.

The Third Grits are well shown in quarries and in the River section at Scout Mill, near Mossley. The beds consist of—

	ft.
Flaggy Micaceous Sandstone	70
Coarse-grained Massive Grit . . .	80
Micaceous Flags and Shale	50
Dark Shales, with 5″ coal . . .	100 to 300

The dip is 16° S.W.

South and west of Tintwhistle, and at Monslow Castle Hill, the grits have a rusty aspect, and are unfit for building purposes. They form finely moulded escarpments, from Glossop by Mattley Moor, Hayfield, Cracken Edge, to Eccles Pike. It then becomes a very coarse red grit, about 200 feet thick.

The shales are 100 feet in thickness at Pule Hill, near Diggle, whilst at Mossley they attain a thickness of 300 feet, and contain a bed of coal five inches thick, which

[redacted]

Mossley; it is two feet thick, and contains much iron pyrites. The shale forming the roof contains one or two species of Goniatites. It is 150 feet thick at Mossley.

In the country west of Halifax the Third Grits occupy an extensive tract of high lands from Sowerby Bridge to Blackstone Edge, the deep valleys of Calderdale, Luddenden, and others, being cut through the rocks of this group. In Luddenden Valley the entire thickness of these rocks may be traced on the hillside to the east. The red grit forms the ridge round Warley Moor, and encircles the upper part of the valley; below this there is a bed of shale with a thin coal and seatearth in its lower part; a little above the coal is a black shale containing Goniatites and Aviculopectens. These lead down to 20 feet of soft yellow sandstone, with a bed of Ganister Rock above it. A bed of shale separates the sandstone from 50 feet of thick-bedded grit, which is probably the equivalent to the Follifoot Rock further north. There are 50 feet of shale below this, and then a number of thin-bedded, bluish-grey flagstones. The surfaces of the flags are profusely marked by worm tracks, and also show ripple marks. Alternation of shales and sandstones occupy the next 150 feet. The sandstone is there quarried at Deep Clough, opposite Castle Carr. It is separated into two parts by a bed of shale about four feet thick, which is rich in fossil plants. It is also worked in many other places for flags and gritstone: below these are about 100 to 120 feet of shales and raggy stone, which conduct to a rough grit forming a conspicuous line reaching round the head of the valley. It is a thick-bedded pebbly grit, divided by joints into blocks. In some parts it is ferruginous, and when split displays concentric red rings round a central blue-grey nucleus. It contains two thin beds of coal about 6″ thick, which have been worked on Wadsworth Moor, and in other places where it could be easily got. It also contains a bed of fine-grained stone, very hard, and quarried for road metal, called Galliard. At Booth, below the rough grit, is a grey, slaty flag, which is full of small tracks of worms. The grit rock contains an abundance of fossil plants common to the coal measures, as Lepidodendron, Calamites, and Sigillaria.

Two hundred feet of shale separates these beds from the thick-bedded Kinderscout Grit.

The Third Grit rocks extend northwards over the Oxenhope and Haworth Moors, attaining a height of 1,462 feet, and on High Greaves Moor 1,505 feet. The sequence of the rocks is generally similar to that already described. They occupy the valleys of the River Worth and Harden Beck, being surmounted by the Flags and Rough Rock of Keighley, Harden Moors, and Brown Hill.

In the construction of a watercourse under Wadsworth Moor, by the Halifax Corporation, some interesting discoveries were made of fish and molluscan remains. The tunnel passes under the hill from Castle Carr to [redacted]

Seat-earth	6	0
Sandstone, thick-bedded and pebbly . .	42	0
Shale	0	9
Coal	0	2
Fire-clay or Seat-earth	3	0
Blue Sandstone	28	0
Blue Arenaceous Shale passing into Sandstone .	108	0
Black Shale	20	0
Blue Shale, containing Goniatites and Pectens, etc.	7	0
Layer of Ironstone Nodules, with fish remains .	0	4
Peculiar Stone called Cone-in-Cone . .	0	2
Hard Canister Seat-earth	4	6
Grey Shale, with White Rock	10	6
Blue Shale, with Goniatites, Aviculopecten, etc.	12	0
Kinderscout Grit	565	11

Whilst sinking the shaft nearest Pecket Well, after passing through a thick rock, 130 feet of "grey shale," with a bed of black shale in its middle part, was reached. The latter contained a great number of marine shells of the genera Goniatites, Posidonia, Aviculopecten, Orthoceras, Nautilus, and Modiola. The shale also contained two or three layers of clay ironstone nodules, which were full of the above fossils. The thick-bedded pebbly grit was next passed through, with a thin bed of coal and seatearth; then followed in descending order 108 feet of arenaceous shale, passing into sandstone, 27 feet black and blue shale, with fossils, and in the lower part ironstone nodules, which contained remains of fish of the genera Acrolepis, Acanthodes, and teeth, which are probably those of Cladodus, all in a remarkably fine state of preservation; below this, a bed of Ganister Rock, with stigmaria, a white grit rock, and, resting immediately on the Kinderscout Grit, a bed of blue shale, containing crushed Goniatites and Aviculopectens.

The town of Keighley is partially built on rocks of the Third Grit, brought up by a large fault running nearly east and west, and abutting against the Rough Rock; the fault trending from between Exley Head and Bunker's Hill, past Clough Bank, to Long Hill End. From this line the Third Grits extend northwards to Sutton and Steeton, having above them at Black Hill and Todley Hill the Flagrock and the First Grit. The River Aire has cut a passage through the series of grit rocks, for we find their counterparts on the opposite side of the valley on the slopes of Silsden Moor. Two or three beds of coal have been worked on each side the valley. The lowest seam, at Morton Banks and Stanbury, and lately opened out at Thwaites, is four feet six inches to six feet thick. It is, however, a poor coal, and leaves when burnt a large residue of ashes. Other and smaller seams have been wrought higher in the series at Black Hill, near Keighley, and Park Wood on the opposite side of the valley. This coal is about 140 feet below the Rough Rock. Another bed 200 feet below the Rough Rock has been got at Rivock Edge, on [redacted] poses. The grit may be distinguished by its even-bedded tabular masses; the Rough Rock above, where seen in escarpments, being usually false-bedded, and forming more rugged cliffs. Eastwards, the Third Grit forms bold escarpments at Otley Chevin, Arthington Bank, and Harewood Park, extending along the south bank of the River Wharfe in a nearly straight line. At Harewood Castle it makes a curve northwards, and from thence dips to the east and south-east, and disappears under the Permian Limestone escarpment at East Keswick. On the opposite side of the Wharfe a general similarity of the rocks composing the Third Grits prevails. A good sequence of these measures is exposed in the railway cuttings from Spofforth to Harrogate. Below the Spofforth and Plumpton Grit, half a mile west of the station, is a bed of shale, *e* (Pl. vi., fig. 17), which overlies a coarse grit, generally rather friable where weathered. It is thick-bedded, and in the upper part false bedding is common. The colour is grey or yellowish-white, with occasional patches of a red colour. The latter are due to the presence of iron, and the sandstone is often found to be quite brown and rotten. Layers of quartz pebbles dovetailing into the sandstone occur, especially in the upper part. The dip of the beds is 15° S.E. This rock has been named the Follifoot Grit, *d*. Fig. 17 will explain the relative position of this and the succeeding strata in the cuttings.

The shales, *c*, are next met with, and a short distance further a grey sandy shale and thin-bedded sandstone, *b*, without much consistency, form a series of anticlinals as far as the Prospect Tunnel. The grey colour is due to a great quantity of small fragments of fossil plants, which are spread through both the shales and flags. The harder beds where exposed are weathered peculiarly; the thin partings of shale between each are disintegrated and washed away, the remaining harder parts presenting the appearance of a well-pointed wall. The surfaces of the flags are covered with worm tracks; many of the tracks are large, an inch in diameter, and may be the tracks of molluscs. The shales and flags are succeeded by hard calcareous sandstones, through which the tunnel is cut; a section of them may, however, be seen in a small quarry about 100 yards to the left of the line, on the roadside from Follifoot to Pannal (Pl. vii., fig. 18). The sandstone is thin-bedded and much jointed; a thickness of about 20 feet is exposed in the quarry; in the upper part it is divided by 10 inches of stiff, white, marley clay. It is remarkable from its being very rich in fossils, containing the remains of several Brachiopods, other molluscs, and Encrinites. The beds of sandstone are usually separated by thin bands of clay. The series have been named the Cayton Gill Beds, from the best sections being exposed in that valley, two miles north of Ripley.

The lowest members of the Third Grits, divided from the Cayton Gill Beds by 60 feet of shale, consist of the Follifoot Coal Grits, so called on account of their being [redacted] inches thick; the lower bed is in some places two feet nine inches thick, but thins out rapidly to the northwards. On the east side the coal has been got, but on the west it still remains, being discontinued on account of the amount of water accumulating in the pits.

Between Ripon and Sawley the Cayton Gill group consists of three beds. The uppermost consists of thin flags full of the remains of encrinites. The second abounds with the casts of Brachiopoda and other organic remains, named "Shell bed." The lowest is an exceedingly hard fine sandstone, and mottled with carbonaceous markings, in which the most common fossil is Bellerophon costatus. At Cayton Gill the two upper beds only are developed.

At Brimham Rocks, on the flanks of the hill on which they stand, both the "shell bed" and the hard white grit may be seen cropping out below. The formation extends westwards as far as Pateley Bridge, and is extensively quarried at Hampsthwaite for material to repair the roads. The fossils found in the localities named are—

Orthis resupinata, *Mart.*
O. Michelini, *L'Eville.*
Productus semi-reticulatus, *Mart.*
P. cora, *D'Orb.*
P. aculeata.
Spirifera lineata.
S. trigonalis, *Mart.*
S. striata, *Mart.*
Spiriferina cristata, *Sch.*
S. octoplicata.
Streptorhynchus crenistria, *Phil.*
Arca, *sp.* allied to cancellata.
Nautilus (Discites) sulcatus, *Sow.*
N. *sp.*

Aviculopecten.
Strophomena analoga, *Phil.*
Clionetes Hardrensis, *Phil.*
Rhynchonella pleurodon, *Phil.*

The uppermost bed of the Third Grit Series, in the northern part of the Riding, is usually characterised by its deep red colour and its tendency to weather into peculiar forms, owing to the unequal hardness in the composition of different parts. It is composed of two beds having a total thickness of 150 to 200 feet; it is a very massive, thick-bedded grit; its red colour is due to the presence of a large amount of iron. The base of the rock is in some instances so full of rounded pebbles of quartz as to form a conglomerate. It affords a serviceable building material where the stone is good, but it frequently exhibits a tendency to pass into purple sandy shales. The picturesque masses formed by weathering may be in part due to this tendency; fine examples can be seen on either side the highroad from Spofforth to Knaresborough. At St. Francis' Chapel a very fine large

[redacted]

1,000 feet. Southwards from Guy's Cliff the red grit, or upper bed of the Third Grit series, covers the higher ground about Thornthwaite and Forest Moor, and sweeps round by Killinghall to Ripley. The upper beds usually consist of red flaggy grits, with a soft purplish sandstone beneath. The interesting group of rocks which form Brimham Crags occupy about half a mile along the face of the ridge. They present most remarkable phenomena; rocking-stones of large size are frequent, and the rocks have been worn, apparently by the action of an ancient sea, into every variety of form. Rocks are of frequent occurrence worn much more near the base than higher up, by the constant lashing of the waves during the period they formed a sea-beach (Pl. viii., fig. 21).

Between the Flagrock and the upper bed of the Third Grits is a series of shales varying from 150 to 300 feet thick. They may be seen forming the sloping hillsides beneath the Rough Rock and Flagstone, wherever those rocks are found capping the hills. In Ogden and Wheatley Valley, near Halifax, about 90 feet below the Flagrock, there is a thin stratum of Fossiliferous Shale, containing numerous marine shells, of the genera Goniatites and Aviculopecten; Modiola, Nautilus, and Orthoceras have also been found. The stratum is not more than four inches thick, and the majority of the specimens are much flattened and crushed.

Near the bottom of these shales there is a bed of coal, from two to eight inches thick, which is usually found immediately above the Third Grits. It has been worked in many places before the means of transit were so good as at present; but is now quite discontinued. The shales above the coal are very bituminous in some localities.

Flagstones and Rough Rock, or Second and Upper Grit.

The Rough Rock, the uppermost bed of the Millstone Grits, is found encircling and immediately underlying the coal measures, from the southern boundaries of Yorkshire with Derbyshire, northward and westward near Huddersfield, and Halifax, and from thence eastward a little north of Leeds, and finally disappears under the Permian Limestone escarpment. The Rough Rock, though very persistent, nowhere attains a great breadth; in its widest parts being never more than four or five miles across. It is a coarse grit, sometimes a conglomerate. It weathers by exposure, containing a large amount of felspar, which decays when under the influence of rain and atmosphere. Very intimately connected with the Rough Rock is the Second Grit in the series; the two in Derbyshire are parted by thick beds of shale. It is a flagstone, and in Yorkshire is often found under the Rough Rock without any intervention of shale, and in some instances is so closely connected that a division line cannot be traced. Usually it is [redacted]

Two or three miles south of Penistone, the Rough Rock and Flagstones are found extending in a northerly direction, separated from the Coal Measures by a fault on the east; and on the west, Whitwood Moor, Edge Cliff, and Middop Cliff, rest conformably on the Third Grits. A narrow strip conducts to Border Hill, and thence by Tapping Moor to Dunford Bridge. From Dunford Bridge the First Grit occupies the tract of Scholes Moor, to Holmfirth, and narrowing at Haggwood, again expands in the neighbourhood of Honley, Netherton, South Crossland, and Linthwaite, to near Huddersfield, dipping gently to the east under the Lower Coal Measures. Two or three miles westward, on a broad plateau of the Third Grit, an outlier of Rough Rock forms a strikingly lofty and conspicuous hill, presenting towards the N.E. a saddle-shaped appearance, owing to a synclinal arrangement of the beds forming a trough, whose axis runs parallel to the Meltham Beck. The eastern flanks of this hill are covered with landslips, and its north and south extremities rise into the peaked Cliffs of Shooter's Hill and West Nab.

From Huddersfield the Rough Rock continues in a narrow strip forming Longwood Edge, and is seen on Holestone Moor. The former is separated from Stainland by two faults, which, running east and west, have thrown down the coal measures below the level of the gritstone at Jagger Green. From Stainland the Rough Rock rises about 6° to the south-east, and forms an extensive sloping plateau, covering the moors of Greetland and Norland, passing under the town of Elland, and reappearing on the opposite side of the River Calder, with the Lower Coal Measures lying conformably above it. The junction of the two series may be seen to advantage at Elland station, in a cutting made by the Lancashire and Yorkshire Railway Company.

To the north the Rough Rock forms the slope on which Halifax is built, and is continued by Ovenden, Illingworth, and Ogden to Mount Tabor and Mixenden. The courses of the River Calder and its tributaries are cut through the Rough Rock, forming deep valleys in the shale beneath, which slope up to the foot of the rock, often covered with trees. The grit usually presents a precipitous face, often weathered into large perched blocks, giving a pleasing variety to the landscape, and affording a distinct horizon, marking the top of the grit series and the base of the coal measures.

Between Holmfirth and Dunford Bridge the Second Grit or Flagrock exists, parted from the upper bed of the Third Grits by a thick bed of shale. It is extensively worked at the Magnum Quarries, and is separated from the Rough Rock above by beds of shale from 10 to 12 feet thick. The section (Pl. ix., fig. 23) will exhibit their relationship.

The shale above and below the coal is grey, micaceous, and sandy; there is no seatearth. The coal breaks easily into small cubes: a short distance to the north of the

the shales are joined into one bed six or eight feet thick, whilst in the opposite direction they are considerably thinner, the intervening Flagrock being nearly connected with the beds above and below it.

The Flagrock is usually found underlying the Rough Rock in the Huddersfield and Halifax districts. It is quarried under the Stainland ridge and at Barkisland; producing fine-grained micaceous flags and slates. It is separated by a bed of shale from the grit above. At Norland it is also quarried, and may be seen under the Rough Rock in North Dean Wood. To the N.W. of Halifax the Flagstone may be traced along the escarpment forming the boundaries of Wheatley Valley. In the southern part, the Rough Rock attains a great thickness; but northwards it has been denuded, and gradually thins out until, at Moor End Quarries, near Mount Tabor (Pl. ix., fig. 24), four or five feet are found; and half a mile further the Flagrock is quarried at the surface along Cold Edge (Pl. ix., fig. 25), and to Fly Flats; at the latter place, a little east, the Flagrocks assume a more gritty and quartzose character, and merge into the Rough Rock which forms the tableland stretching to Ogden Clough, and across the moors to the neighbourhood of Haworth.

In this district there is no real dividing line between the First and Second Grits; they gradually change or dovetail into each other in a very puzzling manner. As a rule no division of shale appears, but occasionally a wedge-shaped mass occurs, developing in a few score yards to 12 or 20 feet in thickness, and as quickly disappearing. Usually the Rough Rock in its lower part becomes finer-grained and very false-bedded; and, lower still, the beds change to a thin-bedded, fine-grained micaceous Flagstone, usually coloured a reddish-brown by iron; but also occurring of a white colour. Intermingled with the Flagstone beds are others, much thicker, used for ashlar stone. They are fine-grained and similar in composition to the flags, but have not their fine laminated structure. There are usually one or two beds of shale in the Flagrock, which are persistent in the Fly and Hunter Hill districts. The coals and grey Micaceous Shales between the two rocks as seen near Dunford Bridge are entirely absent.

III. Freshwater or Estuary Deposits.

1. *Lower Coal Measures, or Ganister Group.*

This group includes all the strata lying above the Rough Rock, and below the Silkstone Coal, also known in various parts of the Riding as the Sheffield or Black Shale Coal, Blocking or Thin Coal, Toftshaw or Cookson's Coal, and Barcelona Coal. The Lower Coal Measures are composed of a number of thick sandstones, shales, thin coals, and several beds of fire-clay, the latter often being hardened into a fine close-grained rock full of roots of fossil plants, and termed Ganister or Calliard. This [redacted] pass to the opposite extreme, and gradually thin out and disappear, giving place to beds of shale.

The coals are much thinner than in the Middle Coal measures. They are often of poor quality and uncertain extent, generally occurring above the beds of grit rock, only parted by the seat-earth or fire-clay. Beds of coal are, however, occasionally found interpolated in the shales.

The Lower Coal Measures exhibit a close analogy with the Millstone Grit series in lithological character. In each there are thick beds of sandstone parted by shales, with a bed of coal and seat-earth usually at the base of the shales. The Lower Coal Measure Sandstones are not usually as thick as those of the grits. They occur more frequently, and are parted by thinner beds of shale. They are not so constant in composition and character, having usually a flaggy bedding, and rarely assuming so coarse a texture as the millstones. The constituents of the several rocks are, however, very similar, being composed of quartz, mica, and felspar. By disintegration the felspar may, in many cases, have served as a cementing material for the other components. The presence of large quantities of mica generally accompanies a tendency to form flags.

The palæontology of the Lower Coal Measures also exhibits considerable relationship to that of the Millstone Grit series. Many of the fossil mollusca, as Aviculopecten, Orthoceras, Goniatites, and other marine forms, have a range from the Lower Millstone Grits to the Ganister series. The groups are perfectly conformable, and the line dividing the two formations is purely arbitrary. The tendency of all the evidence in this part of the country is to show that the Ganister series and the Millstone Grits form one natural division of the Carboniferous System.

The Lower Coal Measures extend from the southern extremity of the county near Sheffield northwards to Penistone, Huddersfield, Halifax, and Denholme. They then turn eastwards, and, continuing a few miles north of Bradford and Leeds, pass under the Permian Limestone escarpment near Barwick-in-Elmete. They are deposited conformably on the Rough Rock, and except near Penistone, where the Coal Measures are thrown against the Rough Rock by a fault, they rise from the incline formed by the dip of the Rough Rock, and are capped by a bold escarpment of the thick beds of the Elland Flagstone. The western flank of this escarpment is formed by the outcrop of the various members of the Ganister Coal Group, and these measures being of nearly equal consistency, they generally form a regular slope, unbroken by any marked features, the outcrop of the thin sandstones they contain not being of sufficient importance to disturb the general even slope of the hillside. The Elland Flagstone, called the Green Moor Rock, near Huddersfield, forms a series of bold ridges, rising to a considerable height, as may be seen from the following examples, taken from various points in its course northwards:—Hartcliff, 1,175 feet;

[redacted]

somewhat concentric circles, gradually assuming smaller proportions towards the centre of the coal-field, and their eastern portion being intersected by the Permian Limestone escarpment.

The Elland Flagrock is extensively quarried at Harehills, Roundhay, and Woodhouse, near Leeds; Idle, and numerous other places near Bradford; North and Southowram, and Elland Edge, near Halifax. It is a mass of sandstone, often nearly 200 feet in thickness, and frequently split up into two or three beds by shales. The lowest bed is usually most valuable; in some localities it is thickly bedded, and forms a good building-stone; in others it is micaceous and flaggy, splitting into layers from the eighth of an inch to six or eight inches thick. In the finer flagstones the planes of lamination are not perceptible in section, and the face of the divided flags is beautifully smooth and clean. The thinner flags are used for roofing slates. Fossil remains of stems of trees are tolerably common; amongst others Lepidodendron and its fruit, Lepidostrobus, Sigillaria, and Hallonia.

The Elland Flagrock is also quarried near Huddersfield, at Lindley, Farnley, and many other places.

Above the Elland Flagrock or Green Moor Rock of the Huddersfield district, there is another bed of flagstones about 60 feet thick, named the Grenoside Rock. The two are separated by a bed of shale with a coal seam, the whole being about 60 feet in thickness. This coal is the equivalent of the Better Bed Coal of Low Moor, and is locally known as the Tinker Coal. It attains a thickness of 18 inches, and is worked. The Grenoside Rock, also known as Farnley Tyas or Kirkburton Rock in those localities, is occasionally found separated into two parts by a bed of shale. It is a finely grained sandstone, yielding excellent flags, and is a beautiful building-stone.

South of the Huddersfield district, the Grenoside is a more marked bed than the Elland Flagstones. It has frequently a thin bed of coal immediately above it. It extends from Farnley Tyas and Kirkburton southwards by Sude Hill and Thurston, and around Penistone to the neighbourhood of Sheffield. Eastwards it forms a broad plateau of sloping rock, until it dips under the shales beneath the Penistone Flagstone escarpment.

The Elland Flagrock forms a well-defined and persistent boundary, dividing the Lower Coal Measures into two distinct parts,—the Lower extending downwards to the Rough Rock, and embracing the Halifax Hard and Soft Bed Coals; the upper part taking in the remainder of the Ganister series, extending from the Flagrock to the Silkstone or Blocking Coal, which forms the base of the Middle Coal Measures of the Barnsley district.

The measures between the Rough Rock and the Elland Flagstones vary much in thickness and composition. In the Penistone and Hazlehead district they are probably nearly 1,000 feet thick. In proceeding northwards to [redacted]

		ft.	in.
	Sandstone	25	0
	Shales	150	0
d.	GANISTER or HARD BED COAL	4	0
	Ganister Rock and Fire-clay	3	0
	Shales	55	0
c.	CLAY COAL	1	2
	Hard Sandstone	15	0
b.	COKING or SOFT BED COAL	1	6
	Flaggy Sandstone	50	0
	Measures		
	COAL	2	0
	Sandstone and measures	250	0
a.	THIN COAL and Fire-clay	4	0
	Rough Rock		

II. HALIFAX DISTRICT.

		ft.	in.
	Elland Flagstone *a.* Flags	45	0
	„ *b.* Shale	35	0
	„ *c.* Flags	120	0
	Shales	80	0
g.	EIGHTY YARDS BAND COAL	0	6
	Eighty Yards Band Rock	15	0
	Shales	80	0
f.	HARD BED BAND COAL (48 yards coal)	1	2
	Shales with Ironstone	35	0
e.	THIRTY-SIX YARDS BAND COAL	1	0
	Fire-clay	1	6
	Shale, with occasional Sandstones	100	0
d.	HARD BED COAL	2	2
	Fire-clay, or Ganister Rock	4	6
	Shale	25	0
c.	MIDDLE BAND COAL, or CLAY COAL	0	6
	Middle Band Rock	12	0
	Shale	50	0
b.	SOFT BED COAL	1	6
	Seat-earth	2	0
	Sandstone	20	0
	Shale	80	0
a.	THIN COAL	0	6
	Seat-earth	5	0
	Rough Rock		

III. Leeds District.

		ft.	in.
	Elland Flagstone	50	0
	Shale	50	0
	Sandstone	20	0
	Shale	90	0
	Galliard	14	6
f.	Coal (48 yards Band Coal?)	0	6
	Galliard and Sandstone	15	0
	Shale, etc.	120	0
d.	Hard Bed Coal	0	4
	Ganister or Seat-earth	6	0
	Shale	30	0
b.	Soft Bed Coal	0	3
	Galliard	3	0
	Shale	120	0
	Rough rock		

The coal and fire-clay above the Rough Rock may be seen in section in the railway cutting at Elland station, where the coal is six inches thick, and the seat-earth four feet six inches. At the distance of one or two miles to the eastwards, the coal increases to two feet four inches, and the fire-clay or seat-earth to six feet six inches, and grained, compact, white, siliceous sandstone; it was formerly used as road metal, but latterly has been pulverized and extensively used in iron and brass founding, and also for lining the puddling furnaces in the Sheffield district.

The Soft and Hard Bed Coals are generally worked from the Halifax district southwards. The former is usually of fair quality. It is soft and bituminous, and has a general resemblance in character to the coals higher in the series. The Hard Bed Coal is more peculiar; it has beneath it a foot of hard Ganister rock, and three to six feet of seat-earth. It is an impure coal, containing iron in the form of pyrites, and not unfrequently nodules of the same substance. Rounded concretions containing carbonate of lime are also found in the coal. Both contain vegetable remains in a very beautiful state of preservation; the most minute details of structure are exhibited with wonderful clearness and accuracy in sections of the coal balls, as they are termed, cut for the microscope; and to the study of these fossils, along with those obtained from similar beds of coal on the same horizon in Lancashire, by Prof. Williamson and others, we owe the greater part of our knowledge of the internal structure of the plants of the coal measures.

Immediately above the Hard Bed Coal is a stratum of laminated shale, which is in some localities almost entirely composed of the fossil shells of marine genera, including a large proportion of Aviculopecten. The bed is about four inches thick, and above it is a bed of shale four to six feet thick, containing a considerable number of nodular concretions, composed of carbonate of lime, with an outer covering of iron pyrites. These, when broken, are found to contain great numbers of remains of mollusca, of the marine genera Goniatites, Nautilus, Bellerophon, Ortho-

	ft.	in.
Light-blue Shale, with a bed of Calliard	40	0
COAL	0	5
Seat-earth, or Spavin Stone	7	0
Arenaceous Shale and Rag	40	0
Black Shale	50	0
Shale, with Ironstone	12	0
Black Shale	2	0
d. BEESTON COAL, with partings	8	0
Seat-earth and Stone	10	0
Shale and Raggy Stone	20	0
COAL	0	8
Seat-earth	6	0
Shale, with thin Ironstone	12	0
Oakenshaw Rock	13	0
Shale, with two thin COALS	110	0
c. CROW COAL	2	8
Seat-earth	8	0
White Sandstone	10	0
Black Shale and Ironstone	7	0
b. BLACK BED COAL	2	0
Seat-earth	4	0
Grey Stone and Blue Shale, variable	65	0
THIN COAL and Spavin	5	0
Shale, or Brown Sandstone	30	0

[redacted]

may be traced southwards as far as Sheffield. Northwards, near Denby and Cumberworth, they thin out, the upper bed being in many instances the only one traceable, and at Kirkburton they have altogether disappeared, being replaced by beds of shale, in which occurs the valuable band of ironstone worked at Lowmoor, Bowling, and other places. Around Skelmanthorp the Flagstones are represented by a mass of flaggy sandstone and sandy shales; at the base of the latter is a bed of coal, probably the equivalent of the Lower Penistone.

The Oakenshaw Rock sets in north of the River Calder at Clifton, and extends in a semicircular form, much broken by faults, and divided by valleys, under Wyke, Oakenshaw, Wibsey, Great Horton, and Bradford. It is usually from 70 to 80 feet in thickness at the places named, but in its course eastwards towards Leeds it rapidly thins out, becomes much divided by shales, and a little south-east of that town gradually disappears. Near Wibsey the stone is ground to a powder, and used as moulding sand.

The principal coals are the Whinmoor and the Black Band Coals in the western part of the district, and the Beeston Bed and the Black and Better Bed Coals in the eastern. The Whinmoor Coal occurs in isolated patches on the hill-tops near Penistone and Denby Dale, the lower part of the hill-side being formed by the Penistone Flagstone. The Whinmoor Coal, along with the Thin Coal, is wrought at Hoyland Heights, Pool Hill, West Clayton, to Denby Dale, about Cumberworth, and high up the hills at Shelley and east of Kirkburton. The isolated distribution of this coal is due to the multiplicity of faults occurring in this part of the district.

Near Liversidge, Mirfield, Clifton, and the district south of Bradford, are the Shertcliffe Stone and Low Lowsey

Coals, which are in all probability the equivalents of the Thin, Whinmoor, and Black Band Coals of the district previously mentioned. Still further north-east the Churwell Thin and Thick Beds make their appearance on the same horizon, and are extensively worked. A few miles further these beds appear to have converged and formed the Beeston Coal. This is a most important seam, varying in thickness from four feet two inches to 10 feet 11 inches. Where the coal is thin it is usually good throughout; but where very thick, it is frequently divided by partings of shale and dirt, as in the following section:—

	ft.	in.
Tops, Good Coal	2	6
Parting	0	2
Middle Coal	1	4
Baring Coal and Dirt	0	7
Slotting Coal, good	0	4½
Coal and Dirt	0	2
White Bed Coal	1	3
Dirt	0	2
Good Coal	0	3
Dirt and Coal	0	9

[redacted]

The Better Bed Coal is from one foot to two feet six inches thick. It has been found as far south as Fenay Bridge, where it is one foot six inches; beyond this point it thins out and disappears, being represented by a bed of fire-clay. It is extensively worked in the Lowmoor district, for the purpose of smelting the iron ore found in the shale above the Black Bed Coal. Its freedom from sulphur and other impurities renders it peculiarly valuable for smelting purposes, and it is partially to this coal that the excellence of the Lowmoor Iron is attributed.

Immediately above the Better Bed Coal is a thin stratum of shale, which covers the surface of the coal over an area several miles in extent. It is a quarter to five-eighths of an inch thick, a brownish-black colour, and full of the fossil remains of fishes and labyrinthodonts. The fossils are usually much broken, but occasionally fine specimens are obtained. The following species have been identified :—

Gyracanthus formosus, *Ag.*
G. tuberculatus, *Ag.*
Ctenacanthus hybodoides, *Eg.*
Ctenacanthus, *sp ?*
C., *sp. nov.*
Lepracanthus Colei, *Eg.*
Acanthodes Wardi, *Eg.*
Pleuracanthus lævissimus, *Ag.*
Orthacanthus cylindricus, *Ag.*
Diplodus gibbosus, *Ag.*
Hoplonchus, *sp ? Davis.*
Spine. Gen. nor.
Pleurodus Rankinii, *Ag.*
P. affinis, *Ag.*
Helodus simplex, *Ag.*
Helodus, *sp ?*
Petalodus Hastingsiæ, *Ow.*
Ctenoptychius apicalis, *Ag.*
Cladodus mirabilis, *Ag.*
Pœcilodus, *sp ?*
Harpacodus, *sp ?*
Megalichthys Hibbertii, *Ag.*
Holoptychius Sauroides, *Ag.*
Strepsodus Sauroides, *Hux.*
Acrolepis, *sp ?*
Platysomus, *sp ?*
Acanthodopsis Egertoni, *H. & A.*
Amphicentrum, *sp ?*
Rhizodopsis, *sp ?*
Cycloptychius, *sp ?*
Gyrolepis Rankinii, *Ag.*
Palæoniscus, *sp ?*
Cælacanthus lepturus, *Ag.*
Ctenodus ellipticus, *H. & A.*
C. tuberculatus, *H. & A.*

The remains of Labyrinthodonts, consisting principally of vetebræ and other bones, have been recognized as those of Loxomma. They are rarely found. Above this Bone-bed is a thick mass of bluish shale, which contains only the remains of plants.

The Black Bed Coal occurs near Kirkburton and Fenay Bridge, below the Grenoside Rock. At the latter place it is eighteen inches thick. It is called the Tinker Coal. Southwards the coal gradually thins out and disappears; but in the Lowmoor district it attains a thickness of between two and three feet. There is also a bed of ironstone, only separated from the Black Bed Coal by a few inches of shale, and both are worked together. It is from this bed that the Lowmoor, Bowling, and Farnley Iron Companies obtain their supplies.

The beds of the Lower Coal Measures, above the slope formed by the Elland Flagrock, do not present the bold outline formed by the strata below. Above the Greenmoor Rock, in the S.W. part of the district, the Grenoside Rock forms an escarpment rising nearly to [redacted] the N.E., and having a tolerably uniform slope in the opposite direction. The lines of the outcrops are broken through by many streams and valleys, and the result is a generally undulating country with a gentle inclination in the direction of the dip of the strata.

SECTIONS FROM THE WARREN HOUSE OR BARNSLEY COAL TO THE SILKSTONE OR BLOCKING COAL.

I. N.W. OF SHEFFIELD.

		ft.	in.
k.	BARNSLEY COAL	9	0
	Measures	230	0
i.	SWALLOW WOOD COAL (=Haigh Moor)	4	6
	Seat-earth, COAL, and Light Sandstone	60	0
	COAL	1	6
	Shales, with Ironstone	70	0
	BRANCH COAL	0	10
	Seat-earth	6	0
	COAL	0	6
	Shales, with Beds of Ironstone	44	0
	COAL	1	6
	Sandy Shale	50	0
	Black Shale	12	0
h.	JOAN COAL	1	6
	Shale, Sandstone, and Ironstone	50	0
	COAL and dirt	1	3
	Stone and Shale, containing Tankersley Mine Ironstone	40	0
g.	FLOCKTON OF HEWARD COAL	2	1
	Seat-earth	5	0
	Shale, light-coloured Stone, with COAL	40	0
	COAL, and partings	2	0
	Shale, with 3 COALS	50	0
	FENTON THIN COAL	2	1
	Shale	30	0
	Parkgate Rock	80	0
e.	PARKGATE COAL	8	0
	Seat-earth	6	0
	Shale and Stone, with a Bed of COAL	70	0

		ft.	in.
d.	WALKER'S THIN COAL (Swilley)	2	0
	Shale, etc.	55	0
	COAL, smutty	1	6
	Black Shales	45	0
	Sheffield or Silkstone Rock	65	0
	Black Shale, with Claywood Ironstone	30	0
	Shale and Stone	35	0
e.	SILKSTONE COAL	6	0

II. FLOCKTON DISTRICT.

		ft.	in.
k.	BARNSLEY COAL		
	Measures	80	0
	Blue Shales	100	0
	Blue Shales, with Ironstone	15	0
i.	NETHERTON THICK COAL	4	3
i.	Seat-earth or Spavin	2	6
i.	Sandstone and Shale	35	0
i.	NETHERTON THIN COAL	1	8
	Seat-earth	6	0
	Shales, with Beds of Sandstone	60	0
h.	JOAN COAL	1	6
	Seat-earth	6	6

[redacted]

		ft.	in.
	Seat-earth	1	0
	COAL	0	6
	Seat-earth and Stone	1	6
	Shale	47	0
b.	WHEATLEY LIME COAL	2	7
	Seat-earth	18	0
	Black Shale and Spavin	15	0
	Sandy Shale and Stone	30	0
	Sandstone	25	0
	Shale, with THIN COAL	20	0
	Sandstone	15	0
a.	BLOCKING COAL	1	5

III. METHLEY AND ROTHWELL HAIGH.

k.	WARREN HOUSE COAL	5	6
	Seat-earth	15	0
	Arenacous Shale passing into Sandstone, Ironstone near top	105	0
	Black Shale	25	0
	COAL	0	9
	Stone	7	0
	Blue Shale, with THIN COAL	45	0
	COAL, with dirt parting	2	0
	Sandy Shale, and THIN COAL . . .	20	0
i.	HAIGH MOOR COAL	3	4
	Thornhill Rock / Shales and Sandstones, etc. . . .	300	0
g.	ROTHWELL HAIGH CROW COAL . . .	2	7
	Seat-earth	5	0
	Shale Rock, Shale, with THIN COAL .	40	0
f.	MIDDLETON HAIGH MAIN COAL . .	1	9
	Seat-earth, Stone, and Shale (Birstal) .	45	0
e.	BROWN METAL COALS. { COALS Calliard and Shales } .	80	0
	Sandy Shale, with Ironstone in lower part	35	0
d.	MIDDLETON LITTLE COAL . . .	3	0
	Seat-earth	9	0
	Grey Shale	20	0

		ft.	n.
	GRUBBY COAL	1	3
	Grey Shale and Sandstone . . .	60	0
c.	MIDDLETON MAIN COAL, with partings .	8	6
	THIN COALS and Seat-earth . . .	12	0
	Shales	22	0
b.	MIDDLETON 11 YARDS COAL . . .	2	9
	Shale and Stone with THIN COAL . .	62	0
a.	BLOCKING COAL	3	0

Middle Coal Measures.

This series embraces all the coal seams and measures in the West Riding of Yorkshire, from the horizon of the Silkstone Coal upwards. It is wanting in the thick beds of sandstone which characterize the Lower Coal Measures and the Millstone Grits, but the more rapid alternations of sandstone and shale, of which the Middle Coal Measures are principally composed, give a much greater variety and picturesqueness to the scenery and a richness to the soil, which compensate for the wild magnificence and solitude of the grit-scarped moorlands.

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Like all the sandstones of the Middle Coal series, the Sheffield Rock repeatedly thins out, and is replaced by shale.

There is a sandstone, above the Park Gate Coal, which forms an escarpment from Kimberworth through Grimesthorp to Pitmoor. Northwards from Pitmoor it gradually thins out, and is replaced by shale. The rock reappears occasionally, but never attains the thickness it exhibits in the former localities, where it is nearly 150 feet. It was named by William Smith the "Bradgate Rock." A sandstone occurs near Emley, above the Flockton Thin Coal, which may be its equivalent; and still further north, above the Old Hards Coal, is the Birstall Rock. It is 100 feet thick, and extensively quarried near the town from which it derives its name. The sandstone is massive and thick-bedded, white in colour and closely grained. It yields a good building-stone, and is sawn into flags. An important Grit Rock between the Joan, Parsons, or Rothwell Haigh Crow Coal and the Haigh Moor Coals, forms the escarpment of Thornhill Edge and Dewsbury Bank. This rock forms the summit of the hills under which Morley Tunnel passes. It extends southwards by Batley Carr, Hanging Heaton, and Earls Heaton, thence by Dewsbury and Thornhill to Mirfield. The elevated plateau formed by this rock is divided in several directions by the valleys of the Calder and its tributaries. A number of bold escarpments are thus formed, which give the coal measures of this district an abrupt and varied surface contour, almost equalling the Lower Coal Measures westward, and redeeming them from the characteristic barrenness found eastward.

Between Soothill Wood and Howley Park the Dewsbury Rock is thrown down to the south by a fault which brings in the Haigh Moor Coals in the neighbourhood of

Lower Soothill. Another fault extending from Hanging Heaton, above Batley Carr to Cooper Bridge Station, brings the Dewsbury Rock again to the surface. Throughout the district the sandstone is quarried for building and road stones. It is usually coarse and thick-bedded, often impregnated with iron, and assumes a brown colour. Near Morley it is also sawn into slabs and used for flags.

The most important coals are:—

1. Silkstone, Blocking, or Barcelona Coals.
2. Middleton Coals.
3. Parkgate Coal, or Brown Metal Series.
4. Flockton Coals.
5. Swallow Wood, Netherton, or Haigh Moor Coals.
6. Barnsley or Warren House Coal.

The Silkstone, Black Shale, or Sheffield Coal, is a bituminous or "soft" coal, of great purity, and yielding excellent house-coal. Between Sheffield and Silkstone it consists of two beds with a dirt parting. The workable thickness of the coal varies from four feet to five feet six inches. In the same district the dirt band attains in some

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to be present at Birstall, though it has not yet been worked. At Gomersal it becomes split up by shales, presenting the following section :—

	ft.	in.		ft.	in.
Top Coal	1	0	to	1	2
Shale	0	$1\frac{1}{2}$	"	0	2
Smithy Coal	0	6	"	0	0
Shale	0	0	"	0	$\frac{1}{2}$
Bottom Coal	0	5	"	0	8

At Long Moor, further northwards, it is much split up by dirt partings. Eastwards from Leeds, this bed is named the Barcelona Coal. It has not been worked, but extends with tolerable regularity over the district. It is from two feet to three feet six inches thick, with a parting of shale, as in the following section :—

	ft.	in.
Coal	0	$7\frac{1}{2}$
Shale	0	5
Coal	2	$3\frac{1}{2}$

Between the Silkstone Coal and the shale above there is at Middleton a thin band of shale which has yielded numerous specimens of fossil fish. Amongst others—

Megalichthys Hibbertii, *Ag.*
Cœlacanthus lepturus, *Ag.*
Holoptychius Sauroides, *Ag.*
Strepsodus Sauroides, *Hux.*
Diplodus gibbosus, *Ag.*
Pleurodus affinis, *Ag.*
Cladodus, *sp.*
Ctenoptychius apicalis, *Ag.*
Helodus, *sp ?*
Helodus simplex, *Ag.*
Gyracanthus formosus, *Ag.*
Ctenacanthus hybodoides, *Eg.*
Orthacanthus cylindricus, *Ag.*
Pleuracanthus lævissimus, *Ag.*

Vertebræ and teeth of Labyrinthodonts of the genus Locomma or Pteroplax have also been found.

The variation in thickness and quality of the Silkstone, or Blocking Coal, as traced above, is a common feature in the coals of the Middle Coal Measures, and often leads to great difficulty in correlating them in different districts.

Between the Silkstone and Park-gate Coals of the Silkstone and Sheffield district are three or four beds of coal and a stratum of ironstone. The latter, the Claywood or Black Shale Ironstone, contains numerous fossil plants and a small crustacean. The Silkstone or Four-feet coal is generally traceable; it is represented in the Flockton district by the Wheatley Line, Three-quarter, or 11-yard Middleton Coal. Its thickness is very changeable, reaching its maximum of four feet at Silkstone. The average about Barnsley is two feet six inches. Near Hartshead it has been worked, varying from one foot six inches to three feet, and on Emley Moor there is three feet of good coal.

The Middleton Main, Cromwell, New Hards, or Swilly Coal, is worked extensively in the neighbourhood of Leeds.

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thick. It assumes a more important aspect at Garforth, where it is eight to nine feet thick. It is an inferior steam coal, but is chiefly used to calcine limestone and burn bricks. The following is a section in this district :—

	ft.	in.
Coal	3	0
Clay	1	0
Coal	0	0½
Clay	0	4½
Shaley Coal	0	5
Parting	0	0½
Coal	0	4
Parting	0	2
Coal	0	3
Under Clay, with thin Coal Partings	1	3
Coal	1	4
Hard Coal	1	2
	9	4½

This seam is also known as Hard Band or Green Lane Coal, and between Barnsley and Sheffield as Walker's, or Thorncliffe Thin Coal. It is 18 to 30 inches thick in the latter district, and occasionally yields a house-coal. Above the coal is the White Mine Ironstone, which was formerly mined, but is not worked at present.

The Park-gate Coal, Old Hards, or Brown Metal series, is about 300 feet above the Silkstone Coal. It is an important seam, being composed of a number of beds, some bituminous or soft, others hard, or semi-anthracitic, parted by bands of dirt or shale. The number and thickness of the beds of coal vary much in different places. Near Sheffield the whole thickness is five or six feet, with four or five feet of workable coal. About Barnsley the seam is divided with considerable regularity into two beds, with 18 inches to nine feet of shale between, the coals being from four to six feet in thickness. North-westwards, to High

Hoyland, the coal becomes much split up, and is reduced to three feet. In the Flockton district is a single bed, the Old Hards, which produces good house-coal. In the Leeds district these coals again become split up into several beds, with dirt and shale partings, and assume a greater thickness; some have been worked under the name of the Firth House-coals. East of Leeds the Brown Metal series is about 40 feet above the Middleton Little or Hard Band Coal. It consists of two principal beds of coal; the upper one is four feet four inches thick, and the lower, called Second Brown Metal Coal, is two feet nine inches. Between the two are intermediate thin coals, shale, sandstone, and seat-earth. The coals of this series are worked beneath the Permian Limestone escarpment at several places near its border.

The Flockton or Heward Coals are the next of importance above the Park-gate Coal. In the Sheffield district the two seams are separated by 240 feet of strata. Near Dodsworth, the distance is suddenly reduced to 120 feet, and northwards, at Barnsley, this thickness of intermediate beds is not increased. Sections obtained in sinking mines

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use. Southwards, it thins out and disappears, but in the opposite direction, near Overton and Thornhill, the seam is 20 inches, and at Dewsbury is two feet three inches in thickness. At the latter place it is known as the Dewsbury Bank Coal, and is worked for house-coal, and also supplies a good coal for the manufacture of gas for illuminating purposes. Between Batley and Adwalton the same coal, called the Adwalton Black Bed, becomes thicker, but is not so good in quality, and has a parting of shale, as shown in the following section :—

	ft.	in.		ft.	in.
Coal	0	3	to	0	4
Parting	0	1	,,	0	8
Coal	2	0	,,	2	9

North of the village of Flockton, this seam is known as the Adwalton Stone Coal. At Middleton, the roof of the coal has yielded a considerable number of fish remains, amongst which the following have been identified, principally from the collection of T. W. Embleton, Esq., of Methley :—

Orthacanthus cylindricus, *Ag.*
Ctenacanthus hybodoides, *Eg.*
Pleuracanthus lævissimus, *Ag.*
Gyracanthus formosus, *Ag.*
Cladodus, *sp.* (tooth).
Diplodus gibbosus, *Ag.*
Megalichthys Hibbertii, *Ag.*
Strepsodus Sauroides, *Hux* (teeth).
Holoptychius Sauroides, *Ag.* (scales).
Helodus simplex, *Ag.* (teeth).
Acanthodes, *sp.* (nearly entire fish).

In the above list it is probable that the Cladodus are the teeth of Ctenacanthus hybodoides, and that Diplodus are teeth of Pleuracanthus. Besides the species enumerated are several specimens which have not hitherto been described.

The Flockton Thick Coal, in the Barnsley district, consists of two beds, the upper one averaging two feet, the lower fifteen inches, with a parting of shale varying up to four feet in thickness. The top bed yields excellent house-coal. Southwards from Barnsley, it is known as the Heward Coal; it is much thinner, and not worth working. Northwards, near Emley, it is of fair quality. At Flockton and Overton the coal becomes thicker, but is of inferior quality, and contains a parting of shale. The upper part of the coal at Briestwhistle is a Cannel Coal.

Twenty to forty feet above the Flockton Coal is an important bed of ironstone, known as the Tankersley or Mussel Bed Ironstone, in the Sheffield and Barnsley districts, and as the "Cockle-shell Bed" near Ardsley and Flockton. It contains a great number of fossil anthracosia.

The Joan Coal is a very constant bed over the whole

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as the Swallow Wood, and are probably its equivalent. By-and-by these run together, and form the Haigh Moor Coal, which is a most valuable seam, and is got extensively for engine-coal, and sometimes yields good house-coal. The following is a section of the bed at Soothill:—

	ft.	in.
Top Coal	0	9
Parting	0	1½
Coal	1	0
Parting	0	1½
Coal	1	0

Two hundred and thirty feet above the Swallow Wood Coal we arrive at the Barnsley or Nine Foot Coal, which is the greatest seam of the Middle Coal Measures. Near Sheffield it is about four feet six inches in thickness. Near Rotherham it increases to seven or eight feet, and in the Barnsley district to eight or ten feet, or even more. It contains, besides the soft coals used for household purposes, three or four feet of hard coal, very valuable for locomotive and steamer fires. Northwards it becomes split up by earthy partings. In the railway cutting near Crigglestone Station the annexed section is exposed:—

	ft.	in.
Coal	1	7
Grey Shale	0	7
Coal	0	2
Grey Shale	4	6
Ironstone Nodules	0	1
Dark Shale	1	0
Coal	0	1
Grey Clay	0	2
Black Shale and Coal	1	3
Coal	2	10

Near Haigh there are also many partings, and further north it becomes so much divided as to be unworkable.

In the Barnsley district it may be divided into three parts, the lowest and uppermost being soft or bituminous coal, and the middle a hard or semi-anthracitic coal. In the direction of Pontefract it is called the Warren House Coal, and is of poor quality, often worthless. About Horbury and Ossett it is a yard thick, and is known as the Gawthorpe Coal.

Middle Coal Measures—above the Barnsley Coal.

I. Shireoaks District.

	ft.	in.
Soil, etc.	8	0
Light-Red Sandstone and Marl . .	45	0
Magnesian Limestone	90	0
Hard Blue Shale, with thin bands of Limestone	50	0
Quicksand	8	0
Shale, with Ironstone	40	0
Coal.	2	0
Blue Shale	15	0
Red Rock, Rotherham	200	0

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		ft.	in.
	Sandstone	35	0
	COAL, Black Shale, etc.	50	0
	COAL	1	2
	Shale, Sandstone, and Fire-clay	70	0
f.	WATHWOOD COAL	4	4
	Seat-earth and Shale	55	0
e.	COAL (2′ or ½YD. COAL?)	3	2
	Seat-earth, Sandstone, and Shale	22	0
d.	Two COALS 1′ each, and Seat-earth	7	0
	Sandstone and Shale	32	0
c.	COAL	2	8
	Shale, with Ironstone Nodules, etc.	23	0
	Two COALS and thin Fire-clay	3	3
	Shale, with Ironstone	45	0
	COAL	2	1
	Sandstone and Shale, with Fe.	70	0
b.	HIGH HAZLE COAL	3	8
	Seat-earth, Sandstone, and Shale	30	0
	Shell-bed	1	6
	Shales, etc.	60	0
	COAL	1	4
	Shales, etc.	95	0
	Sandstone	35	0
	COAL 7″ and Shale	15	0
a.	BARNSLEY OR TOP HARD COAL	3	10
		1530	0

II. DENABY DISTRICT.

	ft.	in.
Earth and Clay	10	0
Warp	7	0
Shale, with THIN COAL at top	13	0
SHAFTON OR BILLINGSLEY COAL	3	0
Seat-earth and Shale	12	0
Blue and Grey Sandstone (Chevet Rock)	88	0
Blue Shale and Rag	30	0
COAL and Shale	1	4
Seat-earth	5	6
Blue and Black Shale	42	0
Seat-earth	3	0

		ft.	in.
	COAL	1	0
	Arenaceous Shale and Black Shale	27	6
	COAL	3	6
	Seat-earth, Blue Shale, and Grey Sandstone	185	0
	Oaks Rock	80	0
	Blue Shale, with THIN COAL	66	0
g.	SWINTON POTTERY COAL	2	6
	Seat-earth and Sandy Shale	48	0
	White Sandstone	20	0
	COAL	0	6
	Seat-earth, with Cauk at base	10	0
	Blue Bind	35	0
	NEWHILL COAL	1	7
	Seat-earth	2	0
	Shale and Sandstone, the equivalent of the Woolley Edge Rock further W.	67	0
	COAL 6′ and Seat-earth	5	0
	Sandy and Black Shale	20	0
f.	WATHWOOD COAL or OAKS COAL	3	6
	Seat-earth, Sandstone, and Shale	67	0
e.	TWO-FOOT or HALF-YARD COAL	4	4
	Seat-earth and Shale	30	0
d.	ABDY or WINTER COAL	3	7
	Dark Shale, with Ironstone	20	0

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III. Featherstone District.

		ft.	in.
	Soil, etc.	6	0
	Shale	40	0
	Blue Shale, with Ironstone	36	0
	Coal	3	6
	Seat-earth and Shale	25	0
	Two Coals, with dirt parting 1′ 3″	4	2
	Shale and Sandstone	28	0
	Shale, with Thin Coal and Seat-earth	105	0
	Coal	1	4
	Seat-earth and Shale	10	0
	Coal	1	10
	Seat-earth, with thin Ironstone	18	0
	Shale, with Thin Coal	35	0
	Coal and Dirt	1	1
	Seath-earth and Strong Shale, with a Thin Coal 4″	56	0
	Coal	1	7
	Seat-earth and Shale	15	0
	Coal	1	4
	Seat-earth and Shale	56	0
	St. John's Rock of Wakefield	125	0
	Shale	6	0
f.	Coal (Wathwood of Barnsley)	0	6
	Seat-earth, Shale, and Black do.	33	0
e.	Cat Coal = 2 ft. Coal	2	0
	Seat-earth and Shales	53	0
d.	Scale Coal	4	11
	Seat-earth and Coals 1′ 2″	8	6
	Sandy Shale	15	0
c.	Stanley Main Coal	5	0
	Seat-earth	4	0
	Coal	2	3
	Seat-earth and Sandstone	23	0
	Shale	12	0
	Coal	0	7
	Shale and Sandstone	70	0
	Coal	0	5
	Shale, with Beds of Seat-earth and Sandstone	120	0
a.	Warren House or Barnsley Coal	7	10

Above the Barnsley Coal is a thick bed of sandstone, which forms an escarpment, running through and adding considerably to the beauty of Wentworth Park. It may also be seen at Nether Haugh, and thence on to Rawmarsh, where it is most thickly developed, a section cut through it giving a thickness of 90 feet. This sandstone, like all those of the Middle Coal Measures, is speedily replaced by shales.

The Woolley Edge Rock ranges in a fine escarpment from New Miller Dam in a southerly direction along Woolley Edge, between Barnsley and Monk-Bretton, and Ardsley to Hemingfield. Here the picturesque cliff disappears, the sandstone becomes split up in several sections, and is only indicated by a few slight ridges, which eventually disappear, and the place of the rock is occupied by shales. The sandstone is a coarse thickly bedded grit, sometimes 100 to 120 feet thick. Near Wakefield is a white or grey friable sandstone, which is on the same horizon as the Woolley Edge Rock, above the equivalent of the Wathwood Coal. It is at the surface near St. John's, Wakefield, and dips rapidly to Featherstone [redacted] occur at Ardsley, and are continued to Cudworth Station. The Upper Chevet Rock is the most persistent. It may be traced from Upper Cudworth past Ardsley and Darfield to Bolton-upon-Dearne. The rock is there broken by faults, but reappears at Denaby, and thence its outcrop makes a bold ridge along the east side of the Don to Thryberg Park. It is seen still further south at Wickersley; beyond that place it does not occur.

North-eastwards from Darfield and Bolton-upon-Dearne are patches of sandstone, which may be recognised by their slightly higher elevation above the surrounding district. They appear to be much broken by faults, and the dips indicate that the sandstones occupy basin-shaped hollows in the shales below. From Clayton-in-the-Clay to Brierley Common, the high ground is capped by a mass of thickly bedded, softish, light brown or buff sandstone, named by Prof. A. H. Green the "Houghton Common Rock." Above this is a second sandstone, which may be seen northwards and westwards at Hemsworth, and Brierley, dipping under the measures beneath the Houghton Common Rock. This is called by the same authority the "Brierley Rock." It is similar in character to the Houghton Common Rock. On the N.W. the Brierley Rock abuts against a fault, and beyond this it is not known to occur again. Southwards and eastwards it probably thins out, and is replaced by shales. The Houghton Common Rock is approximately about 1,600 feet above the Barnsley Coal, and the Brierley Rock 400 feet higher.

Another group of sandstones similar to those described extend from the N.E. of Hemsworth Station to Ackworth Moor. They may be divided into two beds. The upper is seen in the railway cutting about a mile and a half from Hemsworth Station, and may be traced northwards through Taylor Wood. The Lower Sandstone, which is probably the equivalent of the Brierley Rock, is the one so extensively quarried on Ackworth Moor Top. It is a thick-bedded sandstone, and appears to be of better quality in this locality than elsewhere. On the opposite side of the valley containing the village of Ackworth is another patch of sandstone, extending to East Hardwick. This is the same as the Ackworth Moor Top Sandstone. Another valley, in which runs a small tributary of the River Went, again divides this rock from the high ground near Pontefract. At the latter place the sandstones are again separated by shales into two parts, each thick-bedded, soft, and a light-brown colour. The lower bed, the Ackworth or Brierley Rock, is not very conspicuous. The upper, which is probably the equivalent of the Houghton Common Rock, is largely quarried. It forms the bold cliff on which Pomfret Castle is built.

These beds of sandstone occupy a similar position, with respect to the Barnsley Coal, to that held by the Chevet Rocks. It appears probable, either that they are [redacted]

Sedgwick and others to be a member of the Permian formation, but this theory is dispelled by the occurrence of a bed of coal and other strata, decidedly Carboniferous, lying immediately above and conformably to the Red Rock. It appears probable that this rock was deposited in a long hollow, denuded from the Coal Measures during the Carboniferous period, and the coal strata were consecutively deposited above it.

The principal coals above the Barnsley or Warren House Coal are—in the southern part of the Riding—the High Hazles or Kents Thick Coal, which has no important equivalent further north; the Beamshaw Beds, not yet worked to any great extent, are called in the north, where they are largely gotten, the Stanley Main Coals. The Wathwood, Woodmoor, Melton Fields, Oaks, or Summer Coal, is an important seam southwards, and is wrought extensively, but northwards it thins out into unimportant seams. Above the Wathwood, the seams of coal are not important, and have not been worked. The uppermost bed in the section, the Shafton or Billingley Coal, has been worked at the places from which it derives its name, but not to any great extent.

The High Hazles Coal is 200 to 250 feet above the Barnsley Coal. Near Sheffield it is a good coal from three feet six inches to five feet thick. In the central part of the district, about Denaby Main, it is two to three feet thick, but near Barnsley it is worthless.

Kents Thin Coal is about two feet thick. It is of better quality and more constant occurrence than the High Hazles.

The Beamshaw Coals in the southern part of the coal-field are excessively variable, and have not been worked hitherto. Northwards, about Featherstone and Wakefield, they assume larger proportions, and are known as the

Stanley Main Coals. The section exposed in the pit at Featherstone is as follows :—

	ft.	in.
Coal	1	3
Dirt	0	2
Coal	1	4
Dirt	0	7
Coal	1	8
Spavin or Seat-earth	4	0
Coal	2	3

This coal is very variable. Near Whitwood the entire thickness, including partings, is reduced from eleven feet three inches to seven feet nine inches, and near Castleford the beds are only four feet thick. They give the following section at the Wheldale Colliery :—

	ft.	in.
Coal	1	0
Dirt	0	1
Coal	1	7
Dirt	0	6
Coal	0	10

Westwards from the Featherstone district the Stanley Main Coal assumes a more important aspect, and at St. [redacted]

Between the Beamshaw and Wathwood Coals are the Winter and Half-yard seams. The Winter, known in the north as the Scale Coal, is a more than usually constant bed. It averages three to four feet in thickness, and when the coals at present worked become exhausted, it may turn out a very valuable seam.

The Two-foot, Half-yard, or Cat Coal is usually present. It has not been worked, but varies very much in character and thickness.

The Wathwood, or Oaks Coal, has been and is extensively wrought. It is not always of the same quality, sometimes yielding a good house-coal, at others split up by dirt partings until nearly worthless. In the southern and central parts of the coal-field, when present, it is three feet to four feet six inches thick; but northwards it thins out, and in the Featherstone sections it is only six inches in thickness.

The coals above the Wathwood seam are generally thin, irregular, and of very poor quality. The most important one is the Shafton, Denaby, Billingley, or Nostel Top Coal. It is about 1,200 or 1,300 feet higher in the series than the Barnsley Coal, and is worked in several places. Its outcrop may be traced from Royston, where it is bounded by a fault ranging N.E. near Pontefract to Bolton-upon-Dearne. On the N.W., or up-east side of the fault, beyond Royston, coal pits are abundant; but southwards the district has been very little explored.

Ingleton Coal Field.

A small track of Coal Measures, widely separated from the nearest coal fields of Lancashire and Yorkshire, occurs in the neighbourhood of Ingleton and Burton. It is bounded on the south and south-west by the outcropping Millstone Grit Rocks, and dipping to the north-east at an angle of about 12°, abuts against the southern branch of the Great Craven Fault. The Coal Measures are partially overlaid in the northern part by Permian Strata, consisting of a calcareous conglomerate, or breccia, commonly known as 'brockram.' It is composed of fragments of limestone and chert, mostly of an angular form, but more rarely rounded by attrition. Above the brockram are irregular beds of red sandstone and red marl. The following is the section exposed in sinking to the coals near Ingleton, which was given by Mr. Hodgson to the late Prof. Phillips :—

	ft.	in.
Red Marl	18	0
Red Sandstone	30	0
Grey Rock	24	0
White post	4	0
Soapstone (Argillaceous)	6	0
COAL	1	0
Sill, White Rock, etc.	31	0
COAL	1	0
Sill, or Fire-clay	4	0
FOUR FEET COAL	4	0
Soapstone	4	0

[redacted]

		ft.	in.
	Black Shale Roof		
Four Feet Coal	Roof Coal	0	6
	Dirt parting	0	1½
	Top Coal (Cannel)	0	5½
	Middle Coal	2	10½
	Fire-clay, good	0	6½
	Fire-clay, poor	0	6
	Yard Coal . . . . . 1 11 to	4	0

The thickness of the clay parting between the Four Feet Coal and the Yard Coal is variable, and occasionally increases, so that the coals cannot be worked together.

The soapstone, or argillaceous shale, above the Deep Coal, contains layers of ironstone nodules; occasionally they are found in large blocks five or six feet in diameter, scattered irregularly through the bed. When broken, the nodules are found to contain the remains of plants, and occasionally of mollusca.

The coals, at their outcrop on the southern extremity of the coal-field, have been worked in small quantities for centuries where exposed; but towards its western extremity, being thickly covered by glacial drift, there is no evidence that the outcrop has been found.

Below the coal formation the Millstone Grit rocks of Bolland come to the surface, and near the base of these is a coal seam which has been worked near Bentham, Hornby, and other places; it varies from eighteen inches to three feet in thickness, and in relative position to the accompanying strata and general character offers close analogies to the bed of coal found on Penyghent. There appears every reason to believe that the beds of North Lancashire and Penyghent are the same; and presuming this to be the case, it proves the dislocation caused by the Craven Fault to have amounted to something near 3,000 feet in this locality.

The position of the Ingleton and Burton coal-field lying conformably on the Millstone Grit, is relatively the same as that of the lower beds of the Lancashire coal-field, and in all probability they were at one time continuous with the coal-field of which Burnley forms the centre. It is now well established that the Lancashire and Yorkshire Coal Fields were formed over one unbroken area, and that the separation occurred when the Pennine chain of hills was elevated to its present position. It does not require a great stretch of the imagination to conceive that the little coal-field of Ingleton may have been detached from the northern extremity of the Lancashire coal-field at the same period, by the elevation of the Fells of Bolland and Burnmoor.

CHAPTER V.

THE PERMIAN SYSTEM.

THE Permian formation stretches in a direction N.N.W. to S.S.E., in a long narrow strip, rarely more than four or five miles in breadth. This is continued northwards through the North Riding into Durham, where the formation is well developed in the neighbourhood of Ryhope, Thickley, Midderidge, and along the coast from Tynemouth to Hartlepool. Southwards the series extends into Nottinghamshire. Towards the northern part of the West Riding the limestone covers a very narrow tract of country. About Ripon and Knaresborough the upper part of the series is only found in small patches. The Lower Limestone is more abundant; near Burton Leonard and in other places it occupies considerable areas. Southward the whole series is better developed, and in the neighbourhoods of Garforth, Brotherton, Knottingley, Pontefract, and Wentbridge, west of Doncaster and Tickhill, the limestones are extensively quarried, both for building and agricultural purposes. The western boundary usually forms an escarpment, overlooking the low undulating lands of the Coal Measures in the southern part, and the bolder contour of the Millstone Grit series further north. The eastern face is not well defined; in many places it is covered by thick beds of drift, and its junction with the overlying Bunter Sandstone is rarely seen. The general dip of the strata is south-easterly, and many good sections showing their order of super-position may be seen in passing transversely across the line of outcrop.

The Permian beds of the West Riding may be divided into the following groups :—

Upper Marls and Sandstones, with Gypsum.
Upper Limestone or "Brotherton Beds."
Middle Marls and Sandstone, with Gypsum.
Small-grained Dolomite.
Lower Limestone.
Quicksands.
Lower Red Sandstone.

Lower Red Sandstone.

Beneath the Permian Limestone, along its western escarpment, are a number of beds of sandstone and shales which in many cases are coloured a deep red, by oxide of iron. They were classified by Professor Sedgwick and others as the New Red Sandstone; but more recent [redacted] tions in quarries exhibit the unconformability of the two series. At Ashfield Fire-clay Works, the variegated Lower Marl rests on the Coal Measures; the lower beds of the former contain numerous fragments derived from the Carboniferous Rocks, which prove their unconformability.

A good section has been exposed at Pontefract, in making a cutting for the new line of rails from Swinton to Knottingley, in which a thick-bedded sandstone is brought by a fault into apposition with shales, thin sandstones, and two or three thin beds of coal. Above these the Magnesian Limestone is superposed in horizontal layers, as in Fig. 26, Pl. IX.

In the beds of several small streams near Barwick-in-Elmete, the Magnesian Limestone may be seen in sections, resting on the shales and thin sandstone of the Coal Measures. The shales are sandy and micaceous, and at their junction with the limestone are a purplish colour. Lower down, however, they have the usual colour of a Coal Measure Sandstone. In the bed of the stream running half a mile east from the village the limestone is exposed, lying unconformably on a hard, close-grained sandstone, which undoubtedly belongs to the Coal Measures. The joints of this rock are filled in with crystals of carbonate of lime. At Garforth, and many other places, the coal is worked beneath the limestone escarpment. A few miles north of Barwick-in-Elmete an important east and west fault brings up the Rough Rock to a level with the Coal Measures. The fault ranges from Meanwood to Kidhall Hall. The Rough Rock, a coarse yellow grit, may be traced along the line of this fault to the latter place, where it dips under the Magnesian Limestone, but is again exposed in Bramham Park, by the denudation of the limestone.

Further north the several beds of the Millstone Grit series pass successively under the limestone, and several sections may be seen north of Thorner. At Etchell Crags the grit rocks form a bold cliff; they are thick-bedded, of a yellow colour, and are considerably rounded and smoothed by weathering. Above the crags, and resting immediately but unconformably upon them, the Magnesian Limestone rises with a gentle undulation, and is worked in quarries a short distance to the right.

At Bardsey, Rigton, and East Keswick, and in the cuttings for the railway from Leeds to Wetherby, the limestone may be seen overlying the Millstone Grits of the third series. The latter are usually the normal grey or yellowish colour characterizing those rocks elsewhere, and do not appear to have been subject to the same chemical action as in some of the districts adjoining, where sandstones a little higher in the series are found, under apparently similar conditions, of a deep red colour. Here they are usually rough and quartzose, often changing to a conglomerate in a very short distance. The actual

[redacted]

actual contact. In St. Helen's quarry, on the left of the road, eight feet of soft thin-bedded yellow limestone rests on 12 to 15 feet of red quartzose sandstone, and between the two, in a trough of the grit, is five feet of shaley marl. A slight thickness in the upper part is a greenish-yellow colour, the remainder being of a deep purplish red. The lower part of the limestone, where in contact with the sandstone, contains numerous grains and small pebbles of quartz, derived from the attrition of the latter. The illustration (Fig. 29, Pl. X.) will show the arrangement of the beds.

A short distance from St. Helens, on the right of the road at Newsome Bridge, is a second quarry; in this one, 30 feet of thick-bedded limestone is seen above a greyish-white grit, about 20 feet being exposed. The lower part of the limestone, near its junction with the grit, is full of rounded pebbles of the latter, and also contains quantities of grains of quartz, evidently the result of the action of the waves during or preceding the deposition of the limestone.

At Plumpton and Knaresborough the grit rocks are of a deep red colour. At the latter place the sequence of the two formations is well shown on the banks of the Nidd, below the castle. The river at this point has carved a passage through the Permian escarpment to a depth of a hundred feet or more, and a very good section is exposed, showing the limestone superimposed on the grit (Fig. 29, Pl. X.). In one instance the limestone encircles a huge mound of the grit, which juts up above the surrounding level, proving, beyond a doubt, the unconformability of the two formations.

From a consideration of the foregoing sections, it becomes apparent that, except in local cases, the sandstones and shales below the Permian Limestone have the common characteristics of the carboniferous formation, and generally the colour is the same that the various members of the series have under ordinary circumstances. The great mass of the Red Grits, near Plumpton and Knaresborough, consists of the uppermost bed of the Third Grit series, and it is worthy of note that this bed, in various parts of the Riding, exhibits a peculiar tendency towards a red colour. Examples may be seen at Warley, near Halifax, and on the moors near Holmfirth, where it is scarcely probably that the Permian Limestone was ever present. Still, in these positions, the grit is continuously of a decidedly red colour. The upper beds of the Millstone Grit series, the Rough Rock, and the sandstones of the Coal Measures are much more frequently found of the usual grey colour than coloured red. Even where the sandstones or shales have the red tint, if they can be traced below the surface, the colour is found to gradually disappear, and give place to the normal colour of the rock. The appearances suggest that the limestones and marls of the Permian age were deposited in a sea, the shores of which were formed by the rocks of the Coal Measures, [redacted]

The Quicksands.

Occasionally between the limestone and the Carboniferous Rocks beds of quicksand occur.

At West Garforth, beneath the thin-bedded limestone, the section (Fig. 30, Pl. XI.) is exposed in a quarry.

The sand in the upper part is very fine, and is gotten for moulding purposes in iron-working. The lower part, about four to five feet in thickness, is much coarser, and contains thin beds of nearly pure quartz-grains, and near the base rounded pebbles the size of a pea are common. They are apparently washed from the bed below. The quicksand thins out rapidly to the south and S.W., and at 100 yards' distance the bed has dwindled to three feet in thickness.

At Glass Houghton, between Pontefract and Castleford, the quicksand occurs, and is extensively wrought, exposing similar sections to those at Garforth.

At Scriven, near Knaresborough, in the N.W. extremity of a small outlier of Magnesian Limestone, a small quarry exposes the quicksand under the limestone, as in the section (Fig. 31, Pl. XI.). In this small section the yellow limestone, No. 3, contains numerous pebbles of a harder rock. The white sand, No. 5, with hard ridges inclined to the plan of deposition, is coarser, and more quartzose than the lowest beds, the latter being composed of a very fine white sand. The bottom of the sand is not reached; but a little to the south, a coarse red sandstone, of the Millstone Grit Series, is quarried. The rock dips to the N.W., in the direction of the section given above, which leads to the inference that the quicksands cannot be much thicker than exposed in the small quarry.

In the extreme southern part of the Riding the colliery at Shireoaks penetrates the Magnesian Limestone before reaching the coal, and the following section is exposed:—

	ft.	in.
Soil, etc., surface	5	0
Light Red Sandstone and Marl . .	45	0
Magnesian Limestone, Lower . .	90	0
Blue Marl, with thin bands of Limestone	20	0
Blue Shale or Marl	32	0
Grey Quicksand	7	0
Coal Measures above the Red Rock of Rotherham		

The Lower Limestone.

At West Garforth, above the quicksands already described, is a considerable thickness of Lower Limestone exposed in large quarries, near the roadside. It is about 25 feet thick, the bottom not being reached; the lower beds exhibit false bedding. The series consist of a number of thin beds, with marly partings. The interior of the limestone when broken is hard and compact, breaking with a concloidal fracture; it is of a blue-grey colour. The thickness of the beds usually averages about

[redacted]

The sand is hardened in some of the lines of bedding, and stands out in ridges, and occasionally the whole is cemented to a sandstone.

The bed of green clay, *e*, is very stiff and extremely fine; it very much resembles a tenacious glacial clay. It varies in thickness, but does not exceed six inches.

These rocks may be traced in the railway cutting, gradually sinking to the S.E., and at Newthorpe a superincumbent bed of limestone is worked. In the quarries, 75 feet are exposed; it is a soft, yellowish-white, thick-bedded limestone, jointed in all directions, and stained yellow by iron. In the upper part, the limestone is much fractured. The Lower Limestone varies considerably in its character, from a flaggy limestone, with thin beds of coloured marls, to thick, irregular beds of yellow limestone, which are soft, and decompose readily at the surface; occasionally it is found hard and crystalline. In the vicinity of the Don, the upper portion is a soft oolitic limestone, thick-bedded and yellowish; intermixed with it are irregularly rounded nodular concretions, sometimes reaching an inch, or more, in diameter; beneath these are thick beds, chiefly composed of comminuted Polyzoa; lower still, and immediately above the sandstone, are thinner, darker-coloured, and more compact beds, which contain many imperfectly preserved species of fossils. Mr. J. W. Kirkby, in the 17th volume of the Journal of the Geological Society, enumerates and describes thirty-one species of fossils from the Lower Limestone beds, principally from the quarries at Hampole, Brodsworth, Moorhouse, Hickleton, and others. The following is a list of them, with localities:—

Nautilus Freieslebeni, *Gein.*	Brodsworth, Aldfield.
Turbo helicinus, *Sch.*	Pontefract, Hampole, etc., common.

Rissoa Leighi, *Brown* . .	Hampole.
Turritella Altenburgensis, *Gein.*	Hampole, Moorhouse.
Chemnitzia Roessleri, *Gein.*	Hampole Stubbs.
Straparollus Permianus, *King*	Hampole.
Natica minima? *Brown.* .	Hampole.
Chiton Loftusianus, *King* .	Brodsworth, Moorhouse.
Dentalium Sorbyi, *King* .	Hampole Stubbs, Conisborough.
Monotis speluncaria, *Sch.* .	
Gervillia antiqua, *Münst.* .	Bunhill, Wentbridge, etc.
,, Keratophaga, *Sch.*	Brodsworth, Pickburn.
Myalina Hausmanni, *Goldf.*	All the localities already given.
Myoconcha costata, *Brown.*	Brodsworth, Barnborough Cliff.
Macrodon striatus, *Sch.* .	Moorhouse, Holywell [Hill.
Leda speluncaria, *Gein.* .	Moorhouse.
Axinus dubius, *Sch.* var. obscurus, *Sow* . . .	At all the above situations, at Garforth, etc.
Axinus dubius, *Sch.* var. nov.	Conisborough, Hampole Stubbs, Brodsworth.
Cardiomorpha Pallasi, *De Vern*	
Terebratula elongata, *Sch.* .	Most of the above localities, Fairburn, Ferry-

[redacted]

At Fairburn, a boring exposed the following section in the Lower Limestone. The occurrence of a bed of Calliard, with limestone above and below it, is peculiar.

	ft.	in.
Earth and Sand	17	0
Cemented Sandstone	1	0
Lower Magnesian Limestone . .	35	0
Calliard.	2	0
Lower Magnesian Limestone . .	85	0

The limestone lies unconformably on the Coal Measures about 70 feet above the Stanley Scale Coal.

The Small-grained Dolomite.

The Small-grained Dolomite is a crystalline, sub-crystalline, or compact limestone, of a slightly yellow, cream-coloured, whitish or silver-grey tint. Amongst the upper beds, intercalations of clay or marl occur, a few inches thick, as at Cliff Quarry, Brodsworth. The stratification is very irregular; the beds thin out from two or three feet thick, in a very short distance, and disappear, their place being taken by other beds, in their turn equally fugitive They present the appearance of false-bedding in sandstones, a feature not very common in limestones.

The surface of the planes of stratification are pitted or covered with little hollows, a quarter of an inch or less in diameter, and about the same in depth. The lower part of the beds contain indistinct traces of organic remains; they are, however, very poor, and no species have been identified; otherwise they are devoid of fossils. The greatest thickness of the Dolomite is about 200 feet; in many places it is much less. It is very extensively quarried, and forms a fine building stone. It can be got in large blocks, and has a close texture suitable for carving; if well chosen, it does not deteriorate by weathering. This limestone has furnished the material for the construction of many of the noblest edifices of this country, as, for example, York Minster, and the Cathedrals of Beverley and Ripon. More recently, large quantities have been used in the erection of the Houses of Parliament.

The Middle Marl and Sandstone with Gypsum.

The Middle Marls and Sandstone with Gypsum consist of red and variously coloured marls, with occasional beds of soft sandstone, and bands of gypsum. The gypsum was formerly worked to make Plaster of Paris, but is now discontinued. It varies much in thickness; it was probably deposited very irregularly, and in some places is absent; it appears to be nowhere more than 50 feet thick. The marls are rarely exposed to view, but their presence is generally indicated, when not too thickly covered with drift, by the red and wet soil, and the springs thrown out near their upper surface. Sections may be occasionally seen in the old plaster pits. The gypsum is exposed in a working above the Lime-

[redacted]

The beds are well exposed at Knottingley, Womersley, Hexthorpe, Wadworth, and many other places. It is largely quarried for lime-burning and repairing the roads. Two species of Molluscs, Myalina Hausmanni (*Goldf.*), and Axinus dubius (*Sch.*), and a species of Algæ have been found. The latter frequently covers the surfaces of the slabs with filiform, brownish, or reddish remains. They are associated with Axinus. At Knottingley the fragments have a linear arrangement, with their longer axis in one direction, as if by the influence of a current. The imperfect state of the specimens, together with the manner in which they are spread over the surface, would seem to indicate a period when they were more or less subjected to the drifting action of water.

At Conisborough, the Lower Red Marls may be seen resting on the coal shales, at a pit or quarry, worked for the manufacture of tiles and fire-bricks. About 30 feet of variegated red and blue marls are exposed resting on five feet of stone, which is reddish in colour and firm in texture; below this a great thickness of yellow and blue shale, clay, and stone have been sunk through, which constitute the upper beds of the Coal Measures. The variegated marls appear to lie unconformably on the bed of sandstone, for though lines of stratification are discernible, they are not decided, and have a wavy character, very different from the distinct lines of the Carboniferous strata below. The marls also contain a considerable number of angular fragments of sandstone, broken from the rocks below, and enclosed in the marly matrix. A similar bed of marl may be seen forming the hill on which Conisborough Castle is built. A section is exposed on the east slope, where the marl has been got for making bricks. A couple of miles to the S.W. the marl is much more extensive; at Hooton Roberts it overlies the Coal Measures, and is surmounted towards Conisborough by the Lower Limestone. Proceeding by Holywell Hill, a fault brings the Coal Measures up to the limestone, and in a small quarry, about a mile from the town, the Lower Limestone may be seen, resting conformably on the red marl.

On the S.E. bank of the River Don, the Lower Limestone forms a bold and picturesque escarpment. Along the face of this, the limestone has been very extensively quarried. The largest quarries are at Warmsworth, at the entrance of the railway cutting, on the line between Conisborough and Doncaster. In this cutting a magnificent section is exposed of the Small-grained Dolomite and the Brotherton Limestone, with the intermediate marls. The quarries expose a clear face of the Small-grained Dolomite more than 100 feet in thickness. The upper part, to a depth of 50 feet, is more massive in structure than the lower, which exhibits a much more decided and very peculiar stratification. The beds, instead of being flat, dove-tail into each other at all

[redacted]

the latter continuing to the eastern end of the cutting. The Brotherton Limestone is worked in large quarries adjoining the line, for repairing the roads. It is thin-bedded, yellowish-white, slaty limestone, with thin partings of bluish shale. It contains numerous remains of the Polyzoon, Acanthocladia anceps, and casts of small molluscs, Myalina Hausmanni and Axinus dubius.

CHAPTER VI.

TRIASSIC SYSTEM.

THE Trias or New Red Sandstone is not fully represented in Yorkshire; it was named Trias by the German authors, on account of its separation into three very distinct formations, namely—

Keuper.
Muschelkalk.
Bunter Sandsteins.

In the British series, the Muschelkalk, a limestone abounding in fossil shells, is entirely absent.

The Keuper is in many places in the south of England separated from the overlying Lias by a brecciated Bone-bed, which contains a great number of remains of [redacted] feet, the upper part of which was in grey shale and freestone. It is probable that these beds represent the lower part of the Keuper series.

The Bunter Sandstone occupies a large area, extending from the slopes of the Magnesian Limestones on the west, and forming the low flat lands of the Vale of York, and reaching far beyond the River Ouse, which is the eastern boundary of the Riding. Ripon in the north, and Doncaster in the south, are built on the Bunter Sandstone. It is soft and thick-bedded, with occasional thin marly partings, and is a deep brick-red colour. Nearly the whole area is so thickly covered with superficial deposits of drift, that it is not often seen in natural sections; the little that is known of its component parts being, as in the case of the Keuper, derived from sections made through it in boring to find coal, or in sinking wells.

In 1835, a boring was made in an unsuccessful search for coal at Reedness, near Goole. A depth of 1,029 feet was reached when the attempt was abandoned. The following series of strata were passed through :—

	ft.	in.
1. Warps, Clays, and Sand	30	3
2. Black Moor Earth, with Rotten Wood .	11	9
3. Black Gravel and Quicksands . .	14	3
4. Alternations of Blue, White, and Red Marls and Sandstones, with several beds of Gypsum	285	9
5. Thick-bedded Red Sandstone . . .	169	6
6. Red Sandstone, with Beds of Marl . .	21	6
7. Thick-bedded Red Sandstone . .	233	6
8. Alternations of Red Sandstone and Marl .	262	6

The first three of the series are of recent origin; number four consists principally of stiff blue and red marls, with thin partings, which are white in colour, and of a more sandy nature; interspersed through the whole of the group are numerous beds of gypsum (from the composition and character of these beds it appears probable that they belong to the Upper or Keuper series). Nos. 5 to 8 are undoubtedly Bunter Sandstone of considerable thickness; they contain, in groups 6 and 8, several beds of red bind or marl, generally one foot to two feet thick. The boring was stopped in a bed of sandstone, which was pierced to the depth of seventy-two feet without reaching the bottom.

The Selby Waterworks exhibited the following section in boring for water in 1853 :—

	ft.	in.
Alluvial Soil and Sand	5	0
Clay	24	0
Sand, with Water	1	0
Clay	24	0
Quicksand	21	0
Red Sandstone increasing in hardness with depth	211	6
Very Hard Rock	10	6
Red Sandstone	6	3
Very Hard Rock	27	9

[redacted]

The Grey Sandstone in this section evidently bears a close relation to the thick bed of sandstone in the Selby section already given, and this is further confirmed by the fact that when the Selby well was made, which is five miles south, a large portion of the water was drawn from the one at Cawood.

The Local Board of Health at Goole have been sinking during the present year in search for water near Goole, and at Snaith. At the latter place, a depth of more than 500 feet has been pierced, and at the former, 360 feet. The appended sections exhibit the strata passed through. First near Snaith :—

	ft.	in.
1. Brown Warp	6	0
2. Grey Loamy Warp	2	0
3. Peat, containing Hazel Nuts	1	0
4. Whitish Sandy Loam	4	0
5. Brown Warpy Clay	20	6
6. Brown Sandy Warp	7	0
7. Brown Alluvial Earth, with Pebbles	5	6
8. Gravel containing worn Pebbles of Chert and Sandstone, and flat angular fragments of Magnesian Limestone	5	0
9. Coarse Reddish-brown Sand	5	0
10. Light Green Marl	1	0
11. Red Marly Sandstone	23	0
12. Coarse Red Sandstone	7	0
13. Red Marly Sandstone	43	0
14. Red Sand and Blue Marl	3	0
15. Red Marly Sand	37	0
16. Blue Marl	3	0
17. Red Marl	2	0
18. Red Marly Sand	88	0
19. Variegated Marl	2	0
20. Red Marly Sand	44	0
21. Coarse Red Sand	20	0
22. Red Marly Sand	48	0
23. Variegated Marl	2	0
24. Red Marly Sand	24	0

		ft.	in.
25.	Variegated Marl	1	0
26.	A similar continuation of the series for a further depth of 112 feet, making the total depth reached 515 feet.		

The section at Goole was as follows :—

		ft.	in.
1.	Warpy Sand	4	4
2.	Warpy Clay	0	6
3.	Peat	0	6
4.	Fine Stiff Clay.	6	8
5.	Red Clay	5	0
6.	Rough Gravel	8	0
7.	Warp Clay	3	0
8.	Red Sand	6	0
9.	Hard Coarse Sand, Light Red . .	24	0
10.	Red Marl	10	0
11.	Hard Sand	11	0
12.	Red Marl	3	0
13.	Hard Sand	26	0
14.	Red Marl	1	0
15.	Hard Sand	61	0
16.	Red Marl	3	0
17.	Hard Coarse Sandstone, with Small		

[redacted]

Between Brayton and Hambleton, the former village a mile and a half from Selby, the surrounding flatness is broken by the New Red Sandstone, which rises at Brayton Barf and Hambleton Heugh, to the respective heights of 150 and 180 feet. Both hills appear to have been left undenuded during the period of the deposition of the gravel beds which fill the plain; no gravel is found on their summits. In an old quarry at the foot of Hambleton Heugh, the following section may be seen:—

	ft.
Red Soil, with Pebbles	2
Loose Red Friable Sand, with a few small Pebbles, and somewhat false-bedded . .	8
Slightly indurated Red Sandstone, with thin partings	6

The dip was 7° E.S.E. at Brayton Barf, in a smaller quarry; the soft Red Sandstone is eight or ten feet thick, and consists of similar materials to those already described.

At Pollington, Heck, and Hensall, near Snaith, there are extensive gravel pits, and at the lower part of these the Bunter Sandstone may be seen. It is a fine, purplish-red sandstone, with thin layers of a cohesive substance, which does not weather so quickly as the sandstone, and causes an exposed section to appear ribbed horizontally. At the junction of the Red Sandstone with the gravel there is usually a layer of boulders cemented together, and coloured red, called by the workmen "pan sand." At Heck Railway Station, a good section is exposed where the company have taken away a great quantity of the gravel from above for ballast. The Red Sandstone is very soft, little more than sand in many places, and has a general dip of about three inches to the yard, to the S.E. or S. The section (Fig 34, Pl. XII.) is from Heck, showing the

Red Sandstone under the gravel. The peculiar manner in which the latter has filled up holes in the Red Sandstone may be noted.

In the section at Heck, showing junction of Red Sandstone and Alluvial Gravel beds, are—

	ft.	in.
1. Gravel	7	0
2. Stratified Sand	2	6
3. Gravel, with alternations of Sand . .	2	0
4. Alternations of Sand and Gravel highly inclined, and towards the bottom very Pebbly, in hollows in Sandstone . .	8	0
5. Red Sandstone	6	0

To the right of this section the Red Sandstone crops out, and there is a thickness of twenty-five feet exposed, the lower part being much harder than the upper.

A good section of the Bunter Sandstone is exposed in quarries at Aldborough. They were formerly in use as building-stone, but have not been worked for many years. The stone is similar to that described at Heck, but the lower beds are harder and more durable. The strata dip 10° to the S.S.E., and consist, in the upper part, of about

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circular depressions, generally sloping down the sides to the centre, but occasionally having a deep, perpendicular shaft. They are fifty to a hundred feet across, some of them containing water, the majority, however, being dry. Besides these distinct depressions, the ground has the appearance of a succession of small hills and valleys in consequence of other irregular subsidences. These hollows may be accounted for in the following manner. Below the Bunter Sandstone, the Magnesian Limestone consists of thin-bedded small slabs resting on gypseous marls, which are much contorted. The continual passage of water through these beds gradually wastes away the gypsum, leaving hollow chambers beneath the limestone and Red Sandstone. Eventually these beds fall into the hollow, forming from the surface a perpendicular shaft; the sides fall in, filling up the bottom, and the crater-like depressions are caused which are so common. Several have sunk during the last fifty years.

CHAPTER VII.

POST TERTIARY PERIOD.

THE Post-Pliocene and Superficial Deposits occurring in the West Riding of Yorkshire may be divided into two parts, the Glacial and Post-Glacial. The former include the Clays or Tills and Gravels brought together by the action of Glaciers, or during the so-called Glacial Period. The Post-Glacial include all the estuarine beds of the Vale of York, river Terraces, and the Alluvial Deposits near the mouth of the Humber. The two series may be conveniently divided into the following groups:—

Cave Deposits.
River Terraces.
Forest Beds.
[redacted]

The Rivers Lune, Ribble, Aire, and Wharfe have their sources amongst these hills, the two former draining the Howgill Fells, Graygarth, Whernside, Ingleborough, and Penyghent districts, and running westwards to the Irish Sea. The Aire and Wharfe pursue an eastward course, and receive their supplies from the hills about Malham, the eastern slopes of Penyghent and Fountain's Fell, Great Whernside, and the Moorland district east of the Wharfe. The mountainous district is brought suddenly to an end, westwards and southwards, by the Pennine and Craven Faults, and comparatively low undulating plains succeed, forming a broad valley, across the axis of which the Rivers Lune, Ribble, and Aire have carved their channels. Near Ingleton the low ground is occupied by Coal Measures and Permian strata. Between the Lune, which runs on the western boundary of the coal-field, and the Ribble, the Millstone Grit Rocks rise to a height of nearly 1,800 feet from beneath the coal, forming Burn Moor and the Fells of Bolland. Standing on the summit of one of these hills, and looking along the tops of those adjacent, they are found to present a nearly even surface with a dip to the north. The tops of the hills are usually rounded, often presenting escarpments, and are clothed with a covering of peat, in many places twelve or fifteen feet thick.

The River Ribble in its course southwards runs through an anticlinal valley, the sides and bed of which are formed of alternations of shale and limestone, easily disintegrated and removed by denuding agencies. Between the Ribble and the Aire a series of anticlinals bring up the Mountain Limestone in the Barnoldswick and Thornton districts. The channel of the Aire is cut across the limestone anticlinal at Skipton, and a short distance southwards its course passes across the strike of the Millstone Grit Rocks, separating the series of table-lands into two parts, the Moors of Keighley and Haworth on the one side, and Rumbles Moor on the other. The Wharfe and the Nidd have each carved their channels in a similar manner through the various members of the Carboniferous Group of Rocks, without regard to their out-crops or the line of the rocks, but pursuing a general south-easterly course, and cutting through hard rocks or soft, apparently one as easily as the other.

The lower part of the watercourse, after passing the Permian Escarpment, which in each case is also cut through by the river, is along the low-level lands of the great Vale of York, the Nidd, the Wharfe, and the Aire, being successively absorbed by the Ouse, which empties itself into the German Ocean.

The Calder and the Don pursue a similar path. They and their tributaries have their source in the high ground forming the western boundary of the county, and after carving their channels through each successive escarpment of the Grits and Coal Measure Sandstones, they pass east-[redacted]

Cumberland mountains, loaded with granite from Shap Fell, and the peculiar Syenite of Ennerdale, along with numerous other well-defined rocks; these masses, rounded and striated during their long transit, are found mixed with the Scotch stones in the glacial clays of the Eden Valley, and are known also to have crossed with the ice over the pass of Stainmoor, at a height of 1,500 to 1,800 feet above the sea level, being found in the Till deposited in the Valleys of the Swale and the Tees in abundance. Whilst one part of the Great Glacier, descending along the west flank of the Pennine Escarpment, passed over Stainmoor, and found its way to the Vale of York, another was separated by the high hills of Nine Standards and Mallerstang, and proceeding southwards was mainly diverted into the Valley of the Rawthey, and towards the source of the valley occupied by the River Eden. Passing over the summit of drainage between the Eden and Wensleydale, rising to the height of nearly 2,000 feet, this latter branch of the glacier proceeded down Wensleydale, leaving numerous evidences of its progress in the deposits of Boulder Clay in the deep narrow valleys near the source of the river. On the water-shed between Mallerstang and Lunds, the cuttings made in forming the Settle and Carlisle Railway have exposed scratches on the rocks, cut by the ice in its passage across the summit. On the summit of Swarth Fell ice scratches are recorded by the members of the Geological Survey at elevations between 1,950 and 2,200 feet above the sea. Some of the scratches are very slight; others are quite distinct and well preserved. On Barfell, the rocks at a height of 2,100 to 2,200 feet shew several well-striated surfaces; their general direction is W.S.W. On the north side of the Fell there also occur patches of drift, with scratched stones, which reach up the hill-side to a height of 2,100 feet. Though the scratches are not in all cases well preserved by the Grit Rocks forming the summit of these mountains, there is sufficient evidence to prove that the glaciers proceeding southwards were so large as to completely envelope them, passing over them, shearing off the sharp edges of the rocks, leaving deposits in the valleys on their flanks, and scratches on the rock surfaces on their summits.

The thick mass of ice descending the valley of the Rawthey was joined by another large glacier coming down Garsdale, and numerous scratches and markings of glacial action are found in these valleys, tending in Garsdale in a westerly direction. On the opposite side of Garsdale is the hill called Rysell, 1,823 feet above the sea level, on the top of which ice scratches are discernible, with a westerly or south-westerly direction. Eastwards from Rysell, and separated from it by a broad valley, ice scratches have been observed on the upper surface of Widdale Fells, at a height of 2,000 feet, pointing in a similar direction to those on Rysell. These cases appear to indicate that the glacier passed over the tops of these

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Sedbergh, the rest being in all probability detached and taking a south-easterly course down Dentdale. Looking at the corner of Middleton Fell from a distance, evidences of glaciation on a large scale are very distinct. The Silurian Rocks of which the fell is composed consist of alternations of shale and gritstone, which under ordinary circumstances tend to weather into terraces following the line of the beds. The terraces here are furrowed by a great number of roughly parallel ruts, which cross the strike of the beds at acute angles. On the western flank of the fells scratches occur pointing in a southerly direction. From this place the glacier appears to have taken a south-westerly direction, numerous striæ being found on the eastern slope of Farleton Fells and other exposed places, *en route* to Morecambe Bay.

On Howgill Fells, behind Sedbergh, the deep valleys are filled up with glacial *débris*, through which the streams have cut their channels, exibiting numerous sections. The clays in the upper part are a blue-grey colour, lower down they have a brownish tint. They contain a great number of scratched boulders and stones. The majority are angular, only a small proportion being well rounded. They consist mainly of Silurian Grit and Carboniferous Limestones.

The branch proceeding up Dentdale swept round the northern part of Graygarth, and was turned by the great mass of Whernside up Dibdale, where scratches and other remains may be found quite to the summit, and again on the south side in Kingsdale. During this part of its course many evidences of its passage may be seen. Masses of limestone lie perched on the Silurian Rocks of Middleton Fells, and scratches are seen along the summit. Thick masses of Till, full of striated stones, are common everywhere, and a careful examination of the nature of the stones will generally point clearly in the direction whence they have been derived.

On Ingleborough, scratches are found on the western side, with a direction generally parallel with the valley called Chapel-le-dale. On the east slope of the mountain a numerous set of striæ has been observed passing in a curve round the projecting mass of Simons Fell, rising in their progress southwards from a height of 1,235 feet to 1,350 feet. Taking the same direction as the scratches is a long moraine-like mound, probably left on the retreat of the great ice sheet, or of some more recent and local glacier. On the opposite side of the Ribble Valley, from Horton, in Ribblesdale, to Settle, many striated surfaces are found, the scratches having a general north and south direction. The rock surfaces in the valley are usually covered with a thick coating of boulder clay. Many sections in this, overlying the Silurian and Carboniferous Limestone, are exposed in the cuttings for the new Midland Railway. Examples may be seen in figures on Pl. XIII., Figs. 35, 36, and 37.

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ment, about half-way between Clapham and Moughton Scar, above the village of Austwick. The Mountain Limestone in the valley above this village has been denuded, forming a roughly circular amphitheatre about a mile in diameter. In the lower part of the valley, the Silurian Grits are exposed at the base of the Limestone Scars, and, as usual, are inclined at a considerable angle. The glacier which desended this valley has torn away huge fragments of the grits, and carried them in a westerly and south-westerly direction to the position they at present occupy. They appear to radiate in three principal lines from their source, and for a distance of a mile and a half to two miles lie scattered in immense numbers along the limestone slope above Austwick. The most westerly line of boulders is far up the hill-side, and must be 200 feet higher than the place whence they have been removed. Another stream has taken a south-westerly course, and the boulders deposited near the edge of the escarpment, whilst between these a third line of the boulders covers the nearly level table of limestone. The last is the most important group. It extends beyond the escarpment of Norber towards Clapham. Numerous blocks are found in the bed of an old lake, at the foot of the scars, which was drained only a few years ago; and isolated blocks of considerable size may be traced still nearer Clapham, beyond which place they are not found. Many of the transported blocks on Norber are of immense size, twelve or fifteen feet in diameter not being uncommon. They are found in nearly all cases to be raised from eighteen inches to two feet on pedestals of limestone which have been protected by the overlying boulders from the effect of rain and other atmospheric agents, whilst the surrounding limestone has been disintegrated and washed away to that depth since their deposition. Careful search on the upper surface of the sheltered limestone will occasionally reveal striations pointing in the direction whence the blocks were brought. The sketches (Pls. XIV. and XV., Figs. 38—43) will give an idea of the elevation of the grit boulders above the neighbouring limestone.

On the southern side of the Craven Escarpment, in the Valley of the Ribble, numerous scratches are found on the surface of the rocks, in situations where the overlying drift has been by any means removed. They have a general tendency southwards, occasionally with an easterly and sometimes with a westerly direction, apparently caused by the varying form of the ground. On the opposite side of the valley to the Ingleborough district, a series of elevations form the hilly country around Burn Moor and Bolland Knotts. The elevations are composed of the lower beds of the Millstone Grit Series, and are characterized by picturesque ridges and escarpments. Near the road passing from Clapham to Slaidburn, at a height of 1,400 feet above the sea, are scratches on the rough conglomerate composing the surface. They have been preserved under a thick bed of drift. On

[redacted]

Westwards from the Ribble Valley a branch seems to have been diverted by the high ground, forming the Pennine Ridge eastwards in the direction of Skipton, several striated surfaces being found, with the scratches pointing in that direction.

The Glacial Drift in the south-west part of the Ribble district may be divided into three parts :—

1. Upper Till, or Boulder Clay.
2. Sand and Gravel.
3. Lower Till.

The Lower Till is a brown or bluish stiff clay, with laminations, and containing numerous angular pebbles and boulders, abundantly striated, composed of fragments derived from local rocks of the Ribble Valley. The Carboniferous Limestones and Gritstones occur most frequently, and the Silurian grits of the district, extending from Ingleborough to near Malham, are also numerous. The Limestone Pebbles are very abundant. Before the introduction of railroads they were burnt for the purpose of obtaining lime, and the limekilns, long since disused, may still be found scattered over the district.

The sand and gravel consist of beds of fine sand, with interbedded gravels of rounded water-worn pebbles.

The Upper Till, or Boulder Clay, is occasionally split in two by a bed of sand and gravel. It is a stiff clay, sometimes sandy, and usually more or less laminated. It contains similar stones to the lower clay.

Deposits of the three Glacial Beds have been spread in great quantities over this district, and have since suffered considerable denudation. The general contour of the land was in all probability the same before the glacial period as at present, except that it has been rounded by the action of the ice, and many of the deep valleys have been filled up and made shallow by the deposits of glacial matter. Between Gisburne and Skipton the low ground assumes the form of peculiar rounded hillocks, which is principally due to drift clay. The smooth outline of the hills is no doubt due to the coating of glacial *débris;* but were that removed, in all probability the land would be found to have nearly the same form as at present, except that the limestone would stand out in sharper ridges.

In the country a little north of Barnoldswick the glacial mounds are composed of clay, which is not so stiff as usual, and contains a number of striated stones, which are exceptionally well rounded. Occasionally mounds composed entirely of well-rounded water-worn stones and fine sand are found. The three divisions of the deposits as seen in the south-west are not found anywhere in this part of the district. The highest point at which deposits of till have been found is 1,200 feet, though many localities much less elevated are quite free from it. On the synclinal south-west of Carlton, drift is exposed at [redacted]

Ickornshaw Beck and Summerhouse Clough thick deposits are also found; near the village of Ickornshaw they are well-nigh 100 feet in thickness. The glaciers do not appear to have passed over the water-shed further south; the lowest points are at Widdop Cross, 1,286 feet, and Harestones, 1,240 feet; but the drift is not found in the Widdop Valley, or in that of the Gorple Water, and further south there is a total absence of glacial clays or scratched stones.

On Boulsworth, Ickornshaw, and Emmott Moors are numerous mounds composed of gravel. In many of the old pits which are found in these districts the gravel is consolidated, and near Cowloughton this drift conglomerate assumes peculiar forms, which may be due to some extent to quarrying operations; east of Foulridge station, is an excavation made in a bank of drift to obtain ballast. The section is in strata containing stones which are rounded and consist principally of limestone, ganister, and grits; one part of the section is cemented into a conglomerate. In the railway line adjoining, sections are exposed in a red sandy earth without stones, and also in a brown sandy deposit, which contained large stones.

A very fine section was exposed in making the railway to Barnoldswick, near Salterforth. Drift sands and gravels were bared, which were stratified, but very much current-bedded. The dip was to the S.E. conformably to the slope of the ground. A bed of Boulder Clay was seen near Cross Lane, and on this there was a thin layer of gravel, which possibly may correspond to the base of the gravels already mentioned. The clay rests on the slope of Grit Rock, and dips in the same direction as the gravels. Above the Boulder Clay was also observed a mass of loamy sand, almost free from pebbles. A few occurred near the surface, consisting of sandstone and limestone, the latter scratched. There was no trace of fossils in either bed.

In the Dales south and west of Malham large quantities of Boulder Clays occur; but with one exception all the stones which they contain have been derived from local rocks. Carboniferous Limestone is most frequently found, and blocks of grit and hard shales are also common. In the upper part of the Aire Valley fragments of Silurian Grits occur, usually small and well rounded, as though they had travelled a long distance; they were probably derived from the Silurian Rocks, between Ribblesdale and Malham Tarn. These facts point to a system of local glaciers, descending from the high ground to the north, along the valleys of the Aire and Wharfe, and their tributaries. This is very likely to have been the case; for, as already shown, the glaciers bearing the granites of Shap and Scotland, and the syenites and other rocks of Cumberland, were driven partially over Stainmoor, into the Valleys of the Tees and Swale, and mainly along the western slope of the Pennine anticlinal, reaching south-

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cases where the rocks are soft, or they have travelled a long distance, they are found to be well rounded. Good examples of the deposits may be seen at Gargrave, Bell Busk, and Skipton, and usually overlying the quarries east and west of the latter place. Near the old station at Skipton, the section exposed in the railway cutting consists of stiff, dark-blue, laminated clay, full of smooth finely striated boulders, all of local origin. Intercalated with the clay are one or two beds of fine sand, showing bedding planes, and indicating a period when the glacier appears to have retired a little, allowing the beds of sand to lie deposited from water, and then a re-advancement of the ice, depositing the superincumbent Till.

On the north bank of the Aire, near Shipley, beds of Boulder Clay are frequently met with. On Bingley Moor, at an elevation of 750 feet, a stiff tenacious clay, of a bluish colour, and containing boulders of sandstone with occasional lenticular patches of sand and gravel, was exposed in making a reservoir in connection with the Shipley waterworks. A similar mass of Till or Boulder Clay extends from Calverley Moor to Eccleshill and Idle, about 600 feet above the sea level. A peculiarity of these beds is, that whilst they contain numerous subangular boulders of grit and sandstone derived from the Millstone Grits and Lower Coal Measures south of Skipton, no Carboniferous Limestone has been found. This circumstance, taken in connection with the scratched and *moutonné* surfaces which have been observed on the Grit Rocks beneath the peat on the eastern portion of Rumbles Moor, appears to indicate that these deposits of Till were left when the ice sheet was gradually receding northwards and becoming limited in extent, whilst the deposits in the valley of the Aire, extending southwards to Bradford, were probably formed from the morainic *débris* brought down by a smaller glacier of later date.

The basin-shaped hollow, in the centre of which stands the town of Bradford, is well-nigh covered by a thick deposit of Boulder Clay, containing numerous rounded and subangular stones covered with striæ. The clay is bluish, not laminated, and very tough, especially in the lower part, and turns a brownish colour on exposure to the atmosphere. The enclosed fragments are derived from the grits and limestones of the northern part of the Aire Valley. A whitish crystalline rock, of which there are many examples, appears to have travelled from the limestone of the Settle district. Patches of similar drift have been exposed near Guiseley and Apperley Bridge, in the Aire Valley to the east of Bradford. The water-shed on the south of this area is formed by the hills crowned by Lower Coal Measure Sandstones stretching from Halifax to near Leeds; and it is a most remarkable circumstance that with the exception of a small bed of Boulder Clay recently exposed near Barnsley, and described by Prof. A. H. Green [redacted] rounded stones which have been principally derived from the Grit Rocks of the immediate neighbourhood, along with a smaller number which have been carried long distances, several kinds of granite and syenite along with Trap Rock being most common.

The following section was exposed at Dewsbury—

	ft.	in.
1. Earth and Sandy Subsoil	7	6
2. Boulders, consisting, in the upper part principally of local rocks and gradually merging into those below . . .	22	0
3. Boulders nearly all foreign . . .	8	0
4. Clay with Sand and Boulders . . .	5	0
White Carboniferous Sandstone		

As the deposit deepens, the proportion of strange or travelled boulders becomes much greater, and near the bottom of the section they are far more numerous than the local ones. All traces of striation have been removed, and the boulders have evidently been subject to the rolling action of water, probably during the subsidence of the land after the glacial age or during an interglacial period. No remains of mollusca or other animals are known to exist; but near Thornhill trunks of trees have been exhumed, which appear to lie buried near the place where they grew.

In the valleys south of the Calder, in the West Riding, no remains of glacial denudation are known to exist.

In Wharfedale glacial deposits are of frequent occurrence, and with one singular exception they are all composed of clay containing boulders derived from rocks *in situ* in the immediate neighbourhood. The upper part of the valley is narrow, with high hills on each side. Near Kilnsey the Wharfe is joined by the stream from Littondale, and a few miles lower the dale widens considerably, and spreads out westwards into a plain which reaches as far as the

Aire; below Threshfield the valley again converges, and is narrow as far as Ilkley. About Threshfield, where the valley is widest, the drift deposits contain boulders of Silurian Grits somewhat similar in character to the grits of Horton in Ribblesdale. They also occur a little further up the valley towards Kilnsey. A reasonable explanation of the occurrence of these Silurian boulders is proposed by Mr. Dakyns, of the Geological Society, in a paper read in April, 1877, at a meeting of the West Riding Geological and Polytechnic Society. He suggests that at the base of Kilnsey Crag the Silurian Rocks occur, as is usually the case in the Carboniferous Limestone district further westwards, and that during the glacial epoch these rocks were at the surface and were broken, the fragments being carried down the valley to the position in which they are at present found.

Two glaciers appear to have descended the dales of Litton and Wharfe. At their confluence a great mass of drift has been heaped up in the angle formed between them. It is not an unusual occurrence to find similar accumulations at the point of convergence of several other

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part of the valley. Mountain limestone pebbles are almost if not entirely absent. The deposits near Ripley are not extensive, nor are they of great thickness. The Magnesian Limestone escarpment in the neighbourhood of Ripon and the country eastwards is covered by a boulder clay and gravels differing much in character from the local drift of the Nidd district. It is much more extensive and thicker, and contains a large per-centage of striated limestone pebbles and occasionally fragments of granite and greenstone. The boulders of granite, in some instances, contain the large flesh-coloured crystals of felspar characteristic of the granite of Shap Fells. The deposits are generally horizontal, and the lower beds contain the greatest proportion of limestone and other boulders.

This Boulder Clay is only found in the district drained by the Ure and the Iwale, and is evidently derived from the glacier which passed over Stainmoor and descended the valleys to the eastward. The *débris* is found covering the Magnesian Limestone escarpment to a hieght of 600 feet, but is not found westwards from it. Eastwards it descends towards the great vale of York, and fills the whole valley, dipping under the later deposits of alluvial matter, but reappearing again on the opposite side on the Lias rocks in the neighbourhood of Easingwold. The glacier appears to have been deflected eastwards by the ridge of Permian Limestone, the drift on the west of it being entirely local, derived from the Millstone Grit rocks of the district.

Dispersed over the district are several beds of gravel and sand, containing rounded stones with scratches, ranging from one or two feet diameter to fine sand. These gravels appear to have been washed from the Boulder Clay, and redeposited, but their relation to the Boulder Clay is nowhere defined. Examples may be seen at Wormald

Green and on the sides of the valley of the Ure near Ripon. At the latter place the gravels derived from the Boulder Clay are mixed with sand from the New Red Sandstone. They are current bedded, and are occasionally much contorted, as though a mass of ice, floating down the valley, had ploughed up and pushed forward the gravels.

At Marton, Hopperton, Flaxby, Allerton Park, and other places, are hills composed of gravel and boulders of various formations, confusedly mixed without stratification. The boulders are often three or four feet in diameter. The hills have a greater thickness, and differ much in contour from the other deposits of similar material.

The gravels and sand beds form a light dry soil, easily distinguished from the heavy lands produced by the boulder clays. They have also materially altered the physical form of the country, and in place of the gradual slope eastwards of the Magnesian Limestone, have produced an undulating, slightly hilly, park-like surface of the country.

The Magnesian Limestone further south is nearly free

[redacted]

Estuarine Beds.

Covering the glacial deposits already described in the northern part of the great vale of the Ouse, and extending over all the formations southwards and into Lincolnshire, is a great deposit of re-assorted water-worn boulders. Apparently they have been washed from the Till during a submergence of the land, and after being subject to the attrition of the waves for a period, were left when the land re-emerged from the water, occupying the low lands in the eastern part of the Riding.

They occur in great abundance in the south-east, where they cover the district occupied by the New Red Sandstone formation, and encroach in many places over the Permian Limestone. Eastwards towards Selby and Goole the boulders dip down under the more recent deposits of Warp and Alluvial Clays.

The boulders are exposed in several gravel pits, where the stones are dug out in order to repair the roads. The boulder beds are usually twenty to thirty feet thick, and where superimposed on the Bunter Sandstone, the lower stratum, about six or eight inches thick, is firmly consolidated by some cementing material, forming what is locally termed 'pan sand,' which is impervious to, and turns out, water.

At Pollington a gravel pit exposes the section as below.

		ft.	in.
Gravel beds highly inclined		20	0
Coarse sand cemented	Pan sand	0	6
Boulders partially cemented	Pan sand	0	8
Bunter sandstone		4	0

The gravel beds are inclined at an angle of 25° to the S.W.; they are current-bedded, with layers of sand occasionally interspersed. The pebbles are principally derived from local rocks, the greater number being Millstone Grit, Carboniferous Sandstones, and Permian Limestones; boulders from more distant formations are however not uncommon, the black limestone from the Yoredale or Mountain Limestone rocks frequently occurring.

At Heck, adjoining the Railway Station, the gravel beds have been extensively wrought by the Railway Company for material to form the embankments, and good sections are exposed. The beds consist of alternations of sand and gravel, with the usual "pan sand" at the base. The junction of these beds with the Bunter beneath is for some distance rather peculiar. The Red Sandstone appears to have been denuded into a series of hollows, which have been filled by the pebbles of the boulder series. The section (Pl. XII., fig. 34) will serve to illustrate this peculiar arrangement.

A gravel pit near Hensall Station exhibits a larger proportion of limestone boulders than elsewhere.

Near Askern a large section is exposed, the boulder beds being sixty feet thick; at the base is a bed of sandy [redacted] considerable distances. The very characteristic granite from Shap Fell is found as far south as York, associated with fragments, all rounded and water-worn, from the north-west of Yorkshire and the Cumbrian mountains.

Occasionally, at rare intervals, remains of animals are found associated with the gravels. They are principally of extinct species, or of species which do not at present occupy this country. At Overton, a few miles north of York, on the banks of the Ouse, the gravel was formerly excavated to a considerable extent, for the purpose of repairing the roads. Many years ago, at a depth of about thirty feet, the remains of the following animals were discovered :—

Horse.
Rhinoceras tichorinus.
Elephas primigenius.
Elk.
Stag.
Reindeer.
Tiger.

These remains were found in a dark-red clay, beneath pale-red sand and a bed of gravel.

Warp Clay.

A peculiarity of this district is the finely laminated muddy deposit called "Warp." Some of the older deposits were doubtless formed when the land was at a slightly lower level than at present, causing the sea to run up and overflow the country where they occur. At each high tide, a thin stratum of mud being deposited would be dried during low tide, and thus the finely laminated structure would be produced. Occasionally a sandier deposit than usual would be made, which might receive the ripple marks so often observed in the thin partings of sand. An exactly similar action is carried on artificially by agriculturists at the present time. The whole country is mapped out with drains and dykes, by means of which the tide can be admitted, and allowed to overflow certain fields or lands. The silt is allowed to deposit until a sufficient thickness has been obtained ; the sea is then again dammed out, and the fine mud is worked into the land, producing a rich loamy soil very highly prized. The warp is a fine sediment, of a light-brown colour, peculiarly soft and silky to the touch, and containing numerous glistening scales of mica. It is found to contain about six per cent. of lime and magnesia, and about an equal quantity of aluminia. The source whence the warp is derived is a question about which there is much diversity of opinion,—some maintaining that it is brought down by the rivers, others that it is carried up the Humber by the tides. From a series of experiments made by Dr. Parsons, of Goole, it appears that the warp reaches its maximum at Swinefleet, a short distance below Goole, whilst in the tidal portions of the rivers Aire and Wharfe there is a very small quantity of sediment under

[redacted]

no inconsiderable part of the warp. The river is remarkably destitute of the lower forms of animal life. Molluscs are never seen, and rarely Crustaceans. Consequently, they are not found in the deposits of warp.

Forest Beds.

The south-east part of the Riding is occupied to a large extent by alluvial or estuary deposits from the River Humber. Reaching from Goole westward to Doncaster, and southward to the borders of Lincolnshire, the surface of the country is nearly a dead level. Hatfield Chase and Thorne Waste are extensive peat bogs, and were until lately subject to inundations of the sea, and floods from the rivers. They are now drained by artificial means. In the drains made for this purpose the roots and stems of the trees of a great forest were found. The trees were of the same species that now exist in the district, as oak, birch, fir, thorn, ash, beech, etc. Many of them are found cut down by rude axes; in some instances the stone axe or wooden wedge has been found in the cloven trunk of the tree. A great number have been burnt down; the stems of some are found quite burnt through. The charred ends of sticks or branches are often met with at depths which exclude all suspicion of their having been burnt since the demolition of the old forest. The stumps of the trees may be seen along the embankment of the railway in the neighbourhood of Goole, where the land has been lowered in many places along the side of the line, to raise the level of the rails. In such situations the roots and short stems of the trees are found in the position in which they grew, and were afterwards cut down. The forest bed extends northwards as far as Drax, whence, towards the north and west, the sand and gravel cover the land. The peat bed near Goole is usually from twelve to twenty-four inches thick, and consists of stems of trees, large numbers of the rhizomes of Arundo phragmites (which is still a common plant in the marshes), fir cones, leaves of flags and rushes, and other plants. When first dug up, they contain a great quantity of moisture, and on drying shrivel up to a small size, losing a great deal of their character and structure. The elytra of many species of insects have been discovered, the metallic lustre of some of them being preserved as though they had existed yesterday. The bones of a deer have been found in the peat or clay on Hatfield Chase, and in the more northern parts of the valley of the Ouse other animals have been discovered, notably the Irish elk and the ox.

The following is an average section got in sinking wells at Goole:—

	ft.	in.
Yellow sandy warp	3	9
Blue micaceous clay	1	0
Dark-brown peat with forest bed . . 1 0 to	2	0
White quicksand	2	0
Strong stiff brownish or bluish clay (old warp ?)	10	0
Sands and clays	15	0

[redacted]

fragments of oak, at a depth of about three feet from the surface. On the southern border of the county, near Sandloft and Crowle, the peat is absent; but near Moor End Farm, on Goole Moor, about half the distance between Crowle and Goole, a ditch was cut through eight feet of peat, with a bed of white sand at its base. The peat contained large stumps of Scotch Fir and Willow, the roots of which were embedded in the sand beneath. The stems bore the imprint of the ancient tools used in felling them. The layers of peat above the stumps of the trees were found curved as in Pl. XVI., fig. 44.

Whilst sinking for a foundation for the pier of the Railway Bridge at Hook, near Goole, the following series of strata was penetrated below the bed of the river:—

	ft.	in.
River Mud	1	6
Peat	7	6
Sand and Gravel	3	0
Clay	1	6
Sand and Gravel	4	6
Soft Clay	1	6
Soft blue Shale	12	0
Strong blue Shale, with layers of Gypsum	3	6

The bed of the river is twenty feet below high-water mark. In the peat bed were found hazel nuts and cranberries (Vaccinium oxycoccos).

This section differs very materially in two or three points from the average section at Goole. The peat is very much thicker, and it occurs about ten or twelve feet below its ordinary level at Goole. The subjacent clays are only one-third their usual thickness, and instead of being a simple bed of clay, they are intercalated with sand and gravel. It appears probable that the thick clays met with elsewhere in this district have been hollowed out by the river, and the basin filled up with sand

and peat, which may be of an earlier date than that of Thorne Waste. The cranberry only fruits on Thorne Waste in damp situations, round the edges of ponds; and the abundance of fruit found in one layer at the Hook Bridge section appears to show that it was growing in a similar wet hollow.

Lacustrine Deposits.

Remains of lacustrine origin are not uncommon in this district. An example may be seen near Askern. The ground a little eastward of the town, at two or three inches from the surface, is composed of the mud of an old lake, and contains innumerable shells of land and fresh-water molluscs. Near Monk Frystone is a deposit exactly similar. The following species of mollusca have been found :—

Limnæus pereger	Zua lubrica
Limnæus palustris	Helix hispida
Limnæus truncatulus	Helix rufescens
Limnæus stagnalis	Helix rotundata
Planorbis marginatus	Helix caperata

[redacted]

portion of the streams branching from it were subject to tidal action.

Flat terraces may be seen on the sides of the Skell, near Ripon; and on the banks of the Nidd, between Knaresborough and Cowthorp, where the stream crosses or cuts through the Permian Limestone escarpment, terraces may be seen on each side the river, a little more than the height of one hundred feet above sea level. Nearer the source of the river a terrace surrounds the large outlier of Permian Limestone at Ripley.

At Collingham, in Wharfedale, a pit has been dug in River Gravel, exposing a section about ten feet deep. The gravel contains boulders of trap, black limestone, grits, sandstones, and magnesian limestones, some of them being of large size. Between Thorp-arch and Tadcaster terraces occur. On the south side of the river, near Boston Spa, is a raised terrace, about fifty feet above the present level of the stream.

In the valley of the Aire there are extensive deposits of River Gravels and Clays. The town of Leeds is built on one of these, the bed extending westward to Kirkstall. It consists of various alternations of gravel, containing boulders of local origin—which are usually well rounded by attrition—sands, and clays. In the gravels many remains of animals have been found—bones of the horse, ox, pig, goat, and red-deer; and associated with these were trunks and branches of large trees, hazel nuts, and in rare instances fragments of pottery and other human relics.

In a bed of blue clay, at a depth of about ten feet below the surface, the nearly entire skeleton of a hippopotamus (Hippopotamus major) was found, and along with it the teeth and bones of two other animals of the same species, several bones and a jaw with teeth of the

Mammoth (Elephas primigenius), and a molar tooth and bones of a large ruminant (Bos primigenius) were also discovered in the same bed of clay. From the arrangement of the bones of the hippopotamus there was no doubt that it had died in the locality in which it was found, whilst the associated bones were more fragmentary, and appear to have been washed from a distance. The remains were found at a brick-works at New Wortley, and are now deposited at the museum of the Leeds Philosophical Society.

In the Calder valley, beds of gravel, with boulders of the local sandstone, and harder black shales, are found in several places,—at Kirklees Park, Elland Cemetery and Railway Station, and in various patches on the slopes of the hill as far up the valley as Hebdon Bridge. At Elland the bed rises to a height of nearly four hundred feet above the sea level, and is a hundred and fifty feet higher than the bed of the Calder.

Cave Deposits.

In the limestone districts of the northern part of the [redacted] above the sea level. At the entrance of the cave, a huge mass of fallen blocks of limestone and other matter forms a steep slope descending to the valley below; whilst above the cave rise the perpendicular or the over-hanging cliffs of the Attermire Lear, to a height of thirty or forty feet.

The entrance to the cave was discovered by a dog, belonging to Mr. J. Jackson, of Settle, following a rabbit through a hole in the rock, and evincing by his barks that there was a large hollow within. Mr. Jackson followed up this discovery, and commenced, and for many years carried on, the exploration of the cave. His labours were rewarded by the discovery of a "remarkable series of ornaments and implements of bronze, iron, and bone, along with pottery and the broken bones of animals. Fragments of Samian ware and other Roman pottery, coins of Trajan, Constantius, and Constantine, proved that the stratum in which they were found was accumulated after the Roman invasion. There were also bronze fibulæ, iron spear-heads, nails, and daggers, as well as bronze medals, pins, finger-rings, armlets, bracelets, buckles, and studs. The broken bones belong to the red deer, roebuck, pig, horse, Celtic shorthorn, sheep or goat, badger, fox, or dog. The whole collection was just of that sort which is very generally found in the neighbourhood of Roman villas and towns, and was doubtless formed whilst the cave was a place of habitation." * The results of these researches may be seen in Mr. Jackson's private collection, and in the British and the Leeds museums.

The exploration was carried on privately until 1869, when a committee was formed at the instigation of Prof. T. McK. Hughes, and subscriptions were obtained sufficient

* Prof. W. B. Dawkins, F.R.S., etc., *Jour. Anthrop. Inst.*, vol. i., p. 61.

to carry on the work systematically. Prof. Dawkins undertook the scientific direction of the work until 1873, when stress of work compelled him to resign the post. Since that time the operations have been under the direction of Mr. R. H. Tiddeman, of H.M. Geological Survey.

Mr. Jackson's work had been entirely in the interior of the cave, the entrance used by him being considerably higher than the present one, in a niche of the rock on the left of the present opening. It was now determined to commence digging away the talus, so as to gain access by the lower aperture. This has been used since that time, and is much enlarged. After removing the covering of broken limestone which had fallen from the overhanging cliffs, a stratum of blackened soil and stones was exposed, containing remains very similar to those already obtained from the interior. Many of the stones were burnt, and had evidently been used by the occupants of the cave in forming places for fires. Bones were found in abundance, burnt and broken; many fragments of pottery, and a few coins. This black layer gradually approached the surface as the interior of the cave was reached, and was found to [redacted] cemented together by the percolation of water bearing carbonate of lime, held in solution by excess of carbonic anhydride. The lime being deposited as it trickled amongst the stones.

Inside the cave the beds may be divided into—

Upper Cave-earth.
Laminated Clay.
Lower Cave-earth.

The upper and lower cave-earth are somewhat similar in composition; in some parts of the cave the laminated clay is absent, and the two run together. They consist of a stiff clay of a brownish colour, containing angular blocks of limestone which have fallen from the roof. Intermixed with these are beds of stalagmite, formed on the floor of the cave, and masses of stalactite, which have been originally deposited on the roof of the cave, and afterwards fallen with the limestone to which they adhered. Both beds of cave-earth contain the bones of animals, many of which are extinct, and others are not now inhabitants of this country. There is a wide difference, however, in the character of the animals whose remains are found in the two beds, and also in the climate which we may infer to have prevailed whilst the animals lived. In the Upper Cave-earth there are traces of Man, as evidenced by bones which have been hacked or cut by some sharp instrument, also of—

Fox.	Pig.
Grizzly Bear.	Reindeer.
Brown Bear.	Red Deer.
Badger.	Goat or Sheep.
Horse.	

This bed represents a considerable length of time, and the presence of the Reindeer indicates a very cold climate.

The remaining animals give evidence of cold or temperate conditions. Several antlers of the Reindeer were found in chamber D in the upper part of the laminated glacial clay. (Pl. XVI., fig. 45.) In the Lower Cave-earth a very different set of animal remains is found, amongst which the following are the most important :—

Man. (?)	Elephas antiquus.
Hyena.	Rhinoceros leptorhinus.
Fox.	Hippopotamus.
Brown Bear.	Bos primigenius.
Grizzly Bear.	Red Deer.
Bison.	

" The chief horizon along which these bones occur is a layer of occupation by the hyena, whose dung exists in great abundance. From the characterstic gnawing and cracking of the bones we may conclude that to him and the other carnivores we are indebted for probably the whole of this assemblage of fossils. Although a fibula of man was found, there is no evidence so far, sufficient to justify us in concluding that he used this cave as a [redacted] great adaptability to existing circumstances. Arctic species are totally absent.

The stratum in the Lower Cave-earth, containing the greatest number of the animal remains brought in by the hyena, is about twenty feet below the Laminated Clay. Higher up in the series the remains are less frequently met with, and the tropical species gradually disppear; only the bones of the bear, the fox, and the ox are found at rare intervals. These also disappear before reaching the under surface of the Laminated Clay, and in the latter there are no evidences of animal life whatever.

The Laminated Clay attains a thickness of near twelve feet. It consists of a fine impalpable mud in very thin laminæ, which may be divided or pulled asunder with the greatest ease. Though the laminæ are thus easily separated, it is very stiff and tough, and digging it is a work of considerable difficulty. It extends, in varying thickness, from the entrance, seventy feet into the interior of the cave. In the upper part in contains well-scratched and rounded boulders. Outside the cave, under a depth of nineteen feet of screes of fallen limestone, a bed of Till and other glacial deposits has been exposed. The Till is a clay of great tenacity, with intercalated beds of sand and laminated clay. It contains numerous well-scratched boulders, from small pebbles to masses tons in weight. The boulders consist of subangular blocks of a dark-coloured limestone, quite different from that of the scars above. Millstone grits occur, and a good proportion, near half, are of Silurian Grits. These evidences point to a period when the country was covered by vast glaciers; one of these appears to have passed from or across Ribblesdale, along the face of the Attermire Cliffs, towards Long Preston, bearing with it, and depositing, the Silurian and Carboniferous rocks at the entrance of the cave, and doubtless in other similar sheltered situations which are covered by the screes.

We may thus infer that during the period the cave was occupied by the hyena the climate was a warm one. There was then a gradual change in temperature; the tropical animals disappeared first, and then the hardier ones also were driven southwards or perished. Next succeeded a long period of glacial cold, during which the formation of Till was deposited outside the cave, and the Laminated Clay inside. The intense cold of the glacial period having become ameliorated, a more temperate climate succeeded, and the animals of the Upper Cave-earth flourished, their remains being possibly brought into the cave by the bears. From this we approach the historic period, and numerous evidences are found of the cave being occupied about the time the Romans invaded and conquered this country, causing the aborigines to seek shelter in the caves and more inaccessible fastnesses of the mountains.

PART II.

PHYSICAL GEOGRAPHY AND BOTANICAL TOPOGRAPHY.

CHAPTER I.

THE RIDING AS A WHOLE: ITS PHYSICAL GEOGRAPHY AND BOTANY.

"WEST YORKSHIRE"—our title adopted for brevity—must be regarded as an equivalent term for that parliamentary third of the county of Yorkshire known as the West Riding—the latter word being a corruption of *tri-thing*. In it the Ainsty has been included (although dealt with botanically in a previous work upon "North Yorkshire"), because geographically most clearly, and (now) also parochially and politically, it is an integral part of it.

The aggregate area of the surface under consideration is 1,768,380 acres, or about 2,760 square miles: projected on the flat, its shape is an irregular oval, obliquely disposed to the cardinal points, its axis running from N.W. to S.E. Ninety miles in its extreme length, with an average breadth of about thirty-five, it abuts upon seven counties, and is bounded on the north and east by the N. and E. Ridings, on the south-east by Lincoln and Notts, on the south by Derbyshire, on the south-west by the long dale of Cheshire; on the west it has Lancashire, and for a few miles at its extreme north-west corner it is joined by Westmoreland.

The late Professor Phillips, who studied its features so much, and loved them so well, has remarked with felicity that Nature mapped out Yorkshire with natural boundaries befitting its distinction, and he has said of it that "its rivers are emphatically its own; born among its mountains, they give life and beauty to its dales, and transport the fruits of its busy population to estuaries worthy of such tributaries:" but if this is true of the county as a whole, it fails in applicability to its greatest third—its *West* Riding; for its boundaries are not, for the most part, such strikingly natural ones as those of the three Ridings viewed as one county; for though the rivers Ouse and Ure, and the water-parting of a long lateral spur of its great hill-range, map out most of its boundary line on the east and north, yet the exceptions south and west to a natural limitation are somewhat numerous, and in one grand respect—the extension of the county beyond the broken summit ridge of "the backbone of England"—most important in relation to its climatic and vegetal phenomena.

The exceptions alluded to require some detailed indication. In the Ripon district, in some places, the natural dividing line of the Ure is departed from. In the north-

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found in the south-west in the Dobcross and Saddleworth parishes, to take in which the county line is made to bend south by west, away from the summit ridge of Blackstone Edge, and down into the valley of the Tame as far as Mossley, almost within hearing of the busy hum, and certainly within influence of the factory smoke, of Lancastrian manufacturing towns; then turning east, by a devious course up again to the ridges dividing Yorkshire from Cheshire; thus including in a Yorkshire Riding a district of some thirty square miles in area, drained by streams tributary to the Mersey. Further south-east the Derbyshire Derwent drains some few square miles of moorland in the vicinity of Bradfield; and hereabouts grows a plant —*Cotyledon Umbilicus*, Pennywort or Navelwort—claimable in consequence as part of its flora, though properly both it and the districts it grows in belong to Derbyshire. Finally, from Heeley, south of Sheffield, east to Beighton, where the Rother valley is cut across, and onwards by devious curves past Shireoaks, Letwell, and Harworth, to Bawtry, the line of separation from Notts is artificial; and brings within the Riding some fifty square miles of surface, that drains south-east into the broad valley of the Trent, by pretty winding streams, which in course of ages have cut out for themselves miniature gorges in the Magnesian Limestone. This region, with its ancient Abbey of Roche, geographically a part of Nottinghamshire, has amongst others less obvious this botanical peculiarity; about Anston, Laughton, Firbeck, Maltby and Sandbeck, a gently undulating, well-wooded country is remarkable for the abundance and fineness of its yew trees—evidently truly indigenous, and certainly forming the most striking feature in its landscape.

The diversity of surface in the Riding could hardly be much greater; ranging as it does from dreary tracts of peatbog and marshland near sea-level, some of which are cultivated by means of submaritime sediment spread by warping over the soil; through rich-loamed corn lands, wetter clay-soiled coal districts, and breezy sandstone dales partitioned off by rolling swells of heatherland; to the thin-soiled verdant grazing pastures of the Craven slopes, and the frowning masses of grit-rock over limestone and slate forming its grander mountains: a region at once terribly grand and sublimely beautiful, carrying everywhere its history on its face, for those who can read the signs in ice-scratched blocks, rounded boulders, terminal moraines, *roches moutonnées*, wall-like cliffs, and rugged gorges. The prevailing hues are bronze-brown, heather-purpled in autumn, where the rock is a grit stone; lichen-gray or bald and hoar-white where "pavements" of limestone terrace the middle zones of the steep hillsides with upright scars—marking the successive levels at which sea waves beat long ago; and black against the sky, with broken rigid outlines, where the hills are of slate—whose steep slopes, strewn with sharply angular blocks, and furrowed by the stony beds of winter torrents, give [redacted] confluence of the rivers Trent and Ouse. Here the Flora of the Riding is enriched by several maritime species of plants which find favourable conditions of growth on grassy flats and mud banks more or less regularly overflowed by the tide. The rarer of these, found nowhere else in the Riding, are *Ranunculus hirsutus*, *Zannichellia pedicillata*, *Triglochin maritimum*, *Scirpus glaucus* and *maritimus*, *Juncus Gerardi*, *Carex divisa*, and *Lepturus filiformis*.

Unlike most of its adjacent counties, the area in the Riding devoted purely to agriculture assumes comparatively unimportant proportions by the side of its great Coal-field, and much of its gritstone surface, given over almost entirely to mining and manufacturing industries. The original physical charms of many of its streams and their valleys, notably in the dales of Aire, Calder, Colne, and Don, save in their initial windings, have been obscured, if not altogether "improved away" by that aggressive spirit of modern manufacture (which the botanist and artist have alike so often to deplore), in whose alphabet *utility* is alpha and omega; but under whose fostering influence the towns of the Riding have become large and famous in the federation of the world. In this work, however, it is the physical history of the district, not its population and commercial aims, that concerns us: our business is with its everlasting hills and its some still smiling valleys, and the forces of ice and water which, after rudely fashioning, have left them in their main features much as at present, to be softened down and beautified in the cycles since their birth, (for age can beautify the face of Nature's Dame, whatever its effect upon finite fleshly forms,) by the disintegrating forces of sun and rain, and the wonderful complexity of purpose answered by vegetation—by lichen and fungus, as by wheat-ear and oak-tree—that builds up whilst it destroys.

The general character of the north and west of the Riding depends upon its geological structure—capable of definition in brief as Hard rocks on all high surfaces, with softer shales below. None of the rocks *in situ* in the Riding are of igneous fashioning: all of them own to an aqueous parentage, formed as they were of sediment (differing in constitution) thrown down or deposited from water; and which has been variously squeezed, twisted, or exposed, subsequent to deposit. But it may be remarked *en parenthèse* that a frozen flood during the Ice Age, coming down from Westmoreland and Scotland, and deflected from a straight course by the lofty group of mountains in the N.W. of the Riding, broke into two streams in the vale of the Eden; one fork of which, passing over Stainmoor and down Wensleydale, as it spread itself out fan-like in the central plain of Yorkshire, deposited huge masses of Shap Fell Granite along with Drift over the lower lands, through which now run the rivers Wharfe, Aire, and Don, into the Ouse valley; whilst the other fork of the glacier flowing south from

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fertile fields in many instances, by Till and Boulder Clay, as in Airedale and the dale of the Ribble, where it widens below Settle, etc.; the great central plain of the county met with in the east as the Ouse is approached being also formed of material essentially the same, brought down in past ages by tributaries on either hand from the hills east and west, until out of a great arm of the sea, whose waves broke against the hill-scars themselves originally, the fertile "Vale of York" was at length formed.

In a general way the Riding may be defined as an irregular tract of surface, about 80 miles in length by 40 in breadth, its longer axis obliquely placed from N.W. to S.E., divided by a broad chain of hills, running in a similarly oblique direction, into very unequal portions, that to the east consisting of five long river valleys flowing south-east to the Humber, sub-parallel with one another; and that to the west, a very much smaller portion, only one-fifth of the whole in size, as five partial river valleys running west by south, and forming parts of three watersheds, whose main areas are beyond the limits of the Riding. The hill range is a continuation of the great Pennine chain of England, its highest peaks (which alone touch the arctic zone above 1,800 feet) being scattered somewhat irregularly in the north-west, where the main chain is supplemented by secondary ridges, and more regularly, but with lessened altitude, as the southern part of the Riding is approached. In the Sedbergh district, most of the main fells reach a height of 2,000 feet, but by the time the western border of the Calder and Don valleys has been reached, the peaks have given place to rolling swells of high moorland and gritstone ridges, whose altitude is nowhere much above 1,800 feet, and only on an average 1,500 to 1,600. In the north the river Ribble runs almost due south between the two ranges into which the Pennine chain is there divided ; further south a comparatively wide gap in the range is found about Elslack, where the Leeds and Liverpool Canal passes into Lancashire ; but soon the chain is taken up again in Keighley Moors and Boulsworth Hill, to continue from that point without intermission south-west to the Peak in Derbyshire, as a broad unbroken band of high moorland, whose summit is of considerable breadth, intersected by cloughs and hollows, whose rivulets wind about, almost on the level at first, amongst the deep peat and "feather-bed" mosses, with but little fall until the real eastern descent begins. The secluded cloughs and glens *amongst* the hills, not east of them, with their atmospheric conditions approximating to districts much further to the west and south, nourish some few species of plants, notably the Ivy-leaved Bell-Flower (*Wahlenbergia hederacea*), which nowhere to the east of the hill-range find conditions suitable for their growth. The western slopes and the spurs of hill falling to the west are, as a rule, much shorter and steeper than on the east of the broad

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the plants within any given area, and contrast one part with another, a division of the Riding *ab inter*—in yet a third way, horizontally—into clearly defined districts is necessary. Such districts may be either artificial or natural, but the adoption of botanical divisions, coinciding with natural river-basins, or drainage districts, by means of the summit ridges which divide them, has one great advantage: whilst impressing the physical geography on the mind, and the topography of its vegetation (which last artificial areas equally do), it ever suggests a connection (of which examination shows the reality) between the facts in botanical topography with the limitations or expansions —with the *possibilities*, so to say—of the physical field. It is for this threefold reason that, in order to a botanical and geographical review of the West Riding, ten districts, corresponding with as many distinct watersheds, have been adopted. Upon the large physico-botanical map accompanying these pages the limits of each drainage district are, it is thought, indicated with sufficient accuracy to render unnecessary any detailed description of their boundary lines, as the scenery and more important natural and botanical features of each of them pass under review; and where the scale of the map (four miles to an inch) is too small to indicate clearly the waterpartings in some of the more level districts, reference to the Ordnance Survey maps will always show to which district any particular plant-locality must belong.

The following table gives the names and the approximate area in square miles of the West Riding drainage districts, and further indicates to which of the vice-counties adopted by Mr. Hewett C. Watson in his works on topographical botany, "Cybele Britannica" and "Topographical Botany," each of them is referable:—

WEST RIDING DRAINAGE DISTRICTS.

Name of District.	Vice-County of Cyb. Brit.	Approximate area in sqr. miles.
I. Lune, draining west	North-West and Mid-West York .	160
II. Ribble ,, ,,	Mid-West York	230
III. Mersey ,, ,,	South-West York	30
IV. Ure, draining east	Mid-West York	100
V. Nidd ,, ,,	Mid-West York	260
VI. Wharfe ,, ,,	Mid-West York	470
VII. Aire ,, ,,	Mid-West and South-West York .	480
VIII. Calder ,, ,,	South-West York	380
IX. Don ,, ,,	South-West York	600
X. Trent ,, ,,	South-West York	50
	Total,	2760

In respect of three of these divisions and their corresponding Watsonian vice-counties a few words of explanation are necessary. In H. C. Watson's vice-comital scheme the northern third of the Lune district was regarded as geographically a part of North-West Yorks, and that portion of it north of a line drawn due east from the three-county stone on Gragreth to the Newby Head Inn was taken as part of that vice-county. That part of the Ure drainage district coming within the parliamentary

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in this Work with the Aire tributaries. Lastly, since Mr. Watson took the river Aire as far as Leeds, and the Liverpool Canal from that point north-west to Skipton, and thence to Foulridge on the county border, as *his* line of separation between his vice-counties of Mid- and South-West York, it follows that the natural river-basin of the Aire to the north of that line comes within the former, and that to the south of it within the latter of those vice-riding divisions. The importance of this explanation is perhaps not great, but its omission might be the cause of confusion to any one who wished to check some botanical localisations in this work by the records for one or other of the vice-counties in " Topographical Botany."

Before treating the drainage districts *seriatim*, and comparing the facts of plant distribution within them, and their relations to one another, it may be well to say something, less complex than an exact summary of the West Riding Flora in its entirety; and for the use of those who may not wish to go deeper into the subject than is necessary to get a clear general idea of it, to sketch the commanding points which determine its general character, and give rise to its features of special interest; and then to contrast the West Riding Flora as a whole with those of adjacent counties, in order to see how far the demonstration is supported or weakened by the additional facts such comparison provides.

All things considered, the Flora of the West Riding is a remarkably rich one, much more so than one would at first imagine. Within its boundaries 1189 species of Flowering Plants, Grasses, Ferns, and their allies, have been found growing. From this total, what are called the *Aliens* (made up of casual stragglers brought in grain, grass seed, or ballast, escapes from garden cultivation, etc.), numbering 158; the *Denizens* (species almost certainly introduced, mostly in remote times, although now perfectly naturalized), of which there are 63; and the *Colonists* (in which category come the annual weeds of our cultivated lands, more or less frequent and permanent, but still not aboriginal possessors of the soil), numbering 64, have to be rigidly excluded. In seeking to account for the plant distribution of our area upon sound physical bases, their inclusion would vitiate every calculation, inasmuch as such species may turn up anywhere, on all sorts of soils, and at very various altitudes, being dependent in their occurrences upon accident, and not law. Subtracting, then, these three classes, we have left 904, which we may safely claim as the number of our indigenous—truly native—plants of the higher forms. This number does not include the Mosses, of which our Riding can boast 319 species, all natives; nor the Lichens, 222 in number; nor the 75 Liverworts; nor the 388 Fungi as yet clearly known in the Riding. Were these lower forms included in our calculation, we should get a grand total [redacted] which may not readily be over-estimated: lying intermediate as it does in latitude between the extremes of north and south, and with tracts and conditions within its limits fitted to be the home of both northern and southern types of vegetation, we find that the powers of dispersion possessed in a greater or less degree by those, as by all plants (acting slowly through long ages, of course) have been richly exercised, and their perpetuation secured.

Changed conditions (not alone climatic, though chiefly so) would appear to have by degrees very nearly overcome the power of existence of some species formerly found in the Riding—the Killarney fern, *Trichomanes*, is an example; this and some few others, such as *Asplenium lanceolatum*, still linger in single stations; whilst three others, normally sea-cliff plants—*Plantago maritima*, *Armeria maritima*, *Silene maritima*—whose vital adaptability (so to say) is considerable, still survive on some mountain scars and by subalpine rills in the mountain tract, the last relics of a maritime flora, and a proof (if one more was wanted) that a sea once washed the steeps where they grow.

These exceptional survivals of a bygone Flora, however, are but few; and the Riding flora of to-day embraces many northern species which have descended southward by its hill range to the land east of it, and find with us their southern limit in England. Such are—

Thalictrum flexuosum.	Galium boreale.
Dryas octopetala.	Crepis succisifolia.
Alchemilla alpina.	Hieracium anglicum.
Epilobium alsinifolium.	Hieracium iricum.
Sedum Rhodiola.	Hieracium pallidum.
Sedum villosum.	Hieracium gothicum.
Saxifraga stellaris.	Hieracium prenanthoides.
Saxifraga aizoides.	Hieracium crocatum.
Saxifraga oppositifolia.	Bartsia alpina.
Meum Athamanticum.	Melampyrum sylvaticum.
Peucedanum Ostruthium.	Primula farinosa.

Trientalis europæa.
Polygonum viviparum.
Rumex aquaticus.
Salix nigricans.
Salix phylicifolia.
Salix herbacea.
Habenaria albida.
Cypripedium Calceolus.
Allium Scorodoprasum.
Sesleria cærulea.
Aspidium Lonchitis.

The more important, on the other hand, of the many plants whose centres (and greatest abundance) are to the south, which have advanced northward through Cheshire and Lancashire, or Lincoln and Notts, and find, either with us, *or in other parts of the county a trifle more to the north*, their *boreal* limit, are the following :—

Clematis Vitalba.
Anemone Pulsatilla.
Meconopsis cambrica.
Hutchinsia petræa.
Cardamine impatiens.
Barbarea stricta.
Drosera intermedia.
Arenaria tenuifolia.
Cerastium aquaticum.
Hypericum elodes.
Wahlenbergia hederacea.
Gentiana Pneumonanthe.
Polemonium cæruleum.
Veronica triphyllos.
Linaria Elatine.
Orobanche minor.
Lamium Galeobdolon.
Polygonum mite.
Daphne Mezereum.
Euphorbia platyphylla.

[redacted]

Examples of this are *Meconopsis cambrica*, *Asperula cynanchica*, *Filago apiculata*, *Chlora perfoliata*, *Cuscuta europæa*, *Convallaria Polygonatum*, *Carex divulsa*, and *Arbutus Uva-ursi;* and others given in the same lists have been ascertained not to have been indigenous in the localities whence alone recorded, and are therefore omitted here. Another species given in the same place—the Sea-buckthorn (*Hippophäe rhamnoides*)—has been unfortunately exterminated in its sole station, the diluvial sea-bank near Upgang, Whitby; and another (*Eriophorum gracile*) is in all probability also extinct.

Yet another and a most efficient cause of this rich West Riding flora remains to be indicated. As physically its division into two portions, an eastern and a western, by a lofty chain of hills, has been shown to be its salient feature; so from a botanical point of view one important characteristic has its origin in the same fact. The position of the mountain range, with its long river valleys and gentle slope open to north and north-eastern winds, and its shorter descent to the west, open mostly to south and south-western breezes, has eventuated in two different climates—the milder in winter that on the western, the hotter in summer that on the eastern side of the summit ridge—the greatest humidity of the hills themselves being on the west also. This fact in the physical configuration of the Riding is a most powerful factor in the sum of its flora—and a matter which it is most important to bear in mind in analysing that flora—so intimate is the connection between the geology, climate, and physical character of a district, and the variety of its plant-species. This variation in climate has brought about a different numerical proportion in the kind and the type of the plants found (in like situations) on the opposite slopes. Every one in building a house and planning the position of its garden fruit wall, knows why that is set with its face as near to the south as may be: and in the bleak western dales of the Riding it is often curiously instructive to notice how the clustering hamlets and farmsteads are for the most part built upon what the dale folk call the 'colder sides of the hills,' with their front entrance and 'living room' or 'house place' to the south, and the humble 'garth' in front of it. And in the West Riding we have a botanical instance upon a large scale of the same arrangement. Nature within our area reared her garden wall, a huge Pennine one, neither due N. and S. nor due E. and W., but with a rare partiality for the fifth portion so protected, running from north-west to south-east. Thus it is that on this broad chain of hills in their western half, and beyond them in the western valleys occur a number of plants of a montane (northern), or a south-western (Atlantic) type, whose advance, it is probable, has been made in two directions: from the Cumbrian district, through the Sleddale hills and other Silurian ridges connecting our Howgill and Sedbergh Fells with the Kendal and Lake district mountains; and [redacted] suitable for it, we have no proof that it did not. Nay, the chances are that it did; unless, indeed, we take another view of the matter altogether, and look upon the fact of only one of the known western-type species being now found in the eastern valleys, although many survive in the west, as supporting the belief that the Killarney fern never was indigenous, but that "when found" it had been *introduced.* If it has ever been native, it is inexplicable that it should have lingered longest on the eastern side of the hill range; but we have the authority of James Backhouse, jun., of York, for the statement that it survives up to the present day in one or two spots in North Wales, and even in one station in the West Riding. Thus theories must give way before facts; and its introduction in its existing locality held to be something as yet unproven.

As examples of these west mountain and Atlantic plants may be mentioned the following species, which within the Riding occur only on the west, and *nowhere* (indigenous) *to the east* of a line drawn from Widdale and Cam Fell in the north, through Penyghent, Malham Moor, Elslack, Heptonstall, and Holmfirth to Derwent Edge, near Bradfield, in the Peak district of Derbyshire:—

Cardamine impatiens.
Meconopsis cambrica.
Impatiens Noli-me-tangere.
Alchemilla alpina.
Epilobium alsinifolium.
Sedum Rhodiola.
Sedum anglicum.
Circæa alpina.
Cotyledon Umbilicus.
Saxifraga oppositifolia.
Saxifraga umbrosa.
Crepis succisifolia.
Wahlenbergia hederacea.
Pyrola secunda.
Melampyrum sylvaticum.
Cephalanthera ensifolia.
Malaxis paludosa.
Lastrea rigida.
Ceterach officinarum.
Asplenium lanceolatum.

Two others, *Thalictrum alpinum* and *Juncus triglumis*, have been once or twice reported from the mountain moorlands of the Lune district, but require confirmation before they can be admitted as additional evidence—although, so far from being improbable, it is quite likely they will some day be detected.

On the other hand, what do we find on the east of the hills, and still further east, when quite clear of montane influence we reach the more level country? A compensation for the loss of western species. On the gritstone moorlands, and at the heads of the eastern river valleys, where Scar Limestone occurs almost more abundantly than west of the summit ridge, we have certain montane species which are not found on the west. As they are nearly all of them found in North Yorkshire or Durham and Cheviotland, we may suppose them to have spread southwards in past ages by some "east coast route" of natural preference. And, secondly, in the level country to the east of the line already indicated, certain other species of two types are found occurring, corresponding to, but here in number more than compensating for, the absence of the southern visitors of the western slopes. These types are the south-east English, whose centre in England lies to the south, and the "Germanic type" of species, which have

[redacted]

The more remarkable species occurring only on the east side of the hill-range, and on the plains of the east part of the Riding, are as follows :—

Anemone Pulsatilla.
Myosurus minimus.
Helleborus viridis.
Draba muralis.
Turritis glabra.
Reseda lutea.
Viola canina, Bab.
Drosera intermedia.
Drosera anglica.
Silene noctiflora.
Stellaria nemorum.
Linum perenne.
Astragalus hypoglottis.
Peucedanum palustre.
Campanula glomerata.
Galium boreale.
Hieracium prenanthoides.
Rumex aquaticus.
Veronica triphyllos.
Bartsia alpina.
Trientalis europæa.
Ophrys apifera.
Ophrys muscifera.
Stratiotes aloides.
Gagea lutea.
Scheuchzeria palustris.
Carex limosa.
Brachypodium pinnatum.
Equisetum hyemale.
Lastrea cristata.
Lastrea Thelypteris.

The beautiful Bird's-eye Primrose (*Primula farinosa*) is another species not given in the above list, because not quite confined to the eastern side of the summit ridge; yet it, too, is incomparably more abundant upon the limestones on that side, and is another of those sub-montane species which in the north of England have eastern rather than western tendencies. Those species in the catalogue last given of a germanic or south-eastern type have, of course, reached us by these dispersions through the East Riding, Lincolnshire, or Notts; very few, it would appear, of which *Carex digitata* is perhaps the best example, by way of Derbyshire. The pretty little Squinancy Wort (*Asperula cynanchica*) is yet another example of a plant found in the Riding only on the eastern side; yet outside our limits, in Silverdale, near Morecambe Bay, twenty miles due west of Ingleboro', it turns up, and there attaining higher latitudes and elevation, reaches its northern limit in Britain, though on the east side of our island it gets no further than the neighbourhood of Malton,—an example of a rule worth while repeating, that the rarer ascending species of plants always reach their highest altitudes and elevations upon the western slopes of hill ranges.

Comparative Botany of the Riding.

Passing, in conclusion, to a comparison of the Riding Flora in its entirety with some of the counties immediately surrounding it, we find that if by such comparison some absentees are discovered, some individual advantages are gained. Emphatically a middle link in the comital chain, the northern species whose southern range stops a little short of us are more than compensated for by the southern species that advance as far as our Riding, but go no further north. A list of the latter has been given. As to the former, North Yorkshire has 35 species *not known* (for certain) in the West Riding, of which the principal are—

Thalictrum alpinum,
Teucrium Scordium,

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Potentilla argentea,	Salix herbacea,
Alchemilla alpina,	Callitriche autumnalis,
Rosa inodora,	Potamogeton prælongus,
Sedum Rhodiola,	Potamogeton mucronatus,
Saxifraga oppositifolia,	Stratiotes aloides,
Saxifraga umbrosa,	Malaxis paludosa,
Sison Amomum,	Polygonatum officinale,
Peucedanum palustre,	Carex strigosa and paradoxa,
Asperula cynanchica,	Festuca sylvatica,
Carduus acaulis,	Aspidium Lonchitis,
Campanula hederacea,	Nephrodium rigidum,
Symphytum tuberosum,	Nephrodium cristatum,
Asarum europæum,	Polypodium calcareum,
Salix undulata,	Asplenium lanceolatum,

are the most noteworthy that occur with us, and not in North Yorkshire.

The eastern vice-county of Yorkshire has a few ascertained species, the more remarkable of which are *Cochlearia danica, Glaucium luteum, Petroselinum segetum, Lathyrus Nissolia, Torilis infesta, Linaria spuria, Mentha sylvestris, Alisma natans*, and *Potamogeton plantagineus*, lacking within our limits so far as is yet known; but, on the other hand, West Yorkshire has a host of species (over ninety), too numerous to mention, not occurring in its sister Riding, because, of course, of the less diversity of surface there.

Westmoreland, as was to be expected, has several species (probably about twenty-five, but as no complete Flora of that county is yet published, it is impossible to say exactly) on its loftier group of mountains, and the muddy line of sea-arm, which are not constituents of the West Riding Flora. Such are—

Thalictrum alpinum.	Potentilla fruticosa.
Viola arenaria.	Epilobium anagallidifolium.
Cerastium alpinum.	Saxifraga nivalis.
Tilia parvifolia.	Lobelia Dortmanna.

Vaccinium uliginosum.
Gentiana verna.
Erythræa littoralis.
Myosotis alpestris.
Hieracium chrysanthum.
Hieracium alpinum.
Saussurea alpina.
Tofieldia palustris.
Juncus triglumis.
Carex rigida and capillaris.
Isoetes lacustris.
Arabis petræa?
Subularia aquatica?
Alchemilla conjuncta?
Statice Limonium.
Oxyria reniformis.
Juncus filiformis.
Asplenium germanicum.
Woodsia ilvensis.
Lycopodium annotinum.

But, on the other hand, the West Riding has a very much larger number than 25, owing to its level eastern plain, which Westmoreland cannot claim. Of those Westmoreland species named, which are montane in character, one or two, it is *quite possible*, may yet be discovered in the Sedbergh district (such as *Thalictrum alpinum*, *Epilobium anagallidifolium*, *Saxifraga nivalis*, *Juncus triglumis*, *Carex rigida*, and *Oxyria reniformis*), upon the precipices and rill heads of the higher slate fells; for these cannot be said to have been thoroughly explored, as only three or four competent botanists have paid short visits to them; indeed, two or three of the probable

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Cochlearia danica.
Tilia parvifolia.
Pyrus torminalis ?
Pyrola arenaria, *Koch*.
Linaria repens.
Veronica hybrida.
Stachys ambigua.
Orchis eu-latifolia.
Scirpus uniglumis.
Equisetum variegatum.

And out of these the Pyrola has been *reported* on doubtful authority, whilst the Stachys, Orchis, and Scirpus will probably be ultimately ascertained to occur with us. *Per contra*, the West Riding has over 80 species certainly not occurring in Lancashire.

No flora of Cheshire has yet been published. It is therefore difficult to state the exact extent of variation a comparison with the West Riding would reveal. Its only hilly district—the slope up to the Pennine summit-ridge from Mottram, Tintwhistle, and Woodhead—is singularly deficient in the less common montane species, but in its sandstone tracts and its Delamere and Knutsford districts it is probably more on a par with the flatter parts of the West Riding than any other of the counties conterminous with it ; and several rare plants occur which are not found in Yorkshire. Examples of these are—

Nuphar pumila.
Lepidium latifolium.
Elatine hexandra.
Rosa hibernica.
Callitriche obtusangula.
Hypochæris glabra.
Phyteuma orbiculare.
Verbascum Lychnitis.
Alisma natans.
Carex Bœnninghauseniana.
Alopecurus fulvus.
Anthoxanthum Puellii.
Arundo stricta.

Saxifraga Hirculus, too, formerly occurred, but is perhaps extinct now. The Callitriche, Hypochæris, Alisma, and Carex will possibly turn up in the West Riding. So far as present knowledge goes, the two districts are somewhat on a level as regards lowland species.

Derbyshire is a small county, and it is not strange, therefore, that it should, so far as at present known, possess only some dozen indigenous species not found native in the west Riding. These are—

Silene nutans.	Mentha sylvestris.
Thlaspi virens.	Euphorbia amygdaloides.
Tilia parvifolia.	Cephalanthera grandiflora.
Lathyrus Nissolia.	(Crocus nudiflorus).
Torilis infesta.	Potamogeton zosterifolius.
Verbascum nigrum.	Carex ornithopoda.

The last is a species recently re-discovered, but known under the name of digitata in Salt's time, seventy-five years ago.

With regard to Nottinghamshire, its flora, as contrasted with ours, shows a number of southern-type species which therein reach their northern limit. Some others, which the writers do not know for certain in the West Riding, although there are doubtful records, if really absentees with us, would appear to skip over to South-east or North-east Yorkshire. The native species of Notts not certainly known as natives in the West Riding are—

Silene nutans.	Monotropa Hypopitys.
Medicago maculata.	Verbascum nigrum.

[redacted]

fens several species unknown in West Yorkshire. Some of such are—

Althæa officinalis.	Torilis infesta.
Medicago maculata.	Arnoseris pusilla.
Trifolium filiforme.	Cineraria campestris.
Lathyrus Aphaca.	Convolvulus Soldanella.
Lathyrus maritimus.	Rumex pulcher.
Cicuta virosa.	Aceras anthropophora.
Petroselinum segetum.	Sparganium affine.
Bupleurum tenuissimum.	Blysmus rufus.

West Yorkshire, with its greater diversity of surface and altitude, has of course very many species Lincoln can never furnish; albeit few counties of England offer, in the facts already known, greater encouragement to further botanical work than does this county. Its botany is as yet very imperfectly investigated.

Such is an outline—though who could do full justice in a score pages to all those features of which a Yorkshireman is so proud?—of the West Riding in its lithological and botanical aspects. If it cannot claim the privilege given to Durham of nurturing solely in the British Isles any one plant in particular, it can claim one, *Saxifraga umbrosa*, the pretty 'London' Pride —'Yorkshire Pride' rather!—found truly indigenous nowhere save in South-west Ireland and in the Settle district; eight rarities, *Actæa spicata*, *Impatiens Noli-me-tangere*, *Polemonium cæruleum*, *Bartsia alpina*, the Lady's Slipper Orchid (*Cypripedium Calceolus*), *Carex paradoxa*, *Nephrodium rigidum*, and *Lastrea cristata*, found native in but *very few* other English counties; and a variety of plant form equalled by few and surpassed by none.

CHAPTER II.

THE LUNE DISTRICT.

THE district embraced under this heading occupies the extreme N.W. of the Riding. The river Lune forms its western boundary in the northern part, and it is the tributaries of the Lune, the Rawthey, Clough, and Dee in the north, the Greta and Wenning in the south, that perform the drainage work of the district. The courses of these streams, as well as the principal physical features, are due to the lines of weakness caused by the great and numerous faults which originally broke up the surface, bringing the Silurian grits of Howgill and Holme Fells into juxtaposition with the mountain limestone and Yoredale Rocks of the hills to the east, Baugh Fell and Rysell. The

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sides to the east of the line of faults do not present evidences of this equal erosion, but being composed of a series of beds of very unequal hardness, they exhibit a proportionate amount of variation in surface contour. The hard limestones form rough perpendicular scars, extending in long lines on the hillsides. The softer shales are usually found forming smooth slopes, inclined at a gentle angle to the harder beds above and below, often strewn with disintegrated masses of the limestone or sandstone above. The grit rocks, again, usually form perpendicular escarpments, the rock being divided into rectangular blocks by the vertical joints and the lines of bedding. They present an appearance very different from the somewhat prismatic structure of the limestone scars.

Besides the action of the rivers, in forming the present contour of the valleys and hillsides, there is abundant evidence that during a long period glaciers descended Ravenstonedale, and passed along the valleys west and east of Baugh Fell. These nearly, or completely, enveloped the whole of the county southwards, and it is impossible to over-estimate the effects of the intense grinding action of this immense body of ice on the surface of the strata over which it passed. Angular corners and promontories of rock were removed, and smooth surfaces, covered with scratches, left in their place; the sharp ledges of rock were rounded into undulating hillocks, and the whole surface of the county moulded into a more rounded form. Other evidences of glacial action are found in the immense beds of stiff clay or Till, filled with rounded and scratched stones, which, on the retreat of the ice sheet, were deposited in almost every hollow, and filled the valleys, in many instances, high up the hillsides. These beds of glacial *débris* have also exerted a great influence in the formation of the physical features of the district.

The Rawthey rises on the eastern slopes of Baugh Fell (2,216 feet), and, pursuing a westerly course, is joined by the stream from Cautley Spout. The latter rises on Howgill Fells, whose highest point, the Calf, is 2,220 feet above the sea level. At Cautley Spout the water falls several hundred feet over a precipice of Silurian Rocks, presenting a scene of wild and rugged grandeur unequalled in any other part of the Riding. The united streams wend their way southwards, the bed for some distance being composed of the peculiar red conglomerate at the base of the Carboniferous Limestone. Through this conglomerate the Rawthey has cut a deep channel, whose precipitous red banks are crowned by a luxuriance of overhanging trees, presenting scenes of sylvan loveliness, which, from the contrast of colour and its richness, are most enchanting.

Near Sedbergh the Rawthey is joined by the river Clough, from Garsdale, a deep valley between Baugh Fell and Rysell, excavated in the members of the Yoredale [redacted]

Rubus saxatilis.
Rosa mollis.
Rosa inodora, Fr.
Epilobium angustifolium.
Epilobium alsinifolium.
Circæa alpina.
Ribes petræum.
Rhodiola rosea.
Sedum anglicum.
Saxifraga hypnoides.
Saxifraga stellaris.
Saxifraga aizoides.
Meum Athamanticum.
Myrrhis odorata.
Carduus heterophyllus.
Senecio saracenicus.
Crepis paludosa.
Hieracium murorum.
Hieracium pallidum.
Pyrola secunda.
Gentiana campestris.
Polygonum viviparum.
Salix nigricans.
Juniperus communis.
Orchis incarnata.
Habenaria albida.
Listera cordata.
Epipactis ovalis.
Kœhleria cristata.
Poa Balfourii.
Hymenophyllum Wilsoni.
Allosorus crispus.
Asplenium viride.
Botrychium Lunaria.
Lycopodium Selago.
Lycopodium alpinum.
Lycopodium selaginoides.
Mnium serratum.
Pterogonium gracile.
Hypnum eugyrium.
Hypnum Crista-castrensis.
Tetraplodon mnioides.
Andræa rupestris.
Seligeria pusilla.
Blindia acuta.
Racomitrium fasciculare.
Racomitrium protensum.
Orthotrichum rupestre.
Pogonatum alpinum.
Bartramia Halleriana.
Bartramia Œderi.
Bartramia arcuata.
Ricasolia amplissima.
Parmelia ciliata.

After passing Sedbergh, the Dee from Dent dale joins the Rawthey. The stream rises in the moorlands to the east of Whernside, and, pursuing a course round the northern extremity of the mountain, before reaching Dent is joined by the beck descending the romantic and secluded Deepdale from the stern and rocky slopes of the western flank of Whernside. After passing Dent, the birthplace of Adam Sedgwick, a man of whom Yorkshire will always be proud as one of the pioneers of geological science, the Dee has a tolerably even course to its junction with the Rawthey. It is joined by several tributaries from the mountain slopes on each side, in whose rapid descent a series of small waterfalls and beautiful intricate little dells are formed, down which the water rushes and winds amongst the overhanging rocks, half hidden by stems of mountain ash, hazel, oak, and ivy.

The following are the botanical rarities occurring in these dales and on the northern crags of Whernside, the southern slopes of Rysell, and the high moors and their rill heads about Widdale Fell :—

Trollius europæus.
Meconopsis cambrica.
Draba incana.
Viola lutea.
Geranium sylvaticum.
Vicia sylvatica.
Alchemilla alpina.
Geum rivale.
Geum intermedium.
Rosa dumetorum.
Epilobium angustifolium.
Saxifraga hypnoides.
Saxifraga tridactylites.
[redacted]

Habenaria bifolia.
Juncus triglumis?
Eriophorum latifolium.
Carex fulva.
Sesleria cærulea.
Brachypodium sylvaticum.
Allosorus crispus.
Asplenium viride.
Cystopteris fragilis.
Polypodium calcareum.
Polypodium Phegopteris.
Lycopodium alpinum.
Lycopodium Selago.
[redacted]

sloping banks, clothed with trees and ferns, whilst beyond these are high mountains. To the east rise the bleak grey summits of the Howgill Fells; westwards, the rising ground of Firbank Fell and Owshaw Hill limit the view, their summits brown with heather.

Southward from Whernside (2,414 feet), two streams run, one on each side of the mountain, the Ingleton Dale and Kingsdale Becks. After their confluence they form the river Greta, which flows westward, and joins the Lune near Tunstall. Kingsdale Beck rises on the southern flank of Graygreth (2,250 ft.), and west slope of Whernside. The base of Whernside is formed by the Mountain Limestone, whose bare scars extend along the course of the stream. Above the limestone are sloping shales and bold buttresses of harder rocks of the Yoredale series, whilst the summit is capped by the lower beds of the Millstone Grit. The Mountain Limestone frequently contains fissures and caverns which have been formerly, or are at present, a channel for underground streams. Such a one is the Cavern of Yordas, on the side of Graygreth. It contains a great number of stalactites and stalagmites. The entrance of the cave opens into a large chamber 60 yards long, and beyond this a second one, which, besides being ornamented with pillars of stalactite, in wet seasons contains a cascade, adding greatly to its beauty.

A short distance below Yordas the Beck reaches Thornton Force. The water falls over limestone rocks, which lie horizontally above the highly inclined beds of the Silurian Grits. The latter form the bed of the stream for some distance lower, the water running between precipitous cliffs of Silurian rocks, with an occasional waterfall, until it again cuts through Mountain Limestone, and then expands into a broader valley at its confluence with Ingleton Dale Beck.

Upon the bleak upper ridge of Whernside, of the limestone terraces of Kingsdale and Ingleton Fells, of Thornton Force and Greta Dale, to where it leaves the county east of Kirkby Lonsdale, the following plants have been observed :—

Thalictrum montanum.
Meconopsis cambrica.
Actæa spicata.
Draba muralis.
Draba incana.
Hutchinsia petræa.
Alsine verna.
Geranium lucidum.
Hypericum Androsæmum.
Rhamnus catharticus.
Hippocrepis comosa.
Rubus Chamæmorus.
Rubus saxatilis
Rosa dumetorum.
Pyrus rupicola.
Ribes alpinum.
Sedum villosum.
Saxifraga hypnoides.
[redacted]

Gymnadenia conopsea.
Allium oleraceum.
Allium Scorodoprasum.
Melica nutans.
Sesleria cærulea.
Asplenium viride.
Asplenium Adiantum-nigrum.
Ceterach officinarum.
Cystopteris fragilis.
Nephrodium abbreviatum.
Nephrodium rigidum.
Botrychium Lunaria.
Lycopodium Selago.
Lycopodium alpinum.
Lycopodium selaginoides.
Andræa alpina.
Sphagnum compactum.
Campylopus densus.
[redacted]

there is a fine fall of water that speedily disappears in the heaps of loose stones forming the floor of the cave, and passes by an underground channel for the distance of a mile, reappearing below the little chapel in the Dale. In the immediate neighbourhood there are several other "pot-holes," Gingle Pot, Hurtle Pot, and Douk Hole. They are usually adorned with trees at the entrance; and as the water generally traverses these subterranean courses, leaving the surface dry, the surrounding part of the limestone will only afford nourishment for short grass and lichens.

Many interesting species of plants are to be met with upon the rocky summit and western side of Ingleboro', upon its "pavement," in Helk's Wood, and by the Dale Beck from Gate Kirk Cave and Weathercote Cave to Ingleton: such are—

Thalictrum montanum.
Meconopsis cambrica.
Actæa spicata.
Cochlearia alpina.
Draba incana.
Alsine verna.
Hypericum montanum.
Geranium sylvaticum.
Geranium phæum.
Geum rivale.
Rubus saxatilis.
Rosa Doniana.
Rosa subcristata.
Epilobium alpinum ?
Rhodiola rosea.
Sedum villosum.
Saxifraga oppositifolia.
Saxifraga hypnoides.
Saxifraga stellaris.
Saxifraga Geum.
Saxifraga umbrosa.
Crepis succisifolia.
Senecio saracenicus.
Hieracium pallidum.
Hieracium cæsium.
Hieracium gothicum.
Ligustrum vulgare.
Melampyrum sylvaticum.
Habenaria albida.
Epipactis latifolia.
Cephalanthera ensifolia.
Anchusa sempervirens.
Mentha citrata.
Salix herbacea
Orchis incarnata.
Listera cordata.
Neottia Nidus-Avis.
Epipactis palustris.
Polygonatum officinale.
Allium Scorodoprasum.
Allium oleraceum.
Colchicum autumnale.

Blysmus compressus.
Scirpus sylvaticus.

Carex divulsa.
Carex fulva.
Sesleria cærulea.
Melica nutans.
Poa Balfourii.
Poa alpina?
Hymenophyllum Wilsoni.
Allosorus crispus.
Athyrium incisum?
Cystopteris angustata.
Aspidium aculeatum.
Nephrodium abbreviatum.
Nephrodium rigidum.
Nephrodium spinulosum.
Polypodium Phegopteris.
Polypodium calcareum.
Polypodium Dryopteris.
Andræa petrophila.
Andræa alpina.
Sphagnum tenellum.
Sphagnum rubellum.
Weissia verticillata.
Barbula convoluta.
Barbula rigidula.
Encalypta rhabdocarpa.
Grimmia funalis.
Racomitrium lanuginosum.
Ptychomitrium polyphyllum.
Diphyscium foliosum.
Bryum crudum.
Œdipodium Griffithianum?
Bartramia fontana.
Bartramia Œderi.
Bartramia ithyphylla.
Bartramia arcuata.
Splachnum sphæricum.
Leskea subrufa.
Amblystegium Sprucei.
Hypnum delicatulum.
Hypnum glareosum.
Hypnum catenulatum.
Hypnum depressum.
Hypnum incurvatum.
Hypnum revolvens.
Hypnum sarmentosum.
Omalia trichomanoides.

valley. About Bentham the stream has cut its way through the shales of Carboniferous age, and on its banks an occasional coal shaft may be seen. The scenery of the Wenning is occasionally very pretty, but its general character west of Bentham is rather flat and uninteresting. This, however, cannot be said of the upper reaches of its lovely tributaries. Clapdale, from the point where the water rushes and tumbles from the mouth of the cave at the base of the limestone scar, beneath the giant form of Ingleborough, down to the village of Clapham, forms a series of beautiful pictures of sylvan scenery. The stream, for the greater part of this distance, runs in a deep gorge, with steep banks overgrown by a dense wood; and beyond these, on either side, the bare majestic escarpments of the Mountain Limestone. Numerous falls give variety and beauty to its course, until, reaching the upturned ridgy beds of the Silurian rocks, cascades, deep quiet pools, and rapid narrow passages, give such a quick alternation of scenery as can scarcely be equalled in any other stream in the county. Beyond the mouth of the cave the valley may be traversed down which the beck at one time ran, gaining in beauty, until, on turning a sharp angle to the left, it culminates in the magnificent gorge of Trougill. Its precipitous walls of limestone gradually converge to a narrow opening; through this the stream passed to the valley below; and above, the course of the ancient river bed may still be traced far up the slopes of Ingleborough. Half a mile from Trougill is the celebrated Gaping Gill Hole, an immense cleft in the limestone plateau, down which the stream from Ingleborough is precipitated to a depth of more than 350 feet. It is this stream which, after pursuing an underground course for nearly a mile, reappears at the foot of the limestone escarpment, and flows down to Clapham.

The following are the rarer plants of the southern slope of "Little Ingleboro'" (as the folk of the Lancashire border, who dwell under the frowning heights of the much lower Pendle Hill, have called it), of the ravine of Clapham Beck, past the Cave, and on the scars and rocky pastures about the hamlets of Feizor and Wherf, on the west slope of Moughton Fell, where the Austwick Beck rises, and of the lower ground about Lawkland and Austwick Moss, given aggregated, since all are within the limits of a day's botanical ramble :—

Trollius europæus.
Thalictrum montanum.
Helleborus fœtidus.
Helleborus viridis.
Aquilegia vulgaris.
Meconopsis cambrica.
Cardamine impatiens.
Draba incana.
Thlaspi alpestre.
Viola hirta.
Silene maritima.
Alsine verna.
[redacted]

Carduus heterophyllus.
Senecio saracenicus.
Hieracium Gibsoni.
Andromeda polifolia ?
Pyrola minor.
Ligustrum vulgare.
Gentiana campestris.
Polygonum viviparum.
Daphne Mezereum.
Myrica Gale ?
Juniperus communis.
Orchis incarnata.
[redacted]

Polypodium Dryopteris.
Botrychium Lunaria.
Lycopodium Selago.
Lycopodium alpinum.
Lycopodium Selaginoides.
Sphagnum tenellum.
Rhabdoweissia fugax.
Campylopus atrovirens.
Distichum capillaceum.
Barbula recurvifolia.
Barbula tortuosa.
Encalypta ciliata.
Racomitrium protensum.
Racomitrium heterostichum.
Racomitrium sudeticum.
Orthotrichum nudum.
Orthotrichum rupestre.
Orthotrichum stramineum.
Orthotrichum crispum.
Zygodon Mougeottii.
Aulacomnion androgynum.
Bryum alpinum.
Bryum elongatum.
Bryum julaceum.
Cinclidium stygium.
Bartramia calcarea.
Bartramia Halleriana.
Anomodon viticulosus.
Leskea subrufa.
Pterogonium gracile.
Hypnum plumosum.
Hypnum pumilum.
Hypnum Swartzii.
Hypnum filicinum.
Hypnum Kneiffii.
Hypnum scorpioides.
Neckera crispa.
Collema ceranoides.

Immediately adjoining the present outflow of Clapham Beck is a long series of caves which have been explored by Mr. Farrer, the proprietor, to the extent of near half a mile. At the further extremity is a large chamber, and adjoining this water may be heard rushing past towards its exit already mentioned.

The Austwick Beck drains the valley between Norber, with its magnificent aggregation of ice-born boulders, and the limestone-scarped fells of Moughton.

The two southern streams, the Keasden and the Kettles Becks, have their origin on the precipitous northern escarpments of Bowland Knotts, and, after making a rapid descent into the valley, join the Wenning near Clapham Wood Hall, and south of Clapham, respectively. The Wenning pursues its course in a shallow valley until it quits the county near Wennington.

The botanical list for this district, including the plants of the Wenning valley and stream-side to where it leaves the Riding, presents nothing very special—perhaps because it has not yet been thoroughly explored.

Trollius europæus.
Stellaria nemorum.
Hypericum Androsæmum.
Hypericum dubium.
Geranium sylvaticum.
Lotus tenuis, Kit.
Prunus Padus.
Rubus plicatus.
Rubus saxatilis.
Rosa mollis.
Rosa implexa.
Rosa coriifolia.
Parnassia palustris.
Myrrhis odorata.
Carduus heterophyllus.
Crepis paludosa.
Crepis succisifolia.
Hieracium gothicum.
Hieracium rigidum.
Jasione montana.
Scrophularia Ehrharti.
Veronica scutellata.

Mentha rubra.
Anagallis tenella.
Rumex aquaticus.
Salix rugosa.
Salix purpurea.
Salix nigricans.
Allium Scorodoprasum.
Blysmus compressus.
Carex fulva.
Avena pratensis.
Hypnum loreum.
Hypnum splendens.
Hypnum revolvens.
Anomodon viticulosus.
Phascum muticum.
Encalypta streptocarpa.
Racomitrium protensum.
Tetradontium Browneanum.
Pogonatum aloides.
Bartramia pomiformis.
Bartramia calcarea.
Splachnum sphæricum.

[redacted]

CHAPTER III.

THE RIBBLE DISTRICT.

THE Ribble rises near the border of the county between Blea Moor and Cam Fell, and is speedily joined by several tributaries. Their sources are nearly 1,300 feet above the sea level. The united streams run in a southerly direction over the great expansion of Mountain Limestone, stretching across the valley from Whernside and Ingleborough to Penyghent. During this progression several small streams, often hidden in long subterranean passages or caverns, reappear at lower levels in little glens or tortuous recesses, only to be again swallowed up in the cavernous limestone. Many of these caves and pot-holes are accessible, and may be penetrated to great depths; others pursue their underground course unseen by human eye, untrodden by human foot. Amongst many others, Alum Pot, near Selside, Hull Pot and Hunt Pot, above Horton, may be mentioned as examples. Along the upper part of each side of the valley, numerous mural escarpments extend in long, nearly parallel lines; and above these the shales, thinner limestones and sandstones of the Yoredale series are superimposed; and still higher, forming the summit of all the hills on both sides, are the lower beds of the millstone grits. The strata generally have a dip from south-west to north-east, caused by the Pennine anticlinal. The upper surface of the Scar Limestone is 1300 feet above sea level on Ingleborough, whilst at Ribblehead it has dipped down to 1000 feet; but upper limestone of the Yoredale series forms a 'pavement' at a much higher elevation on Cam and Widdale Fell. It there crops out at 1950 feet—clearly within the upper or Infer-arctic Zone. Whernside is higher than Ingleborough, and Penyghent and Fountains Fell are each respectively lower as we proceed eastwards. A declination still greater occurs in proceeding from Penyghent northwards to Wensleydale, due to the reduced force of the upheaval which gave rise to the Pennine anticlinal; the greatest height being where the expenditure of force was greatest.

The scarcer and more interesting plants that go to make up the Florula of Upper Ribblesdale, viz., about Cam Fell and Ribblehead, upon the east slope of Simon's Fell, about Alum Pot, and Selside, and Moughton Fell, near Horton, and upon the western brows of Penyghent on the other side of the valley, are as follow:—

Trollius europæus.
Cochlearia alpina.
Draba incana.
Viola lutea.

Gnaphalium dioicum.
Hieracium anglicum.
Hieracium cæsium.
Vaccinium Vitis-Idæa.

[redacted]

Poa Balfourii.	Allosorus crispus.
Festuca duriuscula (vivipara).	Lycopodium selaginoides.
Lastrea Oreopteris.	Lycopodium Selago.
Asplenium viride.	Trichostomum lanuginosum.
Cystopteris fragilis.	Andræa crassinervia.

The rare and distinct species of Horsetail (*Equisetum variegatum*) stands on record as growing on "Swarthmoor" near Helwith Bridge. The correctness of the name requires confirmation, and botanists who may visit Upper Ribblesdale will do well to look out for the plant specially.

At Horton-in-Ribblesdale the river enters on a tract of Silurian Grits and Slates, which fill all the valley, and rise high up the hills on either side. The slates are extensively quarried at Studfold and under Moughton Fells. At the latter place occurs a beautiful example of the unconformable bedding of the Silurian rocks and the Mountain Limestone. The latter, nearly horizontal, lie above contorted highly-inclined layers of the former. The Silurian grits, though dipping at various angles, appear to have been planed down to a nearly level surface by the attrition of the sea waves prior to the limestone being deposited. In one of the inequalities of the surface of the grits a pocket of red boulders may be noted. They are of the same character as the red beds near Sedbergh. From the base of these a small stream emerges, which falls rapidly to the Ribble below.

The Ribble makes a slightly circuitous course over the upturned edges of the Silurian rocks; its stony bed, replete with immense numbers of boulders, expands and covers a considerable area. Again, drawn into smaller compass, it passes between precipitous walls of rock, adorned by stunted shrubs and tufts of flowering plants. *Prunus Padus* is plentiful, and primroses grow luxuriantly.

The lower part of the valley is nearly covered by deposits of Glacial Clay and Boulders. Very good sections in these beds, and also in the Silurian rocks, have been exposed in the cuttings of the new railway from Settle to Carlisle.

At Settle the river quits the elevated region which is north of the Craven Fault. The magnificent limestone scars which mark the direction of the fault extend westwards along the precipitous cliff of Giggleswick, at the foot of which is the Ebbing and Flowing Well. Eastwards the scars extend beyond Settle, along Langcliffe and Attermire, to Malham, and are perhaps unequalled in the district for wild and lonely grandeur. It is in Attermire scar that the Victoria Cave, the ancient habitat of the hyena and the bear, and more recently of man, is situated.

The neighbourhood of Settle has been well worked in past times, both by visitant and resident botanists. The following list includes most of the rare species to be met with about Giggleswick, Stockdale, Stainforth, and Attermire scars, and upon the banks of the Ribble down by Settle. *Ranunculus hirsutus* is on record as found once [redacted]

Hieracium Gibsoni.
Hieracium cæsium.
Hieracium prenanthoides.
Hieracium crocatum.
Hieracium rigidum.
Ligustrum vulgare.
Armeria maritima.
Scrophularia Ehrharti.
Mentha viridis.
Mentha piperita.
Mentha rotundifolia.
Lithospermum officinale.
Anchusa sempervirens.
Polygonum Bistorta.
Rumex aquaticus.
Taxus baccata.
Epipactis latifolia.
Epipactis ovalis.
Polygonatum officinale.
Convallaria majalis.
Allium Scorodoprasum.
Blysmus compressus.
Carex sylvatica.
Sesleria cærulea.
Melica nutans.
Poa nemoralis.
Hordeum sylvaticum.
Nephrodium rigidum.
Lastrea æmula.
Polypodium Phegopteris.
Polypodium calcareum.
Bartramia calcarea.
Encalypta vulgaris.
Hypnum scorpioides.
Hypnum depressum.
Hypnum heteropterum.
Racomitrium heterostichum.
Orthotrichum speciosum.
Bryum crudum.
Physcia flavicans?

South of Settle the Ribble pursues a course at first to the south-east, past Long Preston and Hellifield. It is then caused to deviate by the Gisburn anticlinal to the south-west. The whole of this district is thickly covered by drift deposits and beds of more recent date, which appear to indicate that at no very remote period a great part of the valley of the Ribble formed an immense marsh, or perhaps lake. The drift occasionally rises into rounded hillocks; they have a general slope from the fell-sides to the river. The limestone rises through the Glacial Drift into rounded hills in a few instances, and the bed of the river, south of Paythorne, is cut deep through the drift into the solid limestone below.

To the south-west of the Ribble, part of the famous grazing district of Craven, a series of anticlinals have brought up the limestone, shales, and gritstones to a height several hundred feet above the surrounding plain.

Near Barnoldswick, at Thornton-in-Lothersdale, and other places, immense quarries are wrought in the limestone, and afford good sections for the geological student. The Ribble receives several tributaries from the comparatively flat lands on its western side, Tosside Beck amongst the number. From Sawley the river forms the boundary of the county to its junction with the Hodder, which joins it at Great Mitton.

In the lower and less rocky part of the Ribble valley fewer botanical treasures are naturally to be had for the gathering than in the upper half of its Yorkshire course. But about Gisburn and Sawley, where are the remains of an old abbey, under the frowning crest of Pendle Hill, in several rocky dells and cloughs, grows *Impatiens Noli-me-tangere*, native in all seeming; for it is not confined to one or two stations in the vicinity of dwellings, and occurs also over a wide area in the adjacent part of Lancashire, about Huntroyd and Sabden. If it be, indeed, an introduced species, it is difficult to explain why it should occur so much more frequently hereabouts than in other parts of Yorkshire, where it is quite as commonly [redacted]

Myriophyllum spicatum.
Hippuris vulgaris.
Ribes rubrum.
Sedum villosum.
Pimpinella magna.
Sium angustifolium.
Myrrhis odorata.
Pulicaria dysenterica.
Eupatorium cannabinum.
Hieracium murorum.
Hieracium sylvaticum.
Hieracium umbellatum.
Mentha rubra.
Mentha sativa.
Symphytum tuberosum.
Rumex aquaticus.
Salix helix (rubra).
Salix rugosa.
Salix nigricans.
Salix phillyreifolia.
(Salix laurina).
Potamogeton densus.
Allium oleraceum.
Scirpus sylvaticus.
Schœnus nigricans.
Scirpus pauciflorus.
Avena pratensis.
Equisetum sylvaticum.
Tortula intermedia.
Hypnum rugosum.
Hypnum molluscum.
Hypnum Crista-castrensis.

The River Hodder rises in the millstone grit region of Catlow Fells and on the southern slopes of Bowland Knotts. Its course is in a south-westerly direction to Burholme ; from this point it turns south-east to join the Ribble. The valley of the Hodder is nearly parallel to that of the Ribble, the two being separated by the grit-stone moors of Harrop Fell, Easington, and Champion. An anticlinal axis runs along the valley, the Carboniferous limestone being forced to the surface in several parts, at Slaidburn, Ashnot, Chipping, and Whitewell. The grit rocks on each side of the valley occupy synclinal troughs ; they form the top of the hills, being in some instances 1,200 to 1,300 feet high ; the lower part of the hillsides are composed of sloping banks of Yoredale Shale. A second anticlinal runs from Sykes in a north-easterly direction towards Settle. This one differs from that of Slaidburn in the fact of the water-courses crossing it at right angles ; the lower rocks are only seen in the beds of the streams, instead of forming a continuous valley. The intermediate hills rise to considerable heights above the sea-level. Fair Snape Fell, 1,614 feet, Hawthornthwaite Fell, 1,568 feet, Whin's Brow, 1,550 feet, Wolfhole Crag, 1,750 feet, Bolton Head Fell, 1,784 feet, are all on the boundary of the county, and are drained by the tributaries of the Hodder,—Croasdale, Brennand, Langden, and numerous others of less importance. The scenery and configuration of the country is very diversified; the high ground is covered with peat and heather; the valleys are often well wooded, and afford good pasturage to sheep and oxen. The Hodder from Burholme serves as the boundary of the county to Great Mitton.

To the botanist the region of which Slaidburn (with its humble hostelry, the 'Hark to Bounty') is the centre, offers a fine field for investigation and discovery. Still beyond the influence of railways, not yet tourist-ridden, and hardly known save to the peripatetic pedlar, or may be some wandering artist or angler, to the plant-hunter it is almost a *terra incognita*. Except by the writer and a friend, in but one brief excursion, its wild flowers do not appear to have met a chronicler; and yet the diversity of its natural features would seem to promise much the outer world (except in the matter of a propensity for drinking too freely on a fair day) as the outer world has cared to know of them.

In ancient times a Roman road led into the district from the direction of Longridge Fell.

The following list of plants for the Slaidburn district from Whelpstone Crag and Catlow Fell on the north, along the hill ridges, and on the limestone ledges by the stream-sides to Slaidburn and Newton, includes the rarer of those known, but many others no doubt occur. *Cotyledon Umbilicus* and *Circæa alpina*, amongst others, are likely to be found, and in other ways, too, the district would repay investigation.

Ranunculus Lenormandi.
Trollius europæus.
Arabis hirsuta.
Polygala depressa.
Sagina nodosa.
Malva moschata.
Geranium pratense.
Geranium lucidum.
Ulex Gallii.
Prunus Padus.
Comarum palustre.
Geum rivale.
Rubus Idæus.
Rubus rhamnifolius.
Rubus Sprengelii.
Rubus pallidus.
Rubus Chamæmorus.
Rubus saxatilis.
Rosa subcristata.
Rosa dumetorum.
Rosa mollissima.
Rosa tomentosa.
Saxifraga tridactylites.
Parnassia palustris.
Chrysosplenium alternifolium.
Myrrhis odorata.
Carduus heterophyllus.
Pulicaria dysenterica.
Lactuca muralis.
Crepis paludosa.
Hieracium murorum.
Hieracium sylvaticum.
Jasione montana.
Campanula latifolia.
Vaccinium Vitis-Idæa.
Pyrola minor.
Veronica montana.
Myosotis repens.
Pinguicula vulgaris.
Polygonum Bistorta.
Salix nigricans.
Salix repens.
Luzula sylvatica.
Scirpus cæspitosus.
Carex lepidocarpa.
Bromus giganteus.
Brachypodium sylvaticum.
Cystopteris fragilis.
Asplenium Ruta-muraria.
A. Trichomanes.

Lastrea Oreopteris.
Equisetum Telmateia.
Sphagnum papillosum.
Phascum nitidum.
Trichostomum homomallum.
Grimmia ovata.
Racomitrium protensum.
Pogonatum aloides.
Bartramia fontana.
Hypnum revolvens.
Hypnum loreum.
Fontinalis squamosa.
Anomodon viticulosus.
Evernia prunastri.

Viewed as a whole, the Drainage District of the Ribble (with Hodder) is a rich one ; its flora, however, exhibiting a leaning towards species of a montane or a western, rather than an eastern type. In mere number it does not stand so high as some of the eastern valleys, but that is of course explained by the fact that such of them as exceed it include within their area high mountains and crags at one extremity, and after passing through the belt of magnesian limestone, wind through the triassic and lowland tracts into the Vale of York, so rich in arenophilous and hygrophilous species.

CHAPTER IV.

THE MERSEY DISTRICT.

THIS small area, drained by streams tributary to the Mersey, occupies a position west of the summit of drainage, being bounded on the east by the "Edges" of Blackstone, Millstone, and Diggle, and the summit moorland of Dead Head and Featherbed Moss. These elevations present escarpments of Kinderscout grit towards the west, their line of continuity broken where three or four rills, rising on the comparatively level peat bogs beyond them, have worn lips in their rocky rim, and aided by accessory rivulets have cloven out three short narrow lonely valleys, down which flash and leap with ceaseless hurry, in rapids rather than clear waterfalls, the three principal streams—soon to be defiled by dye-stuff and soap-refuse, when, after turning many a mill wheel in their course, they reach the populous villages about Mossley. In an easterly direction the escarpments of gritstone have a comparatively gentle dip.

About the summit ridge, gentle swells of moorland stretch mile after mile to north and south, diversified by hollows of peat-bog where the rills have their rise, and through which they twist in their narrow beds of whitish sand; and crossed by the three highroads, reaching elevations of thirteen to sixteen hundred feet, between Halifax, Huddersfield, and Holmfirth, and the Manchester district. These roads are bad, and but little used, for the principal line of communication is that iron one through the Stan-edge Tunnel, that, three miles in length, enters Pule Hill at Marsden, and emerges in the deep Diggle valley.

The vegetation of the summit moorlands presents a sameness, often seen upon the gritstone. Where heather occurs, at points over 1,500 feet, the Cloudberry (*Rubus Chamæmorus*) may be found intermingled with its wiry stems. *Erica Tetralix*, *Empetrum nigrum* (forming beautiful green cushions), and *Juncus squarrosus*, are abundant among the peat by the overhanging edges of the rills; and on these moors, in the wetter hollows, amongst several species of Bog-Moss (*Sphagnum acutifolium*, *fimbriatum*, *cymbifolium*, *intermedium* and *subsecundum*), *Drosera rotundifolia*, *Andromeda polifolia* (rare), and *Listera cordata*, are present for detection by sharp eyes, aided by venturesome feet. *Leucobryum glaucum* and *Splachnum sphæricum* also occur. Two varieties of Cottongrass (*Eriophorum vaginatum* and *angustifolium*)—beautiful whether seen in summer, with their snowy plumes trembling in the breeze, or in the autumn, when their closely set stems take [redacted] rock may be observed standing out from the hills, and weathered into all kinds of fantastic forms. These have acquired various names, bestowed as local fancy suggested or their character demanded: such are the "Rocking Stones," "Whinberry Stones," "Charnel Rocks," "Dovestones," and "Pots and Pans"—the latter locally, but without the slightest reason, supposed to be Druidical remains, as so often in Yorkshire are such rocks, especially when the upper faces have been flattened by attrition of old glacial sea waves, and subsequently scooped out into basin-like hollows, or channelled by water during centuries of "weathering." Of course theirs is but the sculpturing of a sea whose coast cliffs they were, differing only in the material worked upon, and not in their history, from the mural scars of Craven already so often mentioned.

A cliff with a semi-cascade, known as Seal Bark Rocks, at the head of the Greenfield valley, where its principal brook brims over from the moorland, is well worthy a visit from artist or botanist. Going up the rugged gorge from Greenfield, past the picturesque shooting lodge of Ashway Gap, there lies, close by the stream, in a line between Ashway House and the bold spur of hill styled "Alderman's End"—it is to be hoped not because some civic worthy met a sad fate there!—a swamp known as "Gulliver's." Here is the only Yorkshire station for the diminutive and rare (perhaps because often overlooked) Orchid, *Malaxis paludosa*, with (amongst other things)—

Drosera rotundifolia,	Potamogeton ericetorum,
Hypericum elodes,	Juncus supinus,
Rubus Sprengelii,	Carex lepidocarpa,
Vaccinium Oxycoccos,	Carex fulva,
Lysimachia nemorum,	Equisetum sylvaticum,
Scutellaria minor,	Splachnum sphæricum,
Orchis incarnata,	Sphagnum fimbriatum,

in the same swamp. *Brachyodus trichoides* grows on rocks at Ashway Gap, and on stones and by the Greenfield stream *Seligeria recurvata* and *Fissidens pusillus.*

Seal Bark rocks lie between two and three miles further up the gorge, which, past a lonely inn called "Bill's-o-Jack's," rises rather rapidly; and if the view of these and the other rocks seen towering bleakly from the bed of the Greenfield valley is grand and impressive, a close inspection is not less so, and a good deal more satisfactory to the plant-hunter; for a few rarely gathered plants and some uncommon montane mosses grow upon and near them. Such are—

Circæa intermedia.
Arbutus Uva-ursi.
Vaccinium Vitis-Idæa.
Hymenophyllum Wilsoni.
Cystopteris dentata.
Gnaphalium dioicum.
Polypodium Phegopteris.
Polypodium Dryopteris.
Lastrea Oreopteris.
Zygodon Mougeotii.
Oligotrichum hercynicum.
Racomitrium fasciculare.
Racomitrium lanuginosum.
Tetradontium Browneanum.

Asplenium viride and Circæa alpina are said to occur—but the latter is very doubtful, and in all probability the variety *intermedia* of *lutetiana* above mentioned was so

[redacted]

Myrrhis odorata.
Polygonum Bistorta.
Achillea Ptarmica.
Scirpus setaceus.
Racomitrium aciculare.

On some of the rough grassy hill-slopes and in the case of the last-named, especially in spots where the turf has been cleared by the burning of the heather, may be found—

Gentiana Amarella.
Carlina vulgaris.
Carex pilulifera.
Triodia decumbens.
Botrychium Lunaria.

The Gentian and Carline Thistle prefer the drier saddle-shaped ridge of Yoredale rock marking the axis of the anticlinal which runs from Saddleworth almost due north in the direction of Millstone Edge.

In the bogs and peaty pools *Pedicularis palustris*, *Pinguicula vulgaris*, and *Potamogeton oblongus*, Viv., frequently occur.

For the student of Mosses it may be remarked that in this district of damp valleys and wet rocks, many not common species occur. On clay banks near Saddleworth *Discelium nudum* is to be found, and the following are all known in the district, in addition to those more particularly localised :—

Sphagnum fimbriatum.
Pleuridium nitidum.
Dichodontium pellucidum.
Dicranella squarrosa.
Dicranella cerviculata.
Dicranella rufescens.
Splachnum ampullaceum.
Physcomitrium ericetorum.
Bartramia fontana.
Bartramia pomiformis.
Pogonatum aloides.
Atrichum crispum.
Bryum albicans.
Polytrichum piliferum.
Hyocomium flagellare.
Hypnum ochraceum.
Hypnum squarrosum.
Hypnum loreum.

The beautiful large-cell leaved *Hookeria lucens* occurs in damp shady crevices of the arenaceous rocks.

The centre of the valley of the Tame is occcupied by Yoredale grits, which dip at sharp angles to the east and west, along each side of a line of faults, extending in a northerly direction from Saddleworth. The line of fault here indicated is part of the great anticlinal axis, along which the Yoredale Rocks have been pushed up, displacing the rocks higher in the series, and separating the one-time united coalfields of Yorkshire and Lancashire. Toward the eastern coalfield the dip of the strata is comparatively small, but westward the inclination is very great, and the members of the Millstone Grit and Coal Measures succeed each other rapidly, the Tame cutting its way successively through them in its course towards Mossley and the Mersey.

The Tame is the principal stream in this district. It takes its rise in the moorlands to the south-west of Blacker Edge and March Hill, and, flowing southward by Dory Castle, soon receives the rapid waters of the Hull brook. About its banks, and on rocks in the earlier part of its course near Denshaw, grow—

[redacted]

deep valleys cut back through the grits and shales far into the moorlands. The shelves of the grit rock give rise to numerous waterfalls, and the steeply inclined banks of shale cause the water to descend with a force and rapidity which in wet seasons and periods of flood carries down large quantities of *débris* from the rocks above,—traces of the spates being often visible for years afterwards.

A mile or two below Delph, the Diggle brook, rising between Diggle Edge and Ravenstone Brow, joins the Tame, that now continues its course at a soberer pace until under the lee of Warmton Hill—covered by a funereal-looking larch-wood, the trees in which are dead or rapidly dying, destroyed by a beetle, it is stated—where the Greenfield valley stream joins with it. Another mile or thereabouts, and entering upon comparatively level ground, mills and houses grow more frequent upon its banks, until busy Mossley is reached, and it leaves the Riding. About the lower reaches of the stream the most ardent lover of nature would find little to interest him.

This being the smallest in size of the ten drainage districts, its paucity of species is not remarkable. It presents but little variation in the character of its soil: its rock is all of the eugeogenous type—that is, yielding plentiful detritus, and absorbing and holding water more readily than a harder limestone rock which, from its abundantly honeycombed structure, allows it to run off; the subjacent soil, therefore, is constantly wetter, so that, as was to be expected, and as a numerical analysis of its Flora would show, dry sand and lime-loving species are absent altogether.

Two of its species—the Red Bearberry (*Arbutus Uva-Ursi*) and the least Bog Orchis (*Malaxis paludosa*)—are special to it; that is, they are found in no other drainage district of the Riding.

Laverton and Winksley, thence a little northward, and is joined by the Kex-Beck from Kirkby Malzeard. The united streams turn southward, and flow into the Ure at Ripon. Just prior to entering Ripon, the Laver receives an important adjunct in the Skell. This stream rises in the western part of the Ure drainage area, on the eastern slopes of the Dallowgill Moor, and falling eastwards passes through the romantic grounds of Grantley Hall. Much of the beautiful scenery of this Park is caused by a fault, which passes through it, throwing down the grit-rock to a much lower level, and giving rise to bold scars, which have been taken advantage of in arranging the grounds. Passing westwards near Aldfield, the Skell enters the grounds of Studley Royal. Its channel is cut into the Permian Limestone at Fountains Hall and Abbey, and nearly its entire course through this magnificent demesne is a deep and beautiful channel.

About the banks of the Skell from Dallowgill to Grantley, and on through Mackershaw Woods, and past Fountains Hall and Abbey, to its junction with the Laver, many interesting plants may be found. The [redacted]

Arctium intermedium.
Lactuca virosa.
Hieracium murorum.
Chlora perfoliata.
Gentiana Amarella.
Verbascum Thapsus.
Atropa Belladonna.
Mimulus luteus.
Mentha rotundifolia.
Salvia Verbenaca.
Anagallis tenella.
Primula farinosa.
Aristolochia Clematitis.
Neottia Nidus-avis.
Listera cordata.
Ophrys muscifera.
Ophrys apifera.
Epipactis media.
Habenaria chlorantha.
Crocus vernus.
Narcissus Pseudo-narcissus.
Polygonatum multiflorum.
Convallaria majalis.
Gagea lutea.
Scirpus sylvaticus.
Carex digitata.
Carex divulsa.
Carex strigosa.
Carex sylvatica.
Calamagrostis Epigejos.
Melica nutans.
Hordeum sylvaticum.

Upon the banks of the Laver, in its course from Dallowgill Moors, past Laverton eastward, and by Clotherholme and under Red-bank to Ripon, the following species occur:—

Trollius europæus.
Berberis vulgaris.
Sagina nodosa.
Ulex Gallii.
Genista anglica.
Rubus Lindleianus.
Rubus rhamnifolius.
Rosa rubiginosa.
Pimpinella magna.
Lathræa squamaria.
Hyoscyamus niger.
Trientalis europæus.
Primula farinosa.
Chenopodium rubrum.
Neottia Nidus-Avis.
Ophrys apifera.
Convallaria majalis.
Gagea lutea.
Allium oleraceum.
Carex dioica.
Carex lævigata.
Bromus secalinus.
Lastrea Oreopteris.
Hypnum umbratum?

Upon the banks of the Ure itself, from Norton-Conyers three miles above Ripon, to Littlethorpe two miles below; and eastward from the river to the conventional boundary of the Riding, including the villages of Little Nunwick, Copt-Hewick, and Sharow, and a part of

Hutton Moor—once a good district for hygrophilous plants, but now mostly drained—the following species, some of them very rare or quite unknown in any other part of the Riding, are to be met with :—

Ranunculus fluitans.
Ranunculus circinatus.
Ranunculus Drouetii.
Turritis glabra.
Nasturtium sylvestre.
Silene noctiflora.
Cerastium semidecandrum.
Cerastium arvense.
Stellaria nemorum.
Astragalus glycyphyllus.
Ornithopus perpusillus.
Vicia angustifolia.
Sanguisorba officinalis.
Rubus diversifolius.
Rubus tuberculatus.
Rosa decipiens.
Myriophyllum verticillatum.
Bryonia dioica.
Ribes sylvestre.
Saxifraga granulata.

Verbena officinalis.
Mentha rubra et viridis.
Nepeta Cataria.
Utricularia vulgaris.
Hottonia palustris.
Polygonum mite.
Salix undulata.
Salix stipularis.
Salix rugosa.
Salix purpurea.
Salix rubra.
Sparganium minimum.
Potamogeton natans.
Potamogeton flabellatus.
Butomus umbellatus.
Iris fœtidissima.
Ornithogalum umbellatum.
Allium Scorodoprasum.
Colchicum autumnale.
Carex curta.

[redacted]

That valley has evidently never been formed by the small stream of Cayton Gill, which falls into the river Nidd below Ripley. It would require a much larger volume of water to cut the wide and deep defile of Dole Bank; and it is interesting to note the sharp turn the beck makes towards Markington, so as to avoid the Cayton Gill course. From Markington the stream passes successively through Wormald Green, South Stainley, and Copgrove. Through this extent its channel is carved from the Permian Limestone. After leaving Copgrove, its course is directed northwards, and it falls into the Ure at Newby, near Bishop Monckton.

The following list names the more interesting species that have been found in the more immediate vicinity of South Stainley, Copgrove, Bishop Monckton, and Newby Hall:—

Ranunculus Lingua.
Armoracia rusticana.
Silene noctiflora.
Stellaria glauca.
Geranium pratense.
Genista tinctoria.
Vicia tetrasperma.
Anthyllis vulneraria.
Prunus insititia.
Poterium muricatum.
Senecio erucifolius.
Bupleurum rotundifolium.
Sium angustifolium.
Carduus eriophorus.
Cornus sanguinea.
Specularia hybrida.
Chlora perfoliata.
Mentha viridis.
Mentha sativa.
Calamintha Nepeta.
Lycopsis arvensis.
Humulus Lupulus.
Alisma ranunculoides.
Neottia Nidus-Avis.
Orchis pyramidalis.
Ophrys muscifera.
Spiranthes autumnalis.
Epipactis latifolia.
Narcissus biflorus.
Narcissus Pseudo-Narcissus.
Allium Scorodoprasum.
Allium oleraceum.
Colchicum autumnale.
Carex dioica.
Carex teretiuscula.
Carex axillaris.
Carex hirta.
Carex acuta.
Calamagrostis lanceolata.
Brachypodium pinnatum.
Nephrodium Thelypteris.

Between Newby and Linton-upon-Ouse the Ure receives several minor tributaries from the west. The most important of these is the Minskep Beck, which joins the Ure at Boroughbridge. This stream rises on Brearton Moor, near Farnham, passes across the Limestone tract through Staveley Carrs,—a good locality for some rare water and bog plants—and pursues a north-easterly course to Boroughbridge. A mile from Boroughbridge is Aldborough, the ancient Isurium of the Romans. Near are the three (formerly four) remarkable monoliths called the Devil's Arrows. These monoliths are composed of sandstone, quarried from the Millstone Grit series west of the Permian Escarpment, and may have been brought from a quarry of thick-bedded red sandstone at Scriven, which is the nearest point from which the stone could have been obtained.

In Staveley Carrs, and about Boroughbridge, and in and by the Swale at Dunsforth, and the two Ouseburn villages, the following plants have been found, those within brackets not recently, however:—

Thalictrum flavum.
Nuphar luteum.
Artemisia Absinthium.
(Cuscuta europæa.)

[redacted]

Calamagrostis Epigejos.	Lolium temulentum (arvense).
Glyceria aquatica.	Equisetum Telmateia.

The Magnesian Limestone, which, in the southern part of the West Riding, rarely exceeds 200 feet in height, near Ripon rises to a height of nearly 500 feet. At its highest point it is thickly covered with drift. The Limestone ridge gradually dips to the eastward, beneath the Bunter Sandstone, which forms the central part of the Vale of York. Instead of the uniform slope which would have marked these formations had they been exposed on the surface, the country is characterized by a series of mounds and hills, rendering it generally undulate and park-like. This is caused by the whole surface of the rocks being thickly covered by sands and gravels of glacial and post-glacial age.

The central part of the Vale of York, which is covered by deposits of Warp-clay, forms a plain, almost level, having an average height above the sea of 50 feet.

The Ure drainage district is but a partial one, and only covers an area of some 100 square miles. Did not the narrow belt of the Permian Limestone run through it, it would, from its small diversity of surface, present a less rich flora than it does.

CHAPTER VI.

THE NIDD DISTRICT.

THE river Nidd has its source in numerous small streams, which descend the broad grassy slopes of Great and Little Whernside, respectively 2,310 ft. and 1,984 ft. They are both on the border of the Riding. The scenery in the upper reaches of this dale is simple, but extremely grand, and the views from the summits of the mountains are not only extensive, but very varied, in the form of the adjacent mountains and the numerous intersecting valleys. The valley of the Nidd is cut deep into the mountain side, Millstone Grit rocks forming the upper part of the hill-slopes on the left of the stream, and presenting a [redacted] a long and remarkable chasm in the limestone (well worthy of inspection) before it joins the Nidd.

From Lofthouse the river flows in a south-easterly direction, in a narrow, well-wooded valley, past Ramsgill, Gouthwaite, and several small hamlets, to Pateley Bridge. It receives the waters of numerous tributary rills along its course. These, gathered on the extensive moors of Dallowgill and Heathfield, descend between the picturesque gritstone escarpments crowning the valley on both sides, and rising to a height of 800 or 1,000 feet above the sea level.

For the higher parts of Nidderdale but few rare plants have been recorded. The florula is of the usual gritstone character. *Mimulus guttatus* has naturalised itself by the stream in a lonely situation near Ramsgill, and *Primula farinosa* is reported from Lofthouse, near Middlesmoor.

For the rest, the following list includes the more interesting species that grow in the district from the north-eastern slope of Great Whernside to Dallowgill and Sigsworth Crags:—

Trollius europæus.	Pinguicula vulgaris.
Polygala depressa.	Empetrum nigrum.
Orobus tenuifolius.	Potamogeton ericetorum.
Rosa mollissima.	Lycopodium Selago.
Rubus Chamæmorus.	Dicranella squarrosa.
Vaccinum Vitis-Idæa.	Oligotrichum hercynicum.
Mimulus guttatus.	Hedwigia ciliata.
Trientalis europæa.	Hypnum uncinatum.
Primula farinosa?	Neckera crispa.

Pateley Bridge is surrounded on all sides by lofty hills. Through these the valley of the Nidd has been cut, exposing on their slopes interesting sections descending from the Millstone Grit of Brimham and Guy's

Cliff to the Mountain Limestone exposed in the bed of the river. The Limestone also rises to the surface near Pateley Bridge, at Greenhow Hill (1,441 ft.). This mass has been elevated by the action of the anticlinals resulting from the great system of Craven faults. It is honeycombed by caverns and fissures, amongst which the Stump Cross Cavern stands conspicuous, celebrated for its long series of stalactite chambers. Greenhow Hill is the most easterly outcrop of the Mountain Limestone. The country on the opposite or north-east bank of the Nidd is formed by the red sandstones of the Third Millstone Series. This sandstone covers all the moorlands between Pateley Bridge and Ripon. It is cut through by several streams, forming picturesque valleys, which are usually well wooded.

The rarer plants to be met with about Pately Bridge and Greenhow Hill are as follows :—

Draba præcox.
Geranium sylvaticum.
Arenaria verna.
Genista anglica.

Narthecium ossifragum.
Cystopteris fragilis.
Asplenium Ruta-muraria.
Lastrea Oreopteris.

[redacted]

The Brimham Rocks present a vast number of peculiar and fantastic forms, and several huge blocks are so nicely poised as to form "rocking stones." The rocks are, in all probability, the result of the action of sea waves, which have at a remote period beaten against them, and washed away the softer parts of the stone, leaving the harder parts only to be still further acted upon by atmospheric agencies, producing a curious agglomeration of strange forms; and constituting them one of the wonders of the West Riding.

At Brimham, about the rocks and on the moors, the following plants are to be found, but the *Trientalis* and *Listera* are now very rare:—

Corydalis claviculata.	Listera cordata.
Vaccinium Vitis-Idæa.	Habenaria albida.
Trientalis europæa.	Carex pilulifera.
Digitalis purpurea.	Ptychomitrium polyphyllum.
Empetrum nigrum.	Lycopodium Selago.
Orchis incarnata.	Bryum albicans.

The Nidd continues to flow in a deep valley of millstone grit strata to Ripley, receiving the Darley Beck from Thornthwaite, at Darley; and a second stream, from the south, from Birstwith, joins the Nidd at Hampsthwaite. The Thornton Beck, rising on Brimham Moor, after passing through the lakes of Ripley Park, joins the Nidd south of Ripley. The united streams then run eastwards at the foot of the outlying boss of Permian Limestone, between Nidd Bridge and Killinghall, and about a mile further on are joined by the Oak Beck. The latter rises near John-o'-Gaunt's Castle, on the summit of drainage between the valley of the Washburn and Nidderdale. For some distance it flows nearly due east; then, turning along the line of upheaval of the Harrogate anticlinal, the stream proceeds in a north-easterly direction.

The geological structure of the hilly ground in this district is remarkable. The lower Yoredale rocks have been pushed upwards to the surface, separating the superincumbent grits, and placing their outcrops in a series of hilly lines east and west of the central mass of Yoredale rocks. The whole is indicative of great internal disturbance. It is along these lines of disturbance that the minerals occur which supply the numerous health-giving saline and chalybeate springs for which Harrogate is renowned.

In the following list are named all the more interesting species of plants that have been found in the neighbourhood of Harrogate, Harlow Hill, Reynard Crags near Birstwith, in the tract drained by the Oak Beck, and in that between Harrogate and Ripley :—

Corydalis claviculata.
Fumaria Boræi.
Viola palustris.
Drosera rotundifolia.
Polygala depressa.
Malva moschata.

Sanicula europæa.
Galium uliginosum.
Senecio sylvaticus.
Doronicum Pardalianches.
Crepis nicæensis !
Crepis paludosa.

Carex lævigata.	Nephrodium Oreopteris.
Carex sylvatica.	Nephrodium dilatatum.
Carex lepidocarpa.	Botrychium Lunaria.
Avena pubescens.	Ophioglossum vulgatum.
Aira præcox.	Asplenium Ruta-muraria.
Triodia decumbens.	Racomitrium aciculare.
Molinia cærulea.	Weissia crispula.
HymenophyllumTunbridgense.	Orthotrichum leiocarpum.

The river, after a slightly devious course through a narrow channel of well-wooded Gritstone slopes and crags, between Bilton and Scotton enters the Permian Limestone Escarpment. Its channel is cut completely through the limestone, and the bed of the stream is deep in the Grit Rocks which lie unconformably below. Good sections, showing the two series of rocks in contact, may be seen at Knaresborough, at the foot of the hill on which stands the Castle, and at other places further down the banks of the stream towards Goldsborough. The combination of high precipitous cliffs and red and yellow rocks, the extensive woods and gentle green slopes, give the valley of the Nidd a most charming and agreeable appearance. This is much enhanced by the piles of houses, placed in all kinds of impossible-looking positions on the sides of the cliffs, surmounted by the ruins of the Castle.

Near the second bridge over the river is the famous "dropping well"—a water full of earthy calcareous matter issuing from the Magnesian Limestone ; and near the third bridge, at the end of the "Long Flat," on the south side of the river, Grimbald's Crag stands out boldly; whilst nearly opposite, in the cliff of the north bank, "Eugene Aram's" cave is shown to visitors who may be curious to view the scene of a very common-place tragedy; one that would have been forgotten long ago had Tom Hood's poem and Bulwer Lytton's romance not been written.

About Knaresborough upon the cliffs, and by the river-side from Scotton Banks to Ribston; and on the north of the river, about Scriven Park, Ferrensby, Flaxby, and Goldsborough, the following uncommon plants all occur. The district outlined has an unusually rich florula, although three species that formerly grew at Knaresborough, *Silene nutans*, *Dipsacus pilosus* and *Osmunda*, are now extinct.

Ranunculus Drouetii.
Eranthis hyemalis.
Chelidonium majus.
Helleborus viridis et fœtidus.
Corydalis claviculata.
Reseda lutea.
Silene noctiflora.
Saponaria officinalis.
Moenchia erecta.
Geranium sylvaticum.
Geranium lucidum.
Geranium sanguineum.
Geranium phæum.
Cerastium aquaticum.
Euonymus europæus.
Rhamnus catharticus.

Anthemis arvensis.
Verbascum Thapsus.
Origanum vulgare.
Lithospermum officinale.
Lithospermum arvense.
Echium vulgare.
Verbena officinalis.
Calamintha menthifolia.
Nepeta Cataria.
Leonurus Cardiaca.
Salvia Verbenaca.
Lamium incisum.
Hyoscyamus niger.
Utricularia minor.
Lysimachia Nummularia.
Daphne Laureola.

[redacted]

Scirpus multicaulis.
Scirpus sylvaticus.
Carex divulsa.
Carex pendula.
Bromus erectus.
Milium effusum.
Koeleria cristata.
Cystopteris fragilis.
Botrychium Lunaria.
Bartramia calcarea.
Leskea sericea.
Hypnum loreum, etc.

After many turns and windings the Nidd passes Ribston Park, and is shortly joined by the Crimple Beck. The Crimple has several sources, and drains the Gritstone districts of Pannal, Kirkby Overblow, Spofforth, and Follifoot. The red grit of Spofforth and Plumpton Park exhibits the same tendency to weather into all kinds of odd shapes, that characterizes the grits at Brimham. Near Spofforth numerous examples occur:—large masses of sandstone stand out of the land, whilst all around has been gradually disintegrated and levelled for agricultural purposes. A fine example may be seen near the site of St. Francis' Chapel, (now destroyed,) where a huge block, twenty to thirty feet square, stands by the roadside. At Plumpton Park there is an extensive display of these denuded rocks; they are rendered very picturesque and pretty by the artificial lake at their base, and the fine large trees almost everywhere enveloping them. The Crimple, after receiving the stream from Plumpton, runs southward to Spofforth, and then turns in a north-easterly direction, and joins the Nidd half a mile above Walshford.

Within the area drained by the Crimple tributary, from Pannal, by Plumpton, Follifoot, Stockeld Park, and Spofforth, to where it falls into the Nidd, grow—

Ranunculus auricomus.
Nasturtium amphibium.
Ornithopus perpusillus.
Trifolium arvense.
Trifolium striatum.
(Potentilla argentea?)
Rubus rudis.
Saxifraga tridactylites.
Conium maculatum.
Filago minima.
Campanula rapunculoides.
Hyoscyamus niger.

(Cynoglossum officinale ?)
Narcissus major.
Carex muricata.
Juncus diffusus.
Ophioglossum vulgatum.
Asplenium Adiantum-nigrum.
Pogonatum urnigerum.
Hypnum ruscifolium.

One of the Filmy Ferns (*Hymenophyllum*) is reported by Prof. L. C. Miall, through Mr. J. Emmett, as occurring at Gt. Almia's Cliff, near Pannal; but it is to be feared that in this case, as often before, some moss (*Atrichum* or *Mnium*) has been mistaken for it.

At Walshford the river Nidd enters on the flat, highly cultivated tract of New Red Sandstone and alluvial deposits of the Vale of York. Its course, between Cowthorpe and Moor Monkton,—the district in which lie Tockwith and Kirk-Hammerton,—is excessively devious, frequently turning completely on itself, and repeatedly flowing for short distances in the direction of its source. The sum of these frequent alterations in the course of the river is a general direction towards the north-east. The Red Sandstone, or Trias, is covered by deposits of boulders and sand, which occasionally rise into small hillocks, and have a slightly undulating surface, with a

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Thalictrum flavum.
Ranunculus cæspitosus.
Hypericum hirsutum.
Geranium pratense.
Saponaria officinalis.
Rhamnus frangula.
Genista anglica.
Rubus macrophyllus.
Agrimonia officinalis.
Epilobium parviflorum.
Circæa lutetiana.
Œnanthe Phellandrium.
Viburnum Lantana.
Cornus Mas.
Galium mollugo.
Pastinaca sativa.
Cuscuta Trifolii.
Symphoricarpus racemosus.
Origanum vulgare.
Humulus Lupulus.
Salix Russelliana.
Salix pentandra.
Brachypodium pinnatum.
Hordeum sylvaticum.
Equisetum sylvaticum.
Hypnum triquetrum.

From Kirk-Hammerton the Nidd still continues its tortuous path through Wilstrop Park, Moor Monkton, to Nun Monkton, where its confluence with the Ouse takes place. The whole of this district is covered by the ancient warps and tidal detritus of the Humber, deposited when the tides were much higher, or, perhaps, the land lower, than at the present time, and when the whole of the Vale of York was subject to periodical overflows of the sea. The rarer plants occurring in this part of the Nidd Valley, together with such as are found about Rufforth, Poppleton, and Acomb, drained by streams into the Ouse *above* York, are as follows :—

Thalictrum flavum.
Ranunculus trichophyllus.
Nuphar lutea.
Papaver Argemone.
Coronopus Ruellii.
Turritis glabra.
Cardamine amara.
Alyssum calycinum.
Erodium cicutarium.
Geranium pusillum.
Cerastium semidecandrum.
Cerastium arvense.
Saponaria officinalis.
Trifolium scabrum.
Ornithopus perpusillus.
Vicia lathyroides.
Vicia angustifolia.
Rosa frondosa & platyphylla.
Sedum Telephium.
Sedum acre.
Bryonia dioica.
Conium maculatum.
Hieracium umbellatum.
Inula Helenium.

Veronica triphyllos.
Mentha Pulegium.
Samolus Valerandi.
Lycopsis arvensis.
Colchicum autumnale.
Allium vineale.
Alopecurus agrestis.
Koeleria cristata.

Comparing the flora of the Nidd Drainage District with the others, we find that although rich in arenophilous, and in its lower part in hygrophilous species, yet from the contracted area of mountain-limestone within its limits, its plants of xerophilous type are less numerous than those of the Wharfe and Aire districts.

CHAPTER VII.

THE WHARFE DISTRICT.

WHARFEDALE extends in a direction N.W. to S.E., parallel with the valley of the Aire on the south, and the Nidd northward. It is long and narrow, covering an area of about 470 square miles.

The river Wharfe has its sources high on the slopes of Cam Fell and Cush Knott, amidst wild moorlands of gritstone and overhanging scars of limestone. It is surrounded by the majestic forms of Fountains Fell, Penyghent, Greenfield Knott, Buckden Pike, and Cam Fell. Pursuing a course nearly parallel with the boundary of the Riding, the Outershaw and Greenfield Becks, forming the Wharfe, together run in a gritstone bed to Deepdale, with lofty mountains on either side. From Deepdale the bright clear stream enters a tract of Mountain Limestone. On all sides are lofty escarpments, and in place of the moorlands nearer its source the river runs through narrow pastures of bright green grass. Occasional clusters of trees occur near the pretty hamlets and villages, of which Buckden, Starbottom, and Kettlewell are the most important. To the east of the river rise Buckden Pike (2,302 feet) and Great Whernside (2,310 feet).

The rarer plants of the ascent from Buckden to the Stake Fell Pass, to the Pike and Great Whernside, and of the higher part of Langstrothdale Chase, and by the streamside, are—

Ranunculus Lenormandi.
Trollius europæus.
Draba incana.
Helianthemum vulgare.
Alsine verna.
Sagina nodosa.
Geranium lucidum.
Geranium sylvaticum.
Rubus saxatilis.
Geum rivale.
Epilobium palustre.
Sedum villosum.
Galium sylvestre.
Peucedanum Ostruthium.
Myrrhis odorata.
Hieracium murorum.
Hieracium sylvaticum.
Vaccinium Vitis-Idæa.
Melampyrum montanum.
Symphytum tuberosum.
Primula farinosa.
Pinguicula vulgaris.
Plantago maritima.
Polygonum viviparum.
Empetrum nigrum.
Habenaria albida.
Convallaria majalis.
Allium oleraceum.
Potamogeton rufescens.
Potamogeton oblongus.
Eriophorum latifolium.
Carex fulva.
Sesleria cærulea.
Asplenium viride.
Cystopteris fragilis.
Lastrea Oreopteris.
Allosorus crispus.
Polypodium Robertianum.
Lycopodium Selago.
Lycopodium Selaginoides.
Andræa Rothii.
Racomitrium lanuginosum.
Oligotrichum hercynicum.
Bartramia arcuata.
Bartramia fontana.
Mnium undulatum.
Hypnum fluitans.
Hypnum brevirostre.

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intercept its path in beautiful waterfalls, until it reaches the rocky gorge of Penyghent or Hesleden Gill. Here, though its passage is less wild, the scenery through which it runs is still grand and romantic. On either hand rise precipitous walls of limestone, from the clefts of which spring stunted shrubs. Occasionally the limestone gives place to a steep grassy slope, down which a minute tributary descends; whilst beyond, as shale or hard rock happens to be in the ascendant, rise the successive slopes and scars of Fountains Fell, with the hard Ingleborough Grit for its summit. On the north of the Gill a small bridle-path leads up to the old remains of the Giant's Grave and Blishmire House, and may be pursued southward past Peter Castle to Great Stainforth in Ribblesdale.

Upon the eastern summit and slopes of Penyghent and Fountains Fell, down to the rocky Hesleden Gill stream-side, the following are the rarer species :—

Draba incana.
Cochlearia alpina.
Rubus Chamæmorus.
Rubus saxatilis.
Sedum Rhodiola.
Sedum villosum.
Saxifraga umbrosa.
Saxifraga hypnoides.
Saxifraga stellaris.
Saxifraga oppositifolia.
Crepis succisifolia.
Hieracium anglicum.
Hieracium pallidum.
Hieracium cæsium.
Hieracium prenanthoides.
Hieracium murorum.
Solidago cambrica.
Pyrola minor.
Salix herbacea.
Listera cordata.
Allium complanatum.
Allosorus crispus.
Asplenium viride.
Lycopodium Selaginoides.
Andræa crassinervia, Bruch.
Andræa rupestris.
Zygodon Mougeotii.
Hypnum nitidulum, Wahl.
Leskea moniliformis, Wahl.

From the confluence of the Halton and Hesleden Becks the stream is called the Skirfare. Its course past Litton, Arncliffe, and Hawkswick is very similar to that of the Wharfe already described. At Arncliffe the Skirfare is joined by the Cowside Beck, which drains the limestone tract and "Clouders" of Hard Flask. One of the higher peaks of this district, the Parson's Pulpit, is 1,765 feet. A peculiar feature in this elevated region is the frequent occurrence of lime-kilns which have been used in ages gone by for lime burning. It appears strange that they should occur so frequently in a district where the inhabitants are so few.

The more noteworthy plants of Littondale, the immediate vicinity of Arncliffe, and its "Clouders"—that is, scars in the clouds—are given in the following list. Upon the Clouder slopes towards Arncliffe are the only known West Riding stations for *Sagina subulata*, and the pretty Oak-leaved Avens, *Dryas octopetala*, which covers a considerable space with its wiry stems and roots.

Trollius europæus.
Ranunculus Lenormandi.
Aquilegia vulgaris.
Corydalis claviculata.

Carduus nutans.
Gnaphalium dioicum.
Gentiana campestris.
Polemonium cæruleum.

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Carex lævigata.
Carex sylvatica.
Milium effusum.
Sesleria cærulea.
Avena alpina.
Koeleria cristata.
Melica nutans.
Polypodium Dryopteris.
Polypodium calcareum.
Cystopteris angustata.
(Polystichum Lonchitis.)
Asplenium viride.
Equisetum Telmateia.
Bryum pallescens.
Mnium orthorrhyncum.
(Paludella squarrosa?)
Bartramia calcarea.
Bartramia Œderi.

The Littondale stream joins the Wharfe near Kilnsey, whose bold scar forms a feature of peculiar grandeur in the landscape. The scar is nearly 170 feet high, and forms an abrupt termination to the limestone moors of Malham. The base of the scar has been considerably undermined by the action of ice, and subsequently by the waves of the sea. The ancient glaciers which filled Littondale and Kettlewell dale, converging at the foot of the Hawkswick moors, pressed and ground with much stress on the Crag of Kilnsey, wearing away and rounding the rock, and leaving indubitable traces of its action even to the present day.

In the neighbourhood of Arncliffe and Grassington are the woods where the rare, and of late years (until 1864, 1867, and 1875) almost apochryphal, Lady's Slipper Orchid (*Cypripedium Calceolus*) used to occur regularly. It is not quite extinct, happily, having been seen in bloom in 1875, and *two* flowers observed in 1876. The writer regrets being compelled (for fear the information should fall into sacrilegious hands that would not hesitate to dig up and carry away the plants to satisfy a morbid craving for possession) to withhold a more precise indication of the locality. It is hoped that any one, having read these lines, who may stumble across it will feel bound in honour to leave the roots and root-leaves undisturbed. There would seem to be no harm done by taking the flower and flower-leaf; for, from observations made in 1876, both the blooms watched by Mr. H. Gleadall withered, unfound-out, without being fertilized. If, therefore, as seems possible, a certain quantity of flowers in bloom at one time is necessary to make fertilization (artificially possible with two blooms, no doubt) naturally certain or probable, it will be a long time before the multiplication of plants by offshoots, etc., results in production of a number sufficient to effect the primary purpose of flowering.

The other rare plants of the Wharfe valley from Kettlewell to Grassington and Burnsall, including those of the Crag of Kilnsey, once a rocky "promontory overhanging a primæval sea-loch" (as Prof. Phillips has styled it), and the mountain pastures in its vicinity, are given in the following list:—

Thalictrum calcareum.	Rosa dumetorum.
Thalictrum flexuosum.	Pyrus rupicola.
Trollius europæus.	Ribes petræum.
Thlaspi occitanum.	Saxifraga hypnoides.
Lepidium Smithii.	Parnassia palustris.

Allium oleraceum.	Polypodium calcareum.
Juncus diffusus.	Equisetum sylvaticum.
Avena pubescens.	Trichostomum flexicaule.
Festuca sylvatica.	Encalypta streptocarpa.
Asplenium viride.	Leskea rufescens.
Polypodium Phegopteris.	Hypnum Teesdalii.
Allosorus crispus.	Neckera crispa.

The valley about Linton, Grassington, and Burnsall becomes much wider, opening out to the south-west in a broad hollow, which reaches by Cracoe and Rilstone to the valley of the Aire. From the southern bank of the stream the land rises and culminates in the jagged scars of Burnsall and Thorpe Fells, which attain a height of 1,661 feet. On the opposite side of the river the ground rises at some distance to the Gritstone moors of Hebden and Grassington. Below Burnsall the river Dibb contributes its affluent waters, gathered on the moors of Hebden and Appletreewick, to the Wharfe. From this point the banks of the river converge, and it runs in a narrow channel past the ruined tower of Barden, and through the beautiful sylvan scenery of Bolton Woods. Surrounding the valley are the high Gritstone hills of Barden Moors and Fells. Earl's Seat rises to 1,474 feet, and Simon's Seat to 1,592 feet.

The channel of the Wharfe in Bolton Woods is narrow and rocky, with well-wooded slopes rising from the water's edge on both sides. Footpaths were formed along the woods, and numerous seats placed to catch the lovely glimpses of wood and water, early in the present century, by one, the Rev. Mr. Carr, who, in Wordsworth's words, "has worked with an invisible hand of art—in the very spirit of nature." The river at one point has cut through a bed of gritstone, and runs in a narrow gorge, across which an agile person may leap, though it requires a clear cool head to withstand the bewildering effects of the rapid seething stream below. This point is called the Strid, and its charms have been immortalized in many writings, notably the poems of Wordsworth and Rogers.

In and about the Bolton Woods, with its weird "Valley of Desolation," (the fine oaks once clothing its slopes all dead and stripped of bark, remain standing,) the stream running down which to join the Wharfe forms a pretty cascade, and by the river-side from Barden Tower to Addingham, the following interesting plants may be gathered :—

Thalictrum flexuosum.
Trollius europæus.
Ranunculus auricomus.
Meconopsis cambrica.
Cheiranthus Cheiri.
Cochlearia officinalis.
Hesperis matronalis.
Helianthemum vulgare.
Viola Reichenbachiana.
Stellaria nemorum.
Alsine verna.
Asperula odorata.
Carduus heterophyllus.
Lactuca muralis.
Crepis paludosa.
Hieracium sylvaticum.
Hieracium murorum.
Campanula latifolia.
Convolvulus sepium.
Verbascum Thapsus.
Linaria Cymbalaria.
Melampyrum pratense.

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Carex pallescens.
Sesleria cærulea.
Molinia cærulea.
Polypodium Dryopteris.
Polypodium Phegopteris.
Allosorus crispus.
Polystichum aculeatum.
Lastrea Oreopteris.
Weissia cirrhata.
Weissia verticillata.
Rhabdoweissia fugax.
Dicranum fuscescens.
Anacalypta lanceolata.
Tortula vinealis, etc.
Encalypta streptocarpa.
Grimmia trichophylla.
Racomitrium aciculare.
Orthotrichum nudum.
Orthotrichum Bruchii, etc.
Zygodon Mougeotii.
Zygodon viridissimus.
Pogonatum alpinum.
Polytrichum piliferum.
Aulacomnion androgynum.
Bryum carneum, etc.
Mnium undulatum, etc.
Bartramia pomiformis.
Leucodon sciuroides.
Isothecium myurum.
Pylaisia polyantha.
Anomodon viticulosus.
Hypnum striatum.
Hypnum piliferum.
Hypnum squarrosum.
Hypnum brevirostre.
Homalia trichomanoides.
Neckera complanata.
Fontinalis squamosa.

The Wharfe, which has hitherto pursued a course S.S.E. from Kilnsey, and has made a descent from its source, 1,260 feet above sea level, to about 300 feet, at Bolton Bridge turns towards the E.S.E., past Addingham, Ilkley, Otley, and Harewood. The valley becomes considerably wider, and is bounded on both sides by slopes composed of shale, above which rise the angular-jointed escarpments of Millstone Grit Rocks. To the south rises Rumbles, or Rombald's Moor, to the height of 1,323 feet, with the picturesque and well-known rocks named the Cow and Calf at Ilkley, and the great groups of rocky ridges of Otley Chevin. On these numerous remains of interest to archæologists have been discovered. To the northward there are a great series of moorlands, which stretch away many miles, without any very striking or peculiar features. These are the Blubberhouses and Pockstones moors. They stand at an elevation of 1,400 or 1,500 feet above sea level. High on these moors rises the river Washburn, which is the most important tributary of the Wharfe. It runs in a S.E. direction, and about Blubberhouses the valley is very pretty. The rocky bed of the stream lies deep in the shales and grit rocks, the beetling cliffs of the latter overhanging its banks. The valley is well wooded, and the ground rises rapidly on each side to the nearly level moorlands. The Washburn receives many tributaries, one of which, from Kex Gill, descends a rocky gorge, formed in all probability by the dislocation of the strata by a branch of the great Craven system of faults running in a line from Bolton Bridge to Knaresborough. After passing the villages of Fewston and Leathley, the Washburn joins the Wharfe between Otley and Poole.

Perhaps the most striking botanical feature of the Washburn valley about Swinsty reservoir, and Lindley wood, is the grand profusion in which the real Lent-lily, or wild daffodil (*Narcissus Pseudo-Narcissus*) grows. At the proper season it may be seen covering the sandy banks of the little stream and adjacent pastures, and even in the shade of the trees, not with dozens or hundreds, but

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Ranunculus truncatus.
Cardamine amara.
Sagina nodosa.
Stellaria nemorum.
Malva moschata.
Geranium pratense.
Genista anglica.
Prunus Padus.
Rosa villosa.
Myriophyllum spicatum.
Lythrum Salicaria.
Chrysosplenium alternifolium.
Adoxa Moschatellina.
Parnassia palustris.
Pimpinella magna.
Œnanthe crocata.
Crepis paludosa.
Eupatorium cannabinum.
Campanula latifolia.
Jasione montana.
Veronica scutellata.
Menyanthes trifoliata.
Trientalis europæa.
Lysimachia vulgaris.
Anagallis tenella.
Humulus Lupulus.
Epipactis latifolia.
Orchis incarnata.
Listera cordata.
Habenaria viridis.
Iris fœtidissima.
Narcissus Pseudo-narcissus.
Sparganium simplex.
Carex lævigata.
Carex lepidocarpa.
Equisetum sylvaticum.
Dicranum scoparium.
Fontinalis antipyretica.

The Gritstone escarpment south of the Wharfe is continued from Otley Chevin eastwards to Harewood, and in this part of its course the more interesting species to be found upon the hill-slopes, by the Wharfe-side, and in its now more sluggish waters, from Ilkley to Harewood, are—

Thalictrum flexuosum.
Ranunculus salsuginosus.
Ranunculus circinatus.
Ranunculus Lenormandi.
Aquilegia vulgaris.
Fumaria Boræi.
Fumaria muralis.
Cochlearia officinalis.
Armoracia rusticana.
Cardamine amara.
Hesperis matronalis.
Stellaria nemorum.
Malva moschata.
Hypericum dubium.
Geranium pratense.
Geranium columbinum.
Ornithopus perpusillus.
Agrimonia eupatoria.
Rubus rudis.
Rubus leucostachys.
Rubus affinis.
Rosa arvatica.
Rosa mollissima.
Poterium Sanguisorba.
Epilobium parviflorum.
Epilobium roseum.
Epilobium obscurum.
Conium maculatum.
Œnanthe crocata.
Hieracium boreale.

Tanacetum vulgare.
Doronicum Pardalianches.
Gnaphalium sylvaticum.
Anthemis Cotula.
Matricaria Chamomilla.
Campanula latifolia.
Pyrola media.
Convolvulus sepium.
Verbascum Thapsus.
Scrophularia Ehrharti.
Mentha viridis.
Trientalis europæa.
Anagallis tenella.
Littorella lacustris.
Polygonum Bistorta.
Rumex alpinus.
Empetrum nigrum.
Humulus Lupulus.
Salix undulata.
Salix pentandra.
Salix rubra.
Salix rugosa.
Orchis Morio.
Iris Pseud-Acorus.
Allium oleraceum.
Potamogeton flabellatus.
Potamogeton ericetorum.
Juncus diffusus.
Scirpus sylvaticus.
Carex lævigata.
Carex ampullacea.
Festuca sylvatica.
Botrychium Lunaria.
Tortula insulana.

One rare plant, *Cicuta virosa*, has been reported to grow near the Wharfe at Haslingford, near Poole, but wants verification. The writer could only find *Œnanthe crocata.*

Between Harewood and Collingham, the Wharfe, after many devious turnings, breaks through the escarpment of [redacted]

Clematis Vitalba.
Thalictrum flavum.
Helleborus viridis.
Berberis vulgaris.
Papaver Argemone.
Cardamine amara.
Alyssum calycinum.
Viola Reichenbachiana.
Arenaria tenuifolia.
Stellaria neglecta.
Saponaria Vaccaria.
Rhamnus catharticus.
Genista tinctoria.
Astragalus hypoglottis.
Spiræa Filipendula.
Sanguisorba officinalis.
Adoxa Moschatellina.
Saxifraga tridactylites.
Bryonia dioica.
Viscum album.
Asperula cynanchica.
Inula Conyza.
Cichorium Intybus.
Campanula glomerata.
Orobanche minor.
Lysimachia vulgaris.
Echium vulgare.
Lithospermum arvense.
Lithospermum officinale.
Solanum nigrum.
Veronica Anagallis.
Hyoscyamus niger.
Calamintha menthifolia.
Verbena officinalis.
Nepeta Cataria.
Orchis Morio.
Orchis ustulata.
Spiranthes autumnalis.
Epipactis palustris.
Ophrys apifera.
Habenaria bifolia.
Allium Scorodoprasum.
Polystichum angulare.
Equisetum Telmateia.
Mnium serratum.
Antitrichia curtipendula.
Hypnum riparium et piliferum.
Cylindrothecium concinnum.

Such a variety of interesting plants grow about the craggy banks of the Wharfe where it begins to break through the main Permian formation, that it is not possible to give more than an illustrative Florula for Boston Spa, Thorp Arch, and Newton Kyme. The more interesting species that have been found between the Flint Mill, two miles above Thorp Arch, and Newton Kyme, two below it, upon the wooded river bank and on the flatter land above it, are—

Thalictrum flexuosum.
Ranunculus salsuginosus.
Ranunculus penicillatus.
Adonis autumnalis.
Actæa spicata.
Nasturtium amphibium.
Hesperis matronalis.
Alyssum incanum.
Cheiranthus Cheiri.
Viola hirta.

Silene noctiflora.
Stellaria nemorum.
Hypericum montanum.
Geranium columbinum.
Geranium pyrenaicum.
Astragalus glycyphyllus.
Genista tinctoria.
Rosa micrantha.
Rosa spinosissima.
Pastinaca sativa.
Conium maculatum.
Œnanthe Phellandrium.
Caucalis daucoides.
Saxifraga Geum.
Nardosmia fragrans.
Lactuca virosa.
Galium tricorne.
Asperula cynanchica.
Inula Conyza.
Eupatorium cannabinum.
Scabiosa columbaria.
Anthemis tinctoria.
Picris hieracioides.
Specularia hybrida.
Chlora perfoliata.

Epipactis latifolia.
Ophrys apifera.
Ophrys muscifera.
Orchis pyramidalis.
Orchis ustulata.
Neottia Nidus-Avis.
Narcissus Pseudo-Narcissus.
Allium Scorodoprasum.
Allium oleraceum.
Gagea lutea.
Convallaria majalis.
Lilium Martagon.
Paris quadrifolia.
Potamogeton perfoliatus.
Potamogeton flabellatus.
Lemna trisulca.
Carex digitata.
Carex sylvatica.
Melica nutans.
Brachypodium pinnatum.
Hordeum sylvaticum.
Gymnostomum tenue.
Pottia Heimii.
Physcomitrium pyriforme.
Mnium undulatum.

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Barwick-in-Elmete. Its course in this district is through the Permian formation; along the bank of the stream, where it forms a wooded escarpment, the limestone has been quarried, and good sections are exposed near Barwick. Below the limestone in the bed of the stream the shales of the coal measures may be seen, their unconformability with the limestone being very apparent.

A tributary of the Wharfe runs from Thorner through Norwood Bottoms, *viâ* Clifford flax-mill, into the Wharfe below Boston Spa. The Cock itself passes through Aberford, and for a couple of miles runs east; it then turns northwards, still in the limestone, and falls into the Wharfe near Tadcaster. The plants found within the district about Thorner, Bramham, Barwick, Hazlewood, Aberford, Stutton, and Tadcaster, are unusually numerous and interesting. The rarer are—

Thalictrum flavum.
Adonis autumnalis.
Myosurus minimus.
Helleborus viridis.
Actæa spicata.
Aquilegia vulgaris.
Nuphar lutea.
Draba incana.
Helianthemum vulgare.
Viola hirta.
Viola odorata.
Cerastium arvense.
Arenaria tenuifolia.
Hypericum maculatum.
Hypericum dubium.
Geranium pratense.
Geranium pusillum.
Geranium pyrenaicum.
Euonymus europæus.
Rhamnus catharticus.
Genista anglica.
Ononis spinosa.
Vicia tetrasperma.
Poterium Sanguisorba.
Rubus leucostachys.
Rubus Sprengelii.
Rubus Koehleri.
Rubus diversifolius.
Rosa spinosissima.
Rosa tomentosa.
Rosa micrantha.
Rosa incana.
Rosa verticillacantha.
Rosa subcristata.
Sedum dasyphyllum.
Parnassia palustris.
Chærophyllum Anthriscus.
Bryonia dioica.
Cornus sanguinea.
Asperula cynanchica.
Scabiosa columbaria.
Carduus eriophorus.

Arctium intermedium.
Matricaria Chamomilla.
Anthemis arvensis.
Artemisia Absinthium.
Erigeron acris.
Eupatorium cannabinum.
Picris hieracioides.
Helminthia echioides.
Crepis biennis.
Campanula glomerata.
Campanula rapunculoides.
Specularia hybrida.
Pyrola minor.
(Monotropa Hypopitys?)
Erythræa pulchella.
Chlora perfoliata.
Gentiana Amarella.
Verbascum Blattaria.
Linaria minor.
Linaria Elatine.
Veronica Buxbaumii.
Lathræa squamaria.
Verbena officinalis.
Salvia Verbenaca.
Calamintha Acinos.
Rumex palustris?
Daphne Laureola.
Spiranthes autumnalis.
Epipactis media.
Orchis pyramidalis.
Ophrys muscifera.
Ophrys apifera.
(Ophrys aranifera?)
Allium vineale.
Ornithogalum nutans.
Colchicum autumnale.
Convallaria majalis.
Paris quadrifolia.
(Scirpus acicularis?)
Arundo Epigejos.
Poa nemoralis.
Bromus erectus.
Bromus secalinus.
Brachypodium sylvaticum.
Brachypodium pinnatum.
Lolium temulentum.
Hordeum sylvaticum.
Polystichum angulare.
Ophioglossum vulgatum.
Equisetum hyemale.

[redacted]

what sluggish and uninteresting river, flowing gently in a deep channel between banks no longer rocky, but formed merely of the abrupt loamy or muddy edges of the arable lands it winds among. The tide flowing up from the Humber reaches as far as Naburn Lock in the Ouse; but up the Wharfe only as far as Nun Appleton and Ryther, where it is joined by a stream from Woolas, running by Nun Appleton Hall—in the woods around which the Misletoe (*Viscum album*) grows rather plentifully, but perhaps not truly native. The more noteworthy plants in this district, inclusive of the level area about Church Fenton—in the dykes near which some uncommon water-plants grow—are named in the list now to be given:—

Thalictrum flavum.
Ranunculus trichophyllus.
Nuphar lutea.
Nymphæa alba.
Nasturtium amphibium.
Cerastium aquaticum.
Rubus thyrsoideus.
Rubus carpinifolius.
Lythrum Salicaria.
Hippuris vulgaris.
Œnanthe fistulosa.
Daucus carota.
Sium angustifolium.
Viscum album.
Tanacetum vulgare.
Linaria Elatine.
Nepeta Cataria.
Mentha piperata.
Lysimachia Nummularia.
Samolus Valerandi.
Symphytum officinale.
Salix pentandra.
Salix viminalis.
Salix purpurea.
Salix rubra.
Salix triandra.
Potamogeton flabellatus.
Potamogeton perfoliatus.
Alisma ranunculoides.
Sparganium minimum.
Carex paludosa.
Carex acuta.
Carex riparia.
Hordeum pratense.

One small tract of bog and sandy corn-land in the more immediate neighbourhood of York remains to be described. In mapping out the Riding into drainage districts, some division of the Ainsty became necessary; but on account of the ill-marked water-parting between the Nidd and Wharfe river-basins, the line drawn from Angram through Askham Bryan to York is only conventional. The corn-lands near York are composed of a light sandy loam, and the country lanes with "wasteful bordering" (as the farmers think) of sandy turf and thickety hedgerow provide conditions suitable for the growth of several sand-loving species of plants rare elsewhere in the Riding. Such are—

Papaver Argemone.
Teesdalia nudicaulis.
Coronopus Ruellii.
Alyssum calycinum.
Cerastium semidecandrum.
Cerastium arvense.
Silene noctiflora.
Sagina ciliata.
Erodium cicutarium.
Oxalis corniculata.
Trifolium arvense.
Trifolium scabrum.
Trifolium striatum.
Ornithopus perpusillus.
Vicia lathyroides.

Torilis nodosa.
Pimpinella magna.
Lactuca virosa.
Anthemis Cotula.
Filago minima.
Picris hieracoides.
Linaria Elatine.
Euphorbia platyphylla.
Veronica triphyllos.
Lamium incisum.
Marrubium vulgare.
Ornithogalum nutans.
Allium vineale.
Bromus secalinus.
Sclerochloa distans.

[redacted]

Salvia Verbenaca.
Chenopodium olidum.
Chenopodium intermedium.
Chenopodium murale.
Rumex aquaticus.
Salix amygdalina.
Potamogeton flabellatus.
Potamogeton lucens.
Sclerochloa distans.
Hordeum pratense.
Leskea polycarpa.
Myrinia pulvinata.

Upon Knaves-mire—the York racecourse—and near it on Hobmoor, with its numerous disused brick-ponds, now overrun with Willow bushes, Sedges, and Reedmace, the following noteworthy plants may be found :—

Ranunculus sceleratus.
Cochlearia officinalis.
Trifolium fragiferum.
Veronica triphyllos.
Mentha piperata.
Rumex palustris.
Polygonum minus.
Alisma lanceolata
Hydrocharis Morsus-Ranæ.
Typha angustifolia.
Lemna trisulca.
Lemna gibba.
Carex riparia.
Carex axillaris.
Carex Pseudo-cyperus.
Glyceria aquatica.

From the brick-ponds at Dringhouses, Mr. George Webster, of York, reports *Utricularia vulgaris;* and in "Quaker's Wood," near the same place, *Pyrola minor* has lately been discovered to grow sparingly.

But the best botanical locality in this district is undoubtedly Askham Bogs—one of those bits of undrained, unimproved swamp, overgrown for the most part with aboriginal brushwood, which have now become so rare throughout the lower zone of the Riding. Reclamation is at last seriously contemplated, but at present they remain a veritable picture of the past—much as they were when wolves from the forest of Galtres prowled around them. The Bogs yield a remarkable number of rare and uncommon plants, considering their comparatively limited area—only about a score acres—part being boggy, open, heather-land, where the Sweet Gale or Bog Myrtle grows in profusion—the spring shoots of this plant being locally used in the preparation of a kind of weak beer—and part a dense swampy thicket of Alder and Buckthorn, guarding the Royal Fern (Osmunda), that in its boggy openings attains a perfection of growth rarely surpassed. Fronds, laden in their upper part with noble fructification, may often be gathered five and even six feet in height. The bogs proper are fenced in by wide ditches of stagnant peaty water, in which flourishes the great Spearwort in fine condition, along with *Œnanthe Phellandrium*, the Frog-Bit, and *Hottonia palustris*. Here also grows *Carex paradoxa*, a rare and not ungraceful sedge, in great abundance; and the swampy meadows surrounding the bogs furnish the scarce Unarmed Meadow Thistle (*Carduus pratensis*). The following list enumerates most of the rarer plants to be found in and about the bogs: all of them cannot be said to be ascertained even yet. The writer has gathered one plant, *Carex limosa*, not on record; and Mr. G. Webster has even found *Ophrys muscifera* amongst Whins at the entrance to the bogs; whilst only

[redacted]

Mentha sativa.
Myosotis repens.
Hottonia palustris.
Lysimachia vulgaris.
Samolus Valerandi.
Rumex Hydrolapathum.
Polygonum mite.
Myrica Gale.
Salix rugosa.
Salix aurita.
Salix ambigua.
Salix repens.
Sparganium minimum.
Lemna trisulca.
Lemna polyrhiza.
Hydrocharis Morsus-Ranæ.
Juncus obtusiflorus.
Cladium Mariscus.
Carex disticha.
Carex paradoxa.
Carex stricta.
Carex limosa.
Carex pallescens.
Carex fulva.
Carex Pseudo-cyperus.
Carex riparia.
Carex filiformis.
Calamagrostis lanceolata.
Triodia decumbens.
Molinia cærulea.
Glyceria plicata.
Athyrium Rhæticum.
Nephrodium spinulosum.
Nephrodium cristatum.
Nephrodium Thelypteris.
Osmunda regalis.
Lycopodium inundatum.
Chara flexilis.
Leucobryum glaucum.
Splachnum ampullaceum.
Leskea polyantha.
Hypnum cordifolium.

The Wharfe river-basin, viewed as a whole, must be pronounced rich in plants: it is a large district, however, ranging from an elevation of 2,200 feet on the slopes of the Dalehead to low-lying sandy and marshy tracts not much over 110 feet above sea level. Its river crosses all four principal tracts of Limestone, Gritstone, Magnesian Limestone, and New Red Sandstone; and whilst possessing a full share of xerophilous species, its lower levels are rich in hygrophilous and arenophilous types too.

CHAPTER VIII.

THE AIRE DISTRICT.

THE river Aire occupies a long strip of country, extending from Malham Tarn in the north-west to Goole in the south-east of the Riding. The valley is very narrow, rarely, if ever, reaching a width of ten miles. It embraces a vast range and variety of scenery. Gigantic scars of Carboniferous Limestone characterize the upper and northern part, where the line of the Great Craven Fault passes across the valley, throwing the limestone down to the south, to such an extent that sandstones of Millstone Grit age are found abutting against the foot of the scars of Malham Cove, 285 feet high, and Gordale Scars, which [redacted] phases, we pass from the coal formation, over the Permian Limestone escarpment stretching from Garforth to Pontefract, into the broad flat valley of the Vale of York. This extends to the river Ouse, only relieved from monotonous flatness by Hambleton Hough and Brayton Barf, which, composed of red sandstone, harder than usual, have resisted the denuding agencies of water and ice, and stand 150 feet above the surrounding plain. They are clothed with trees, and form a striking landmark for many miles around.

The River Aire has its source in several small streams rising in the moorlands at the foot of Fountains Fell and Hard Flask. The principal stream runs from Capon Hall to the Tarn, and is joined by others in its passage. A second feeder, having its origin near Capon Hall, runs in a more southerly direction for about a mile over the "Streets," and sinks in a cleft in the rock near an old smelting mill. The Mountain Limestone which forms the surface of a great part of this elevated region is weathered and denuded by the rain and atmosphere in lines crossing each other at all angles. It now presents the appearance of an immense white pavement with deep fissures and cracks dividing it in all directions. From this appearance it has doubtless derived the name "Streets."

Malham Tarn is the only natural sheet of water of any size within our area. It is about half a mile square, surrounded on three sides by peaty moor and bog; the fourth, rising from the banks of the Tarn to a considerable height, presents a series of beautiful scars of limestone, their upper surface forming the summit of drainage between Airedale and Wharfedale. The edge of the Tarn is bog-land in some parts, but in others has a beach of silvery sand.

In Malham Tarn, on the peat-bog around it, and upon the drier limestone pasture and fells in its neighbourhood, the following rare plants have been found from time to time. One or two seem to be uncertain in their appearance, however, being dependent upon conditions that vary as the season is a hot and dry or a cold and wet one; and the water plants are difficult to procure except after a storm, when portions of them may be found, washed from their deeper bed, upon the beach.

Ranunculus diversifolius.
Ranunculus Lenormandi.
Thlaspi occitanum.
Draba muralis.
Hutchinsia petræa.
Viola palustris.
Viola lutea.
Stellaria glauca.
Alsine verna.
Sagina ciliata.
Montia rivularis.
Radiola millegrana.
Potentilla alpestris.
[redacted]

(Orobanche hederæ ?)
Pinguicula vulgaris.
Primula farinosa.
Littorella lacustris.
Salix repens.
Potamogeton ericetorum.
Potamogeton heterophyllus.
Potamogeton lucens.
Potamogeton prælongus.
Potamogeton perfoliatus.
Potamogeton densus.
Gymnadenia albida.
Carex dioica.
[redacted]

Hedwigia ciliata.	Bartramia ithyphylla.
Orthotrichum saxatile.	Bartramia calcarea.
Pogonatum alpinum.	Splachnum sphæricum.
Aulacomnium palustre.	Hypnum Blandovii, W. and M.
Bryum intermedium.	Hypnum nitens et glareosum.
Bryum Zierii.	Hypnum stellatum.
Mnium orthorhyncum.	Hypnum lycopodioides.
Cinclidium stygium.	Hypnum revolvens.
(Paludella squarrosa?)	Hypnum scorpioides.

The stream from Malham Tarn runs half a mile southwards, and sinks through a large opening in the limestone, which is filled to the surface with rounded blocks of stone. Nothing more is seen of the water until the foot of Malham Cove is reached, though there is every appearance of the water having at one time passed along the surface, and tumbled—it must have been a fine cataract!—over the face of the magnificent amphitheatre of limestone forming Malham Cove.

The water rushes in a powerful stream from an opening at the base of the Cove, and, pursuing a southward course, passes through the village of Malham, and half a mile below is joined by the stream from Gordale. The latter has its source on Hard Flask, and flows in a deepening channel across the moorlands between Malham and Kilnsey, between 1,200 and 1,300 feet above the sea level. The channel of the stream deepens rapidly as it approaches the great line of escarpments running eastwards from Malham, until it passes over a series of waterfalls, between immense overhanging mural precipices worn in the limestone, and whose intense grandeur and sublimity cannot be realized in any mere description. Winding at the bottom of the constantly widening gorge, the Gordale Beck emerges in the open plain to the south of the Craven Fault, and, as already stated, joins the Aire below the village of Malham.

The rocky declivities of Malham Cove and the Gordale scar and ravine, and their neighbourhood, are peculiarly rich in uncommon plants. The following are the rarer species only :—

Thalictrum montanum.
Trollius europæus.
Actæa spicata.
Thlaspi occitanum.
Draba muralis.
Draba incana.
Helianthémum canum.
Sagina nodosa.
Geranium lucidum.
Geranuim sanguineum.
Geranium pratense.
Hippocrepis comosa.
Potentilla alpestris.
Rubus saxatilis.
Rubus plicatus.
Rosa spinosissima.
Rosa dumetorum.
Rosa subcristata.
Pyrus rupicola.
Epilobium angustifolium.

Polemonium cæruleum.
Veronica Anagallis.
Lamium maculatum.
Primula farinosa.
Neottia Nidus-Avis.
Epipactis ovalis.
Orchis incarnata.
Allium complanatum.
Gagea lutea.
Potamogeton densus.
Blysmus compressus.
Sesleria cærulea.
Polypodum calcareum.
Cystopteris angustata.
Gymnostomum microstomum.
Seligeria pusilla.
Distichum capillaceum.
Tortula rigidula, etc.
Encalypta ciliata, etc.
Trichostomum tophaceum, etc.

[redacted]

Airton to Bellbusk, where it is joined by the Otterburn Beck. The latter consists of an agglomeration of countless smaller streams, draining the somewhat flat country of Scosthrop and Otterburn Moors. The level of the extensive valley from Otterburn to Gargrave is broken by numerous rounded hillocks rising to a height of about 100 feet, composed of the *débris* of ancient glaciers. It is generally well wooded, or forms rich grazing pastures.

The rarer plants of the woods, pastures, and stream-sides from Malham downwards, by Kirby-Malham and Airton, to Bellbusk and Gargrave, are—

Arabis hirsuta.
Stellaria nemorum.
Geranium pratense.
Euonymus europæus.
Vicia sylvatica.
Geum rivale.
Sanguisorba officinalis.
Prunus Padus.
Rubus suberectus.
Rosa villosa et Sabini.
Rosa verticillacantha.
Sedum sexangulare.
Sedum acre.
Saxifraga granulata.
Adoxa Moschatellina.
Myrrhis odorata.
Hieracium sylvaticum.
Carduus heterophyllus.
Solidago Virgaurea.
Inula Helenium.
Wahlenbergia hederacea?
Campanula latifolia.
Pyrola minor.
Myosotis sylvatica.
Epipactis ovalis.
Convallaria majalis.
Potamogeton densus.
Potamogeton perfoliatus.
Carex lepidocarpa.
Asplenium Ruta-muraria.
Chara aspera.
Bartramia fontana.
Tortula rigidula, etc.
Fontinalis squamosa.

A short distance below Gargrave the Aire is joined by a considerable stream, the product of many rills on Bordley Mastiles. Its southward course is assisted by streams from Malham and Threshfield Moors and the Weets. It runs in a deep channel near Winterburn, and in the beautiful Eshton district. At Eshton Bridge it is joined by a larger tributary from Rilstone and Flasby, and then turns southward to the Aire. The Flasby Fells on the east of the river stand in rugged prominence, and form a characteristic feature in the landscape. They have very much the appearance of an extinct volcano, but the similarity ends there.

From Gargrave to Skipton the valley is a flat, nearly level plain, with hills surmounted by grit-rock on either side. At Skipton the rocks are thrown up in the form of a large anticlinal, which stretches from Clitheroe to Knaresborough. The Mountain Limestone of the Haw Park is a consequence of the anticlinal, and southwards it may be seen pushed to the surface, at Marton and other places.

About Skipton, including the country about Skipton Rock and Draughton, the flora has partly a gritstone and partly a limestone character. The following are the more noteworthy species that may be met with :—

Trollius europæus.	Rubus Borreri.
Draba verna.	Rosa villosa.
Arabis hirsuta.	Circæa lutetiana.
Cardamine amara.	Saxifraga tridactylites.
Lepidium campestre.	Silaus pratensis.
Geranium lucidum.	Carlina vulgaris.

[redacted]

corresponding strata of the moors of Cononley, Keighley, and Bingley. Tributary streams join from all these districts, notably the becks from Silsden and Glusburn valleys; and lower down, the river Worth, which runs along a very finely wooded valley, empties into the Aire near Keighley.

The florula of the Aire valley from Kildwick to Shipley, with the valleys of the tributary streams, Worth and Harden, is not a rich one, the limestone having now been left behind. One or two lowland and aquatic plants begin to put in an appearance by the side of the Leeds and Liverpool Canal; and a few of the commoner montane species that have followed the stream down from Gordale still maintain a place by the river-side. But even such grow scarce as the country becomes more populous.

The climate and general character of the dale must have altered greatly during the last century, if the Killarney Fern (*Trichomanes*), which formerly grew in Bingley Woods, was ever indigenous. Possibly, however, if the truth were known, it had been planted for a purpose, like the *Epimedium alpinum*, introduced into the same woods to deceive Dr. Richardson. And were a former Flora of the Riding trustworthy, instead of the opposite, as shewn upon internal evidence, some strange species, such as *Sium latifolium*, *Peucedanum palustre*, and *Scheuchzeria palustris*, have, in defiance of all the facts hitherto known as to their distribution and vertical range, made this part of the Aire valley their abode! The writer's suspicion as to the *Trichomanes* may, however, be unwarrantable after all. Information has just come to hand * to the effect that "*Trichomanes radicans* is still in Yorkshire (or *was* only a very few years ago). I have a Yorkshire plant found by a lady. It is just Ray's type!"

* From James Backhouse, of York, in letter to Dr. Lees, Oct. 11, 1877.

The following list gives all the more interesting plants now existing in Airedale between Steeton and Rawden, and in the collateral valleys of Holden, Haworth, Harden, and Esholt, with Rawden; those italicised not truly wild, but as casuals or introductions:—

Ranunculus sceleratus.
Nasturtium terrestre.
Lepidium campestre.
Camelina sativa.
Viola odorata.
Drosera rotundifolia.
Fumaria Boræi.
Corydalis claviculata.
Cardamine amara.
Stellaria nemorum.
Lychnis vespertina.
Geranium pyrenaicum.
Geranium pratense.
Hypericum Androsæmum.
Hypericum elodes.
Malva moschata.
Euonymus europæus.
Rhamnus Frangula.

Tanacetum vulgare.
Chrysanthemum segetum.
Solidago Virgaurea.
Vaccinium Vitis-Idæa.
Convolvulus arvensis.
Erica cinerea.
Erica tetralix.
Digitalis purpurea.
Lamium Galeobdolon.
Anchusa sempervirens.
Symphytum officinale.
Veronica montana.
Veronica Buxbaumii.
Veronica scutellata.
Lycopus europæus.
Myosotis sylvatica.
Lycopsis arvensis.
Lithospermum arvense.

[redacted]

Carex paludosa.
Luzula sylvatica.
Aira præcox.
Molinia cærulea.
Aira flexuosa.
Botrychium Lunaria.
Ophioglossum vulgatum.
Polypodium Dryopteris.

The Aire valley is somewhat contracted as it proceeds past Shipley (being joined by the Black Beck from Bradford), Apperley, Newlay, and Kirkstall, to Leeds. At Kirkstall, in a beautiful bend of the river, is the Cistercian Abbey founded by De Lacy in the twelfth century. Formerly, the walls and surrounding district were richer in plants than now; but the gradual encroachment of the town, with the spoliation of mills, dyeworks, and foundries, have banished nearly all of them. *Hippuris vulgaris* once grew in the river at the foot of the Abbey meads, but like the fish that inhabited the same water, is a thing of the past. The following plants, however, may be found:—

Arabis hirsuta.
Geranium pratense.
Spartium Scoparium.
Epilobium parviflorum.
Lactuca virosa.
Valeriana officinalis.
Hieracium boreale.
Tanacetum vulgare.
Digitalis purpurea.
Polygonum Bistorta.
Sagittaria Sagittifolia.
Acorus Calamus.
Butomus umbellatus.
Carex paludosa.
Milium effusum.

In the stonework of the canal banks at Armley Mills abundance of *Potentilla Norvegica*, introduced originally —many years ago—with pit-props of foreign wood, is now thoroughly established.

Four miles from Leeds a small stream rises, which drains through the now disused Blackhill Dam at Adel, and passing through Adel "Blackmoor," down the Meanwood valley by Weetwood, enters the Aire at Leeds. At Adel, whilst breaking some waste ground, a large number of flint implements, along with objects of more recent date, were found, and are now preserved in the Museum of the Philosophical Society at Leeds.

Adel Bog, on Blackmoor, though every year lessened by the inclosure and drainage of some strip upon its border, as it is now almost the only bit of aborignal moorland within easy reach of Leeds, is also one of the better botanical localities.

The following plants still exist, and may all be gathered in the course of a two-hours' walk, without any great deviation in the route from the over-grown swamp (once Blackhill Dam) down by the stream-side, past Adel Bridge, through the Bog itself, and on by Scotland and Smithy Mills and Weetwood Bottoms, to Woodhouse Carr, a suburb of Leeds. In this case the species are given in the order in which they would be found by following the line indicated.

Ranunculus peltatus.	Polygonum mite.
Erythræa Centaurium.	Gnaphalium uliginosum.
Veronica scutellata.	Galium uliginosum.
Sagina nodosa.	Potamogeton lucens.
Radiola millegrana.	Equisetum limosum.

[redacted]

Vaccinium Vitis-Idæa.
Erica Tetralix.
Salix Russelliana.
Lysimachia nemorum.
Genista anglica.
Polygala depressa.
Narthecium ossifragum.
Drosera rotundifolia.
Pinguicula vulgaris.
Myosotis repens.
Hypericum elodes.
Parnassia palustris.
Viola palustris.
Anagallis tenella.
Vaccinium Oxycoccos.
Carex dioica.
Carex pilulifera.
Carex flava.
Carex pulicaris.
Carex stellulata.
Aquilegia vulgaris.
Nephrodium dilatatum.
Carex paniculata.
Carduus heterophyllus.
Nasturtium terrestre.
Stachys palustris.
Rumex sanguineus.
Myosotis strigulosa.
Hypnum commutatum.
Myosotis repens.
Helosciadium nodiflorum.
Rubus rhamnifolius.
Rubus leucostachys.
Solidago Virgaurea.
Rubus mucronulatus.
Epilobium obscurum.
Carex curta.
Senecio saracenicus.
Milium effusum.
Typha latifolia.
Cardamine amara.
Carex remota.
Eupatorium cannabinum.
Vinca minor.
Myrrhis odorata.
Melampyrum pratense.
Aira flexuosa.
Allium oleraceum.
Epilobium roseum.
Polygonum Bistorta.
Lamium Galeobdolon.
Asperula odorata.
Scutellaria galericulata.
Polygonum maculatum, Dyer.
Lythrum Salicaria.
Scrophularia aquatica.

Ranunculus Lingua, *Geranium sanguineum*, *Osmunda*, and *Butomus* formerly grew at Adel and Meanwood, but have long ago disappeared.

The Aire next pursues a course east by south-east, passing through Hunslet, Oulton, and Methley to its confluence with the Calder at Castleford. The whole of this extent is along the Upper Coal-measure tract. The country is well wooded and park-like, and is studded with several stately Halls. Near one of them—Temple Newsam—the river receives a small tributary on its north side, that rising near Shadwell, seven miles away, feeds a fine lake in the Park at Roundhay—now the Leeds Public Park—and flows thence a little south of Roundhay Limehills—the point nearest to Leeds where limestone crops up on the surface, and a good botanical locality—and on, under Killingbeck Bridge, and by Skelton Grange to the Aire. The plants most worthy of notice that occur about Shadwell, Roundhay, and Temple Newsam, together with those to be found on the banks of the Aire from Hunslet to Castleford, are given in the following list:—

Ranunculus submersus.
Ranunculus sceleratus.
Ranunculus auricomus.
Barbarea stricta.
Nasturtium amphibium.
Berberis vulgaris.
Cerastium aquaticum.
Spergularia rubra.
Geranium pratense.
Euonymus europæus.
Rubus Lindleianus.
[redacted]

Tanacetum vulgare.
Atropa Belladonna.
(Orobanche major.)
Hottonia palustris.
Linaria Cymbalaria.
Lycopus europæus.
Chenopodium rubrum.
Salix pentandra.
Salix purpurea.
Salix triandra.
Salix viminalis.
[redacted]

in the survival of an old distich, without application now, unless it be an ironical one, in which some stranger poetaster is said to have sung the healthy custom, and the resultant charms of the young women who dwelt in the town standing where Aire and Calder meet. As the couplet has it—

> "Castleford maids had need be fair,
> For they wash in the Calder and rinse in the Aire."

The matter is almost too trivial for mention, but the botanist visiting the district now, who knew it fifty years ago, when the rhyme represented a fact, could hardly help a passing reflection in regard to it.

Leaving Castleford, the Aire cuts a passage through the Permian Limestone, which rises to an average height of near 300 feet, between Brotherton and Ferrybridge. Upon the river banks here, and in the lower lands from Ferry Fryston to Birkin, grow such plants as—

Thalictrum flavum.
Thalictrum flexuosum.
Ranunculus trichophyllus.
Sinapis nigra.
Nasturtium sylvestre.
Reseda lutea et luteola.
Stellaria aquatica.
Ribes rubrum.
Conium maculatum.
Galium palustre.
Carduus pratensis.
Tanacetum vulgare.
Helminthia echioides.
Mentha sativa.
Mentha rubra.
Lysimachia Nummularia.
Lysimachia vulgaris.
Samolus Valerandi.
Salix pentandra.
Salix Forbyana.
Salix Smithiana.
Salix stipularis.
Sagittaria sagittifolia.
Juncus compressus, Jacq.
Scirpus lacustris.
Carex intermedia.
Carex acuta.
Agrostis alba.
Glyceria aquatica.

Away from the river, upon the gentle wooded elevations of the Permian formation, and in the frequent, disused lime quarries about the villages of Sherburn, Micklefield, Ledsham, Kippax, Brotherton, Fairburn, Pontefract, and

Knottingley, the following characteristic Lowland species of xerophilous type occur, some plentifully, others confined to one or two spots, but all upon the limestone. They may all, however, be found within four or five miles of Brotherton as a centre.

Clematis Vitalba.
Anemone Pulsatilla.
Aquilegia vulgaris.
Actæa spicata.
Papaver hybridum.
Diplotaxis tenuifolia.
Sisymbrium Irio.
Lepidium Smithii.
Senebiera Coronopus.
Reseda lutea.
Viola hirta.
Cerastium arvense.
Sagina apetala.
Hypericum montanum.
Rhamnus catharticus.
Astragalus hypoglottis.
Astragalus glycyphyllus.
Anthyllis vulneraria.

Cichorium Intybus.
Carduus eriophorus.
Carlina vulgaris.
Centaurea Scabiosa.
Anthemis arvensis.
Artemisia Absinthium.
Inula Conyza.
Erigeron acris.
Crepis taraxacifolia.
Campanula glomerata.
Chlora perfoliata.
Gentiana Amarella.
Atropa Belladonna.
Linaria Elatine.
Linaria minor.
Verbena officinalis.
Nepeta Cataria.
Calamintha Acinos.

[redacted]

Pottia curvicollum.
Zygodon viridissimus.
Hypnum molluscum.
Hypnum salebrosum.

The river, after leaving the Permian Limestone, pursues a course, with many turnings and windings, through the comparatively flat plain in which are Birkin, Kellington, Haddlesey, Snaith, Rawcliffe, Camblesforth and Drax. The whole of this district is enveloped in thick beds of drifted boulders and warp clays, so that it is only in occasional gravel pits or excavations for railway purposes that the New Red or Triassic Sandstone is exposed. Such examples occur at Hensall, Heck, and Pollington. A remarkable exception to the otherwise unbroken level of the plain is formed by the two large mounds, called Hambleton Hough and Brayton Barf. These hills are on the north of the Aire, about half-way between Monk Frystone and Selby. A number of small streams gather from this neighbourhood, their united waters forming Hambleton Dyke, which joins the Ouse at Selby. This is about half-way between the Aire and the Wharfe, but in the present instance will be considered as part of the Aire drainage district. The plants that occur most frequently upon this level plain, and upon the two sandstone elevations rising from it, are such as love a dry, light, sandy soil, or else are aquatic. Upon the river bank a few of montane or limestone type may occasionally be met with, brought down by the stream in *spate*, but they are rare. In the following lists the species of a southern and Germanic type greatly exceed those of a northern type.

The more noteworthy species that have been found about Hambleton Hough, Brayton Barf, Morton Bog, Gateforth, Wistow, and Selby, are—

Corydalis claviculata.
Viola canina, Bab.
Erodium cicutarium.
Scleranthus annuus.
Trifolium arvense.
Trifolium striatum.

Ornithopus perpusillus.
Rubus Lindleianus.
Rubus dumetorum, Weihe.
Rubus fusco-ater.
Sedum Telephium.
Œnanthe Phellandrium.
Œnanthe fistulosa.
Pimpinella magna.
Fedia olitoria.
Gnaphalium sylvaticum.
Bidens cernua.
Datura Stramonium.
Lycopsis arvensis.
Lysimachia nemorum.
Verbascum Thapsus.
Plantago Coronopus.
Chenopodium rubrum.
Butomus umbellatus.
Allium vineale.
Potamogeton pectinatus.
Potamogeton obtusifolius.
Potamogeton natans.
Sclerochloa distans.
Lastrea spinulosa.
Ophioglossum vulgatum.
Weissia cirrhata.
Atrichum undulatum.
Bryum carneum.
Cinclidotus fontinaloides.
Hypnum elegans.
Hypnum striatum.
Neckera complanata.

Upon the flat tract of country lying about Birkin, Kellington, Haddlesey, Barlow, Drax, Camblesforth, Carlton, Snaith, Heck, Pollington, Rawcliffe, and about the Aire from Newland to its confluence with the Ouse, the following species have been ascertained to grow: a considerable portion of them—those in italics—naturalizing aliens only :—

[redacted]

Gentiana Pneumonanthe.
Vinca minor.
Solanum nigrum.
Cuscuta Trifolii.
Orobanche Rapum.
Linaria Elatine.
Lysimachia vulgaris.
Lysimachia Nummularia.
Anagallis tenella.
Hydrocharis Morsus-Ranæ.
Orchis ustulata.
Orchis Morio.
Narcissus Pseudo-narcissus.
Allium vineale.
Allium oleraceum.
Typha angustifolia.
Scirpus maritimus.
Cystopteris fragilis.
Nephrodium Oreopteris.
Osmunda regalis.
Ophioglossum vulgatum.
Pilularia globulifera.
Equisetum sylvaticum.
Weissia controversa.
Physcomitrium pyriforme.
Tortula ruralis.
Tortula subulata.
Orthotrichum affine.
Polytrichum juniperinum.
Aulacomnium palustre.
Aulacomnium androgynum.
Mnium punctatum.
Fissidens bryoides.
Climacium dendroides.
Hypnum ruscifolium.
Hypnum fluitans.
Hypnum squarrosum.
Hypnum cuspidatum.

The Flora of the Aire Valley as a whole presents a great similarity to that of the Wharfe. Details of the differences would tell us little, unless the respective features of the two districts, as to soil and rock constitution, and their comparative areas, were taken into consideration; for geographical contrasts purely have had little or nothing to do with the result; and lithology, in relation to plant distribution, will be dealt with in another place. The higher reaches of both rivers are in tracts of mountain limestone, and have in consequence a similar flora. The middle third of the Aire Valley is more populous than the corresponding part of the Wharfe, and so poorer in rare species, for the surface has been more altered; and in their lower parts both rivers break through the strip of Permian Limestone, and debouch upon the level drift-hid Triassic tracts, in which part of their course they are about equally rich in typical arenophilous and hygrophilous species of plants.

CHAPTER IX.

THE CALDER DISTRICT.

THE River Calder receives its supplies from many small streams rising along the summit of the Pennine anticlinal. One of the principal of these has its source in a small clough between Todmorden and Rochdale, and passes eastwards along the Todmorden Valley. The elevation of the Pennine chain is at this point depressed to such an extent, that the watershed is removed considerably beyond the comital boundary, and to the westward of it the Yorkshire Calder rises within Lancashire. This physical feature has been utilized for the passage of the Lancashire and Yorkshire Canal, and more recently the Railway. The river is speedily augmented by numerous

[redacted]

of the trees attain any great size—is made up of Mountain Ash, Oak, Birch, Sallows, Wych Elm, and Hazel; whilst planted woods of Larch or Sycamore and Oak are frequent, natural woods are rare. *Nardus stricta* and *Festuca ovina* are the commonest grasses where the ground is open, and *Holcus* with *Aira cæspitosa* in shadier situations. In spring the Hyacinth Blue-bell (not the Blue-bell of Scotland) carpets the wood-slopes everywhere with its lovely smalt-blue blooms, and later *Allium ursinum* and *Lychnis diurna* vary the surface and make a beautiful mosaic; but the Primrose and some other flowers, abundant upon limestone soil, are rare in this district. Where calcareous grit occurs in the clough bottoms, however, with Primroses and Sanicle—formerly in great repute as a "simple," as shown by an old proverb, "He who hath Sanicle needeth no Surgeon"—may be found *Convallaria majalis*, and *Melica nutans*, as at the "Eaves," near Heptonstall, and Stanelly Clough, near Stansfield.

From the town of Todmorden the united streams run nearly due east, in a deep valley, whose wooded slopes are composed of Yoredale shales and sandstone, and whose summits are crowned by the heath-clad Millstone Grits.

The following are the more interesting plants of the Todmorden vicinage—the moors above the town, the main valley below it, and the glens of the tributary rills; those italicised not being indigenous, but naturalized:—

Aquilegia vulgaris.
Stellaria nemorum.
Rubus Chamæmorus.
Œnanthe crocata.
Lactuca muralis.
Andromeda polifolia.
Gnaphalium dioicum.
Senecio sylvaticum.
Pyrola minor.
Gentiana campestris.
Humulus Lupulus.
Gymnadenia conopsea.
Habenaria albida.
Habenaria bifolia, Bab.
Listera cordata.
Convallaria majalis.
Carex curta.
Carex stricta.

Carex lævigata.
Polypodium Phegopteris.
Botrychium Lunaria.
Asplenium Adiantum-nigrum.
Lycopodium Selago.
Luzula sylvatica.

In a field near Great House, Eastwood, grows *Crocus sativus*, in some plenty and well established, although of course not wild in the proper sense of the word. The members of flourishing Societies of Working-men Naturalists (of which there are many in this part of West Yorkshire) will often insist to a visitor that plants even such as this are "wild"—applying that term as they do to all species found out of gardens, not cultivated for profit, or planted of set purpose. Stanelly (or Stoney-lea) Clough in Hareley Wood yields *Vicia sylvatica*—its only station in this district; and near it *Stellaria nemorum*, *Prunus Padus*, *Rumex alpinus* (near the springs, naturalized only), *Neottia Nidus-Avis*, *Hordeum sylvaticum*, *Festuca sylvatica*, the rare *Leskea latibricola*, and *Hypnum heteropterum*, may also be gathered; whilst above Catholis Dam *Cotyledon Umbilicus* grows, although possibly there, as in the Luddenden valley, it is not truly indigenous.

[redacted]

Pogonatum urnigerum.
Aulacomnium palustre.
Bryum alpinum.
Physcomitrium ericetorum.
Bartramia fontana.
Splachnum sphæricum.
Fissidens incurvus.
Fissidens tamarindifolius.
Isothecium myosuroides.
Hypnum fluitans.
Hypnum revolvens.
Hypnum scorpioides.
Hypnum depressum.
Hypnum arcuatum.

The Calder Valley contracts rapidly to a narrow gorge after passing Stoodley Pike, and maintains this character to Hebden Bridge. The high and precipitous cliffs of sandstone, clothed nearly to their top with stunted and scrubby trees, have a wild but picturesque appearance—a characteristic of the valley through many miles of its length.

At Hebden Bridge the Calder is joined by the Hebden. The latter is composed of the several rivulets draining Heptonstall Moor, Boulsworth Hill, and the Moorlands about Haworth. The beds of these streams are cut deep into the surrounding country; the higher ground they drain, composed of the various beds of the Millstone Grit series, is a bleak open moorland, wholly given up to grouse; whilst the narrow valleys, being well sheltered by the escarpments on each bank, are richly clothed with vegetation, and afford extremely pretty landscapes.

At the upper end of this valley are some rather remarkable detached and weathered rocks, known as Hardcastle Crags—a favourite resort of pleasure-parties in the summer-time—near which grow *Andreæa crassinervia*, and *Schistostega osmundacea* in holes of the gritstone rocks. By Gorple Water, in the same district, *Veronica scutellata* and *Diphyscium foliosum* occur; the more notable plants of the "Eaves" Heptonstall, and other parts of the Hebden valley, being—

Stellaria nemorum.
Prunus Padus.
Pyrola media.
Gentiana campestris.

Listera cordata.
Convallaria majalis.
Melica nutans.
Polypodium Phegopteris.
Asplenium Ad.-nigrum.
Cystopteris fragilis.
Sphagnum compactum.
Dicranum fuscescens.
Dicranella squarrosa.
Seligeria recurvata.
Hookeria lucens.
Neckera crispa.
Homalia trichomanoides.
Fontinalis squamosa.
Racomitrium aciculare.
Bryum Wahlenbergii.
Fissidens viridulus.
Hypnum brevirostre.
Hypnum commutatum.

Further down the vale the Calder is reinforced by a stream from Cragg Valley (in which grows *Cotyledon Umbilicus*), drawing its supplies from Turley Holes and the moorlands to the south. Similar streams from Luddenden, Ripponden, Halifax, and Stainland, pour their waters into the Calder.

In this part of the main valley, by Luddenden, Warley, and on under the lee of North Dean Wood to Elland, as the dale grows more populous and less wild, noteworthy plants become fewer. Within the limits named, on the river banks, and in the woods clothing the "edges" from Broad [redacted] end) has been published as *media*, but it is only *minor*, Swartz.

The whole of this area, from the summit of drainage to Elland, is composed of the rocks and shales of the Millstone Grit series. The lowest of these, the Kinderscout Grit, forms the escarpment overlooking Lancashire. Towards Yorkshire the rocks dip with a gentle inclination to the east, and the upper sandstones of the series successively crop out with the intermediate shales. Towards the west their outcrop usually presents an escarpment of rock or a very steep slope, whilst in the opposite direction they fall gently, and gradually disappear under the next higher bed. This succession is repeated until the whole group disappears under the Coal Measures of Halifax.

Across the successive plateaux of grit-rock the channels of the Calder and its tributaries are cut out. The outcrops of the various strata of sandstone in the beds of the streams cause numerous cascades and waterfalls, whilst the masses of rock disintegrated from these fill the lower reaches of the rivulets with stones and boulders semi-rounded by the rolling action of the water. These physical characteristics are the same in nearly all cases—deep, narrow, and well-wooded valleys intersecting each other at various angles.

The Ripponden district, whose principal stream, the Ribourne, rises on the wild moors of Rishworth, between Walling and Waystone Edge, and running north-west, joins the Calder at Sowerby Bridge, includes one of the Yorkshire stations for the pretty little ivy-leaved Campanula, *Wahlenbergia hederacea*. It grows in Cob Clough ; and up the main Ribourne valley, "in the second lane beyond the Booth Wood Inn," *Meum Athamanticum* has at various times for forty years been recorded as growing. *Circæa alpina* is on record for this Ripponden valley, but the plant found was probably *C. intermedia*. At Blackwood Edge, two miles S.W. of Ripponden, an interesting example may be seen of rock-slips—large masses of rock that have tumbled from their parent escarpment, in consequence of the shales supporting them having been loosened and finally washed away by aqueous percolation.

The Hebble is the last of the northern tributaries of the Calder which drain off the moorlands. It rises in Ogden Clough, and trending south-east to the west of Swill Hill and Ovenden, passes through Halifax, and falls into the Calder at North Dean. In one part or another of this district the following species have been found : some, as indicated, only as naturalized plants.

Geranium phæum.
Saxifraga granulata.
Myrrhis odorata.
Hieracium aurantiacum.
Gnaphalium dioicum.
Jasione montana.
Gentiana Amarella?
Gentiana campestris.
Trientalis europæa.
Listera cordata.
Botrychium Lunaria.
Sphagnum contortum.

East of Halifax and Elland, Calder Vale is carved out [redacted] species found in the area of broad valley from Kirkheaton and Liley, to Batley, Mirfield, and Thornhill.

Ranunculus auricomus.	*Xanthium spinosum.*
Ranunculus sceleratus.	Tanacetum vulgare.
Actæa spicata.	*Doronicum Pardalianches.*
Nasturtium amphibium.	Lamium incisum.
Barbarea stricta.	*Humulus Lupulus.*
Stellaria nemorum.	*Mercurialis annua.*
Myrrhis odorata.	Epipactis latifolia.
Centaurea Calcitrapa.	Sagittaria sagittifolia.
Matricaria Chamomilla.	*Acorus Calamus.*
Senecio saracenicus.	Ophioglossum vulgatum.
Petasites hybrida.	Equisetum sylvaticum.

The Baneberry (*Actæa*) at Liley Wood must there be accounted an introduced species, lying as the station does upon the Coal Measures, growing as it does only in small quantity in one corner of the wood, and being, as it is, so thoroughly outside its clearly ascertained limits. A species of truly xerophilous type, it is not known elsewhere off limestone. *Equisetum hyemale* has been reported from "near Lascelles Hall."

At Cooper Bridge, an important stream, the Colne, has its confluence with the Calder. It brings down the water from a large area of moorland along the summit of the drainage south of the district drained by the Calder. The extensive gritstone uplands about Slaithwaite, Marsden, Meltham and Holmfirth contribute numerous brooks, whose aggregated waters pass through Huddersfield, and joined by a brook from Kirkburton, flow into the Calder at Cooper Bridge.

The rare plants which have, from time to time, been reported to grow in the Huddersfield neighbourhood, upon a stratum elsewhere remarkable for the meagre flora its cold wet soils support, are hardly sufficiently well authenticated to demand mention here. Probably a considerable number of them have really occurred, though only strays from cultivation and casual introductions; to whatever class of citizenship (or no citizenship) they were referable, however, nearly all have proved impermanent, and are no longer to be found in their reported stations. In this and other manufacturing districts of West Yorkshire, certain species of foreign plants, mainly such as have prickly fruits or feathery seeds, liable to get entangled in woollen or vegetable fibre, are constantly occurring, hardly ever two years in the same spot—generally where mill-refuse or grain-siftings have been thrown out—but reinforced year after year. The most frequently found are—

Malva parviflora.
Medicago denticulata.
Medicago lappacea.
Anthemis nobilis.
Anchusa officinalis.
Centaurea solstitialis.
Xanthium spinosum.
Xanthium strumarium.
Echinospermum Lappula.
Chenopodium ambrosioides.
Mercurialis annua.
Digitaria sanguinalis.
Bromus arvensis.
Bromus patulus.

The most noteworthy *indigenous* species of the Hud-

[redacted]

All such species as *Draba incana*, *Lepidium campestre*, *Reseda lutea*, *Viola odorata*, *Saponaria officinalis*, *Erodium cicutarium*, *Anthyllis vulneraria*, *Sanguisorba officinalis*, *Saxifraga umbrosa*, *Lonicera Xylosteum*, *Carduus pratensis*, *Petasites albus*, *Senecio viscosus*, *Melampyrum sylvaticum*, *Leonurus Cardiaca*, *Galeopsis ochroleuca*, *Nepeta Cataria*, *Daphne Laureola*, *Crocus nudiflorus*, *Ruscus aculeatus*, *Paris quadrifolia*, etc., all of which have from time to time been pressed into the ranks of Denizens or Colonists, to swell the Flora of this Huddersfield district, will come under one or other of three heads: errors of specific name (*e.g.*, the *Melampyrum* and *Carduus*), merest Casuals (*e.g.*, *Draba*, *Poterium*, or *Galeopsis*), or palpable Introductions (*e.g.*, the *Saxifraga*, *Lonicera*, and *Leonurus*). A record of these Aliens, *as such*, is desirable, but every honest student of plant distribution must have experienced the annoying sense of doubt as to how far the residuum of any local list may be relied upon, when a wholesale elimination of obvious non-wild species—not marked as such—has to be made before a conclusion can be drawn: evident mistakes in this or that respect so quickly piling up the presumption of error in others.

The configuration of the tract of country drained by the Colne is very similar to that of the Calder; and its main features are due to similar causes. The fine amphitheatre of hills above Holmfirth are particularly worthy of note, and afford magnificent examples of mural escarpments.

An important tributary of the Colne—the Holme—rising in Holme Moss, drains the Meltham, Holmfirth, and Dunford Bridge Moors; in several secluded cloughs of which, about Holmbridge, Farnley-Tyas, and Thurstonland, grows the Ivy-leaved Campanula (*W. Hederacea*): and with it, on Meltham Moss, *Andromeda polifolia*; *Rubus*

Chamæmorus also occurring at elevations above 1400 feet; *Brachyodus trichodes*, *Bryum julaceum*, and *Splachnum sphæricum*, being the best of the mosses found in this district.

Near the summit-ridge of Diggle and Dead Head Moss, from moors adjoining those draining west into the Mersey, the Wessenden, the river Colne's first feeder, runs down a lonely valley to Marsden. In this sheltered valley, and on rocks at the head of it, the following plants are known to grow:—

Campanula hederacea.	Pogonatum aloides.
Vaccinium Vitis-Idæa.	Mnium subglobosum.
Carex lævigata.	Blindia trichodes.
Asplenium viride.	Hypnum flagellare.
Ceratodon purpureus.	Hypnum elegans.

After the confluence of the Colne, the Calder flows lazily in a broad not unpicturesque valley to Thornhill, receiving on its north bank near Ravensthorpe the Spen stream running from East Bierley down the populous Spen valley, past the town-like villages of Cleckheaton, Liversedge and Heckmondwike. Between the Spen and the

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In the Wakefield district the Calder receives a few minor streams from the south, that run from the gritstone edge of Woolley—here the water-parting between the Calder and the Dearne valley—Chevet Hall, New Miller Dam, Cold Heindley, and Walton Hall (the wild-bird Refuge of the late Charles Waterton). The surface here, neither particularly pretty nor botanically rich, is yet pleasant and countrified by contrast with the district through which the Calder flows from Dewsbury; and since intersected by numerous dykes and drains, species of the hygrophilous or water-loving type become more numerous. About the places enumerated the more interesting plants (those italicised uncertainly native) to be found are—

Ranunculus Flammula.
Ranunculus sceleratus.
Corydalis claviculata.
Spergularia rubra.
Hypericum humifusum.
Ornithopus perpusillus.
Vicia sylvatica.
Vicia lathyroides ?
Circæa lutetiana.
Œnanthe crocata.
Œnanthe fistulosa.
Œnanthe Phellandrium.
Sambucus Ebulus.
Bidens cernua.
Campanula latifolia.
Melampyrum pratense.
Lycopus europæus.
Symphytum officinale.
Hottonia palustris.
Plantago Coronopus.
Littorella lacustris.
Sagittaria Sagittifolia.
Alisma ranunculoides.
Juncus compressus, Jacq.
Lemna polyrhiza.
Potamogeton pectinatus.
Potamogeton lucens.
Zannichellia palustris.
Carex lævigata.
Carex vesicaria.
Ophioglossum vulgatum.
Equisetum Telmateia.

From Wakefield the River Calder pursues a winding course along the flat country, full of drifted sands and boulders, above which are alluvial beds of still more recent clays; past Warmfield, Stanley, and Altofts; and joins the River Aire at Castleford. On its sandy banks in this last portion of its course and in the neighbourhood of Lofthouse, Stanley, etc., the following plants have occurred; some of the river-bank species, far from their head-quarters in the hills, their seeds having been washed down by summer floods, and deposited in the mud of the little bays and backwaters that the eddies make at each sudden curve of the stream.

Ranunculus auricomus.
Fumaria Boræi.
Barbarea stricta.
Arabis hirsuta.
Iberis amara.
Silene noctiflora.
Scleranthus annuus.
Cerastium aquaticum.
Malva moschata.
Rhamnus catharticus.
Euonymus europæus.
Ononis arvensis.
Myrrhis odorata.
Cichorium Intybus.
Verbascum Thapsus.
Linaria minor.
Veronica scutellata.
Cuscuta Trifolii.
Lycopus europæus.
Hottonia palustris.
Polygonum Bistorta.
Amaranthus retroflexus.
Habenaria viridis.
Carex paludosa.
Ophioglossum vulgatum.
Equisetum sylvaticum.

At Stanley a portion of the Aire and Calder Company's Canal, connecting Wakefield with the Aire, runs

[redacted]

Camelina sativa, *Melilotus alba*, *M. officinalis*, and *Œnothera biennis*, occasionally occur, but do not maintain their ground.

Such physically and botanically is the Calder district. Fourth in superficial area of the ten drainage districts, its hill-tracts have too much geological sameness, and its lower levels are too thickly populated, for it to present a rich or remarkable assemblage of plant forms. Its rivers cross no tract of Magnesian Limestone or Triassic Sandstone, so that the lime-loving and sand-loving species are poorly represented. Not one plant occurs within its limits which has not been found in any of the other river-basin tracts.

CHAPTER X.

THE DON DISTRICT.

THE River Don originates in several small rivulets on the high moorlands forming the boundary between the counties of Derbyshire and Yorkshire. Its principal source is the Dun Well, a short distance south of the rocky ravine called Ramsden Clough. The waters speedily become aggregated in the artificial lake of Dunford Bridge. The effluent water pursues an eastward course to Penistone, being joined by the streams from Windledon Clough, Wogden Clough, and several others. At first it runs in a deep valley of millstone grit rocks, but for the greater part of the distance the river cuts across the outcrops of the sandstones and shales of the [redacted] course by rivulets from Featherbed Moss. It runs down the lonely and narrow valley of Midhope, to swell the volume of its bigger brother-stream at Deepcar. A third stream, Ewden Beck, rises near Margery Stones, and, pursuing a course parallel to the two Dons, joins the main river opposite the beautiful wooded domain of Wharncliffe—the oaks in which are less famous only than the mythical Dragon of Wantley (or Wharntley), supposed to have haunted them. The Wharncliffe Oaks are both indigenous and remarkably fine: and it is questionable whether the Riding has anywhere else a scene of grandeur and beauty equal in its entirety to that presented by the steep forest-clad escarpment on which the Lodge stands, with its background of higher fells, as seen from the opposite slope of the valley, with the deep Don glen at its foot.

This great tract to the north-west of Sheffield, drained by the Don, the Little Don, and the Ewden, would seem to have had a rich Flora, if past records were trustworthy; and it seems probable they were, from the fact that recent investigation (thanks to the assiduity of Mr. A. Carr, of Sheffield) has confirmed much of what was previously known; but, of course, in the more immediate neighbourhood of Sheffield, as workshops and workmen have multiplied, hardly a vestige remains of the vegetation it was the pride of Jonathan Salt—Sheffield's first botanical enthusiast, about the beginning of the century—to catalogue and chronicle. There seem to be only two old records as yet unverified, viz., *Dianthus Armeria* at "Brightside" (found long ago by Mr. Bohler, and probably only a Casual) and *Carex elongata* at Aldwarke Marsh. In the valleys of the two Dons the diversity in elevation is wide, but the variety in rock-structure very little. Everywhere the uplands present the same floral features—many individuals, but few species—characteristic of the gritstone ; but the air is pure and bracing, the climate good for so hilly and rainy a district, and considering that limestone strata are absent, the species in the sheltered wooded glens and by the stream-sides of the valleys are numerous, and although few of them can be said to be particularly rare, still many interesting and unexpected species occur. The district appears to be peculiarly rich in the Babingtonian forms of *Rubus fruticosus* and in the Bakerian varieties of *Rosa canina*, although some of this may be more apparent than real, and again due to the painstaking exertion and unwearied rambling of Mr. A. Carr. A good many Aliens occur, as was to be expected, and amongst the better established are some very curious ones, such as *Ligusticum scoticum* and *Trifolium agrarium.* The more interesting species are given in the following list, covering the country about Denby, Dunford, Midhope, Wortley, Wharncliffe, and Ecclesfield, and include the plants of the Don banks from Wadsley Bridge to Wincobank and Tinsley :—

[redacted]

Rosa urbica.
Rosa arvatica.
Rosa tomentella.
Rosa Kosinciana.
Rosa Bakeri.
Pyrus communis.
Pyrus Aucuparia.
Circæa lutetiana.
Adoxa Moschatellina.
Myrrhis odorata.
Sium angustifolium.
Scabiosa succisa.
Anthemis Cotula.
Carduus heterophyllus.
Crepis paludosa.
Gnaphalium dioicum.
Aster dumosus.
Bidens tripartita.
Wahlenbergia hederacea.
Vaccinium Vitis-Idæa.
Pyrola minor.
Linaria minor.
Linaria Elatine.
Veronica Buxbaumii.
Melampyrum pratense.
Convolvulus arvensis.
Mentha piperita.
Mentha rubra.
Marrubium vulgare.
Lamium maculatum.
Myosotis repens.
Lysimachia nemorum.
Chenopodium rubrum.
Populus tremula.
Salix pentandra.
Salix purpurea.
Salix Helix.
Salix aurita.
Listera cordata.
Epipactis latifolia.
Epipactis palustris.
Luzula pilosa.
Carex curta.
Carex pilulifera.
Carex lævigata.
Milium effusum.
Catabrosa aquatica.
Glyceria aquatica.
Lastrea Borreri.
Polypodium Dryopteris.
Polystichum aculeatum.
Osmunda regalis.
Equisetum sylvaticum.
Sphagnum squarrosum.
Dicranum pellucidum.
Bryum filiforme.
Cinclidotus fontinaloides.
Hookeria lucens.
Hypnum brevirostre.
Hypnum loreum.

Carex limosa has been reported from a "bog near Wortley," by Dr. Payne, of Barnsley, but some error in the name is to be feared.

Before reaching Sheffield, the Don receives the waters of the two streams descending from the Bradfield and Hallam moors—the rivers Loxley and Rivelin. The river Loxley rises on Carter Stone and Derwent Edge, near Black Tor (1764 ft.), and passes between Strines and Bole Edge, receiving numerous tributaries, and enters

Hollin or Upper Bradfield Dale. Hollin Dale is well wooded, the hillside beneath the rocky escarpment of Bole Edge being completely covered by a fine plantation of trees. The stream empties itself into the Dale Dyke reservoir, about a mile long, that here, together with the extensive larch forest on its west side, gives a wild alpine character to the dale, recalling the scenery of some of the lower Swiss or Norwegian valleys. A short distance below this reservoir the stream is joined by the Agden, rising in Hobson Moss, and passing down a wild gorge between Emlin Ridge and Harecliff Rocher into another picturesquely forked dam, before its waters join those of the Loxley at Lower Bradfield. On the moors at the head of Bradfield Dale, great boulders of Kinderscout Grit—*not* granitic or slaty rock—are frequent; possibly ice-borne, for we are informed that they are styled "travellers" by the dale folk, who would thus appear to have an idea that they are of foreign origin. They are found to resist the disintegrating action of time and weather much better than the local flag-rock. Brad- [redacted] is not botany, nor yet physical geography, but the digression will perhaps be pardoned by all save those whose eyes are for plants and stones alone. Not that this district is without interesting and uncommon species. In it grows a rare fern of western or Atlantic type—*Asplenium lanceolatum*, discovered by the Rev. R. A. Gatty. It flourishes in some little plenty, and the writer is inclined to regard it as indigenous, having seen it *in situ;* but, for obvious reasons, it is deemed better to withhold a precise indication of its whereabouts. The locality referred to being the sole one for it in the West Riding, it would be doubly a pity were it to be exterminated at the hands of some conscienceless collector. In this neighbourhood, too, the ivy-leaved Campanula (*Wahlenbergia hederacea*) flourishes by the rills of the moorland cloughs; and near the Loxley at Lower Bradfield the Wall Pennywort (*Cotyledon Umbilicus*) grows truly wild, and on high exposed rocks above the Abbey Brook, on the north-west slope of Black Tor, beyond Carter Stone Ridge, *Arbutus Uva-Ursi* still exists in small quantity In a well upon the slope to the east of Agden reservoir grow two rare *Hepaticæ*, or "scale-mosses," *Aneura pinnatifida* and *Chiloscyphus polyanthus*. Upon an eminence overlooking the confluence of the Agden with the Loxley is the hamlet of Upper Bradfield, and from this point the view is alike strikingly fine, whether one looks up the valley to the Dale Dyke dam (the one that gave way with such disastrous effect in 1864), or down the dale, at the bottom of which the Loxley runs with a quick descent into a third reservoir below Holdworth Bank, and then onwards past Rowell Bridge, and under the lee of Cliff Rocher (or "Little Matlock"), to join the Rivelin in the once pretty glen of "Wadsley Bottom." Hereabouts, and nearer the Don, grows *Hypericum dubium*.

The valley of the Rivelin is very beautiful. It is hollowed out of the beds beneath the Third Grit rocks, and bounded on either side by craggy escarpments of that rock, picturesquely wooded in some parts. The shales, with an included bed of sandstone, form the slopes of the valley; and the Kinderscout, or Fourth Grit, appears in the bed of the stream. Within the limits of the area drained by the Rivelin from Hollows Meadows and Lord's Seat, near the Redmires dam, to its junction with the Loxley, *Rubus thyrsoideus*, *Hypericum dubium*, and *elodes*, *Scutellaria minor*, *Circæa Alpina*, *var. intermedia*, and *Carex pendula*, are the rarer plants. *Samolus Valerandi* occurs at Hollow Meadows at an altitude of nearly 1,000 feet —clearly within the middle or super-agrarian zone—and is the highest station for this usually lowland species with which I am acquainted. In the valleys of the Rivelin and Loxley the rocks over which the streams flow are more varied in structure than in the greater Don-dale, and limestones of the Yoredale Series come to the surface towards the Derbyshire border, beyond Hollindale ; in consequence, [redacted]

Viola hirta.
Stellaria nemorum.
Spergularia rubra.
Hypericum elodes.
Hypericum dubium.
Geranium lucidum.
Euonymus europæus.
Rhamnus Frangula.
Genista anglica.
Vicia angustifolia.
Prunus Padus.
Rubus suberectus.
Rubus affinis.
Rubus thyrsoideus.
Rubus festivus, Warren.
Rubus atro-rubens, Wirtg.
Rubus Bloxamii.
Rubus diversifolius.
Rubus macrophyllus.
Rubus Koehleri.
Rosa rubiginosa.
Rosa mollis (cærulea)
Rosa tomentosa (farinosa).
Rosa vinacea.
Rosa arvatica.
Rosa obtusifolia.
Rosa Reuteri.
Rosa verticillacantha.
Rosa Watsoni.
Pyrus Aria et communis.
Circæa alpina (intermedia).
Chrysosplenium alternifolium.
Saxifraga granulata.
Cotyledon Umbilicus.
Sanicula europæa.
Torilis nodosa.
Adoxa Moschatellina.
Serratula tinctoria.
Gnaphalium dioicum.
Hieracium umbellatum.
Senecio sylvaticus.
Jasione montana.
Wahlenbergia hederacea.
Vaccinium Vitis-Idæa.
Scrophularia nodosa.
Erythrea Centaurium.
Linaria minor.
Pedicularis palustris.
Melampyrum pratense.
Mentha sativa et rubra.
Mentha aquatica.
Scutellaria minor.
Lamium Galeobdolon.
Myosotis sylvatica.
Samolus Valerandi.
Lysimachia nemorum.
Anagallis tenella.
Chenopodium murale.
Polygonum Bistorta.
Taxus baccata.
Tamus communis.
Galanthus nivalis.
Narcissus major.
Orchis mascula.
Listera cordata.
Epipactis latifolia.
Epipactis violacea. Now?
Habenaria bifolia.
Narthecium ossifragum.
Luzula sylvatica.
Scirpus multicaulis.
Scirpus setaceus.
Carex dioica.
(Carex Davalliana?)
Carex curta.
Carex Œderi.
Carex lævigata.
Carex sylvatica.
Carex præcox.
Carex pendula.
Carex muricata.
Melica uniflora.

Glyceria rigida.
Poa nemoralis.
Athyrium incisum.
Scolopendrium vulgare.
Polystichum lobatum.
Nephrodium spinulosum.
Nephrodium Borreri.
Nephrodium Oreopteris.
Polypodium Dryopteris.
Polypodium Phegopteris.
Asplenium lanceolatum.
Asplenium Trichomanes.
Botrychium Lunaria.
Lycopodium Selago.
Equisetum sylvaticum.
Sphagnum rubellum.
Sphagnum contortum.
Racomitrium aciculare.
Mnium stellare.
Schistostega osmundacea.
Hypnum myosuroides.
Hypnum flagellare.
Hypnum uncinatum.
Hookeria lucens.
Bartramia fontana.
Ptilidium ciliare.
Aneura pinnatifida.
Chiloscyphus polyanthus.

Campanula Trachelium has occurred by the tramroad from the Manor coalpits, but is reported extinct.

At Sheffield the Don takes a sharp turn to the north-east, and after passing Attercliffe and Tinsley, crosses a strip of the Bradgate Rock, a fine-grained freestone used for grindstones, and shortly afterwards enters on the "Red Rock" of Rotherham. Here the Rother—a small, sluggish stream from the south—joins the Don. It enters the Riding near Beighton, but has its source considerably

[redacted]

Euonymus europæus.
Prunus insititia.
Agrimonia Eupatoria.
Poterium Sanguisorba.
Rubus affinis.
Rubus thyrsoideus.
Rubus umbrosus.
Rubus festivus, Warren.
Rosa tomentosa.
Rosa fœtida, Bast.
Rosa mollis.
Rosa platyphylla.
Rosa arvatica.
Rosa obtusifolia.
Rosa verticillacantha.
Rosa Kosinciana.
Bryonia dioica.
Adoxa Moschatellina.
Helosciadium inundatum.
Pimpinella magna.
Bupleurum rotundifolium.
Ligusticum scoticum.
Petroselinum sativum.
Œnanthe fistulosa.
Œnanthe Phellandrium.
Galium tricorne.
Doronicum Pardalianches.
Valerianella carinata.
Tanacetum vulgare.
Anthemis Cotula.
Artemisia Absinthium.
Artemisia vulgaris.
Bidens cernua.
Convolvulus Sepium.
Convolvulus arvensis.
Cuscuta Trifolii.
Scrophularia Balbisii.
Linaria minor.
Pedicularis palustris.
Origanum vulgare.
Nepeta Cataria.
Ballota nigra.
Lamium Galeobdolon.
Symphytum patens.
Hottonia palustris.
Chenopodium rubrum.
C. urbicum (intermedium).
Euphorbia platyphylla.
Salix viminalis et pentandra.
Galanthus nivalis.
Epipactis palustris.
Narcissus Pseudo-Narcissus.
Carex acuta.
Carex paludosa.
Carex vesicaria.
(Alopecurus fulvus ?)
Catabrosa aquatica.
Glyceria aquatica.
Bromus giganteus.
Brachypodium sylvaticum.
Equisetum sylvaticum.

From Rotherham the Don runs north-east by Aldwark—where *Stellaria glauca* grows, and *Carex elongata* has been found, but not recently—to Swinton, where *Trifolium agrarium* occurs as a Colonist in fields; then turning east again, in a shallow valley defertilized by ironworks and foundries, towards Conisboro', where, on its north bank, its largest tributary, the Dearne, falls into it.

The River Dearne rises near Flockton, a little east of the sandstone escarpment overlooking the Kirkburton valley, and at Bretton Park is reinforced by the Parkgate dyke from above Shelley. The united streams flow south-east under Woolley Edge to Barnsley, receiving tributaries from Cawthorne and Stainborough before reaching Darfield.

The Dearne valley had some pretty scenery before unsightly coal-pit scaffoldings disfigured it everywhere, but its Flora was never a rich one. The Coal Measures that reign supreme over nearly the whole tract beneath the ground dominate the vegetation above it, by reason of the cold and wet or stiff soil their alternations of shales and clays give rise to, since they hold the rainfall above them, instead of allowing it to filter quickly away. The exceptions to this state of affairs in the drainage district of the Dearne are worth mention, because of the occurrence of a few plants elsewhere quite rare. On the eastern slope of the Dearne valley, about Windhill, Cudworth, and Houghton, the soil gets sandier and lighter, and in the vicinity of the places named *Myosurus minimus*, *Geranium pyrenaicum*, *Cuscuta Epilinum*, *Orobanche major*, and *Poa com-*

[redacted]

Corydalis claviculata.
Cardamine amara.
Turritis glabra ?
Alyssum incanum.
Barbarea stricta.
Viola palustris.
Spergularia rubra.
Geranium pyrenaicum.
Hypericum humifusum.
Erodium cicutarium.
Malva moschata.
Melilotus arvensis.
Vicia sylvatica.
Genista tinctoria.
Ornithopus perpusillus.
Rubus leucostachys.
Rubus rhamnifolius.
Pyrus Aria.
Scleranthus anuus.
Sedum Telephium.
Sium nodiflorum.
Galium uliginosum.
Bidens tripartita.
Bidens cernua.
Campanula latifolia.
Cuscuta Epithymum.
Cuscuta europæa.
Cuscuta Epilinum.
Solanum nigrum.
Menyanthes trifoliata.
Linaria Elatine.
Scutellaria minor.
Lycopus europæus.
Lamium Galeobdolon.
Galeopsis ochroleuca.
Salix Smithiana.
Paris quadrifolia.
Allium vineale.
Epipactis latifolia.
Listera cordata.
Habenaria viridis.
Zannichellia brachystemon.
Potamogeton crispus.
Potamogeton pusillus.
Potamogeton lucens
Acorus Calamus.
Scirpus sylvaticus.
Carex dioica.
Carex paludosa.
Bromus secalinus.
Lolium temulentum.
Equisetum Telmateia.
Ophioglossum vulgatum.

From near Conisboro', where the Don, now a deep and turbid flood, reaches the Permian tract, to near Hexthorpe, where it leaves it, the Lower Limestone—a hard bluish-white rock, well seen in the railway cutting at Sprotboro'—and the upper, or Knottingley Limestone, are intersected in succession. Over these beds it flows through a narrow strait of fertile pasture, bordered on either hand by undulating wooded banks much broken by quarrying operations; and here, in the vicinity of the stately Norman Keep of Conisboro' Castle, of Cadeby, Warmsworth, and Sprotboro', many uncommon plants, most of them of the xerophilous type, may be found. In unbroken pasture and by the river grows the wild tulip (*T. sylvestris*) in some profusion and for some distance; rarely flowering, however, and perhaps not native, though it is difficult to say to what other category of citizenship it should be referred. Near Sprotboro' is Levitt Hagg, a rough stretch of land overgrown in many parts by brush and briar wood, where grows *Rosa systyla;* and near the river towards Conisboro', *Ranunculus parviflorus* and *Gnaphalium dioicum* have occurred. Between Conisboro' and Swinton, "on the path side, over a bridge," the Rev. G. E. Smith has found *Campanula patula*, but it has not been seen recently, and may possibly be extinct. The rarer plants of this district are aggregated in the following list:—

Ranunculus sceleratus.	Galium Mollugo.
Ranunculus parviflorus.	Galium tricorne.
Helleborus viridis.	Dipsacus pilosus?
Helleborus fœtidus.	Gnaphalium dioicum.
Berberis vulgaris.	(Carduus acaulis. Now?)
Barbarea stricta.	Lactuca muralis.
Armoracia rusticana.	*Artemisia Absinthium.*

[redacted]

Salix repens.
Salix rubra.
Salix viminalis.
Salix Russelliana.
Taxus baccata.
Spiranthes autumnalis.
Orchis Morio.
Orchis mascula.
Gagea lutea.
Allium oleraceum.
Tulipa sylvestris.
Convallaria majalis.
Blysmus compressus.
Carex digitata.
Avena pubescens.
Melica uniflora.
Sclerochloa rigida.

From Hexthorpe to Doncaster is but little over a mile, and here the Don enters the level Triassic plain, so deeply overlaid by gravelly drift where the Nidd, Wharfe, and Aire to the northward run through it ; but in this neighbourhood the same diluvial gravel was more thinly and unequally deposited, and obscured in its turn by the turfy investiture of Hatfield Chase. To this post-tertiary layer is due the wide stretches of marsh land and peaty moors called "carrs" about Balby, Potteric, Bentley, and Loversall, those portions not yet drained being extremely rich in hygrophilous plants. Where the Bunter pebble beds are covered only by gravel, as about Armthorpe, Cantley, Auckley, and Rossington, the lanes and fields are sandy, and furnish most of the sand-loving species already given in the plant lists for the York and Selby districts, together with a few not found elsewhere in the Riding, such as the Maiden Pink (*Dianthus deltoides*), *Potentilla argentea*, *Filago apiculata*, and *Apera Spica-venti*. The following are the rarer plants occurring about Doncaster, from Hatfield and Barnby, north of it to Finningley, Rossington, and Wadworth on the south:—

Ranunculus circinatus.
Ranunculus radians (Godronii).
Ranunculus Lingua.
Delphinium Ajacis.
Nymphæa alba.
Turritis glabra.
Armoracia rusticana.
Alyssum calycinum.
Camelina sativa.
Sisymbrium Sophia.

Saponaria officinalis.
Dianthus deltoides.
Cerastium arvense
Cerastium aquaticum.
Silene anglica.
Silene noctiflora.
Viola flavicornis, Sm.
Drosera intermedia.
(Vicia bithynica?)
Lathyrus palustris.
Potentilla argentea.
Rubus suberectus.
Lythrum Salicaria.
Myriophyllum verticillatum.
Hippuris vulgaris.
Peucedanum palustre.
Sium inundatum.
Œnanthe Lachenalii.
Œnanthe Phellandrium.
Œnanthe fistulosa.
Anthriscus Cerefolium.
Anthriscus vulgaris.
Filago apiculata.
(Campanula patula?)
Gentiana Pneumonanthe.
Myosotis collina.
Symphytum officinale.
Lysimachia vulgaris.
Utricularia vulgaris.
Plantago Coronopus.
Rumex Hydrolapathum.
Myrica Gale.
Habenaria chlorantha.
Orchis pyramidalis.
Epipactis palustris.
(Iris fœtidissima?)
Typha angustifolia.
Sparganium minimum.
Alisma ranunculoides.
Stratiotes aloides.
Hydrocharis Morsus-Ranæ.
Sagittaria sagittifolia.
Ceratophyllum demersum.
Lemna gibba.
Lemna trisulca.
Potamogeton eu-natans.
Scirpus fluitans.
Cladium Mariscus.
Carex dioica.
Carex Pseudo-cyperus.

[redacted]

of moory ground, now for the most part drained, extending to the boundary of the county. The Great Jugs, or Old Eaa Beck, rises near Hemsworth, and north of South Kirkby receives a second rivulet from the sandstone surface of Brierley Common. Proceeding a few miles to the south-east, it takes up the Howell stream from the south, rising on Houghton Common. At Hampole Stubbs, the Beck enters the Permian Limestone tract, and passing Adwick-le-Street, a tributary draining Sutton Common and Owston, continues to Kirk Sandal, where its confluence with the Don takes place. The rarer plants occurring about Kirkby, South and North Elmsall, Hampole, Brodsworth, Hooton Pagnell, Adwick-le-Street, and Sutton Common, are given in the following list:—

Clematis Vitalba.
Anemone Pulsatilla. (Now ?)
Aquilegia vulgaris.
Ranunculus Lingua.
Berberis vulgaris.
Nymphæa alba.
Cerastium arvense.
Spergularia rubra.
Astragalus hypoglottis.
Astragalus glycyphyllus.
Onobrychis sativa.
Sison amomum.
Sium angustifolium.
Asperula cynanchica.
Viscum album.
Bidens tripartita.
Erigeron acris.
Lithospermum officinale.
Myosotis collina.
Euphorbia platyphylla.
Orchis Morio.
Spiranthes autumnalis.
Gymnadenia conopsea.
Ophrys apifera.
Narcissus poeticus.
Narcissus biflorus.
Narcissus Pseudo-narcissus.
Ornithogalum umbellatum.
Bromus erectus.
Hordeum murinum.

The River Went, another important tributary of the Don, rises in the neighbourhood of Ackworth Moor, and having been increased by two streams from Darrington, Carleton, and Badsworth, passes through Wentbridge. Hitherto its progress has been over Carboniferous strata. From Wentbridge it proceeds eastwards in a deep channel across the tract of Permian limestone. About Wentbridge the western escarpment of the limestone is at once bold and picturesque, giving to this part of the valley its local title of Brockerdale (Broken-dale). The Went does not deviate from its directly eastern course; but, cutting a passage through the scars, it opens into a beautiful valley, well wooded or lined with rich rocky pastures, and on either hand bounded by precipices of limestone. These rise so boldly in various parts of the valley, that they have received the appellations of Smeaton and Long Crags. Passing Norton Priory on a promontory of the Upper Limestone, the Went enters on the low, flat lands of Stubbs and Norton Commons and the marshy meads called Fenwick Lows. Much of this is marshland, containing peat, full of the stumps of trees, amongst which have been found the antlers of red deer. Its confluence with the Don is near Bankside.

Within the area drained by the Went, including Campsall and Askern Spa, where are several sulphur springs, many uncommon limestone-loving and aquatic plants are to [redacted]

Œnanthe Lachenalii.
Sison amomum.
Bupleurum rotundifolium.
Viscum album. Planted ?
Viburnum Lantana.
(Dipsacus pilosus. Now ?)
Asperula cynanchica.
Galium Mollugo.
Eupatorium cannabinum.
Inula Conyza.
(Monotropa Hypopitys. Now?)
Pedicularis palustris.
Linaria Elatine.
Linaria minor.
Salvia Verbenaca.
Lamium amplexicaule.
Nepeta Cataria.
Myosotis strigulosa.
Cynoglossum officinale.
Pinguicula vulgaris.
Samolus Valerandi.
Hottonia palustris.
Lysimachia vulgaris.
Rumex Hydrolapathum.
Daphne Laureola.
Euphorbia Lathyris.
Ophrys apifera.
Ophrys muscifera.
Colchicum autumnale.
Typha angustifolia.
Alisma ranunculoides.
Butomus umbellatus.
Zannichellia palustris.
Cladium Mariscus.
Carex stricta.
Carex riparia.
Carex paludosa.
Carex lepidocarpa.
Avena pubescens.
Sclerochloa rigida.
Bromus erectus.
Lastrea Thelypteris.
Anacalypta lanceolata.
Eucladium verticillatum.
Didymodon luridus.
Trichostomum mutabile.
Barbula tortuosa.
Encalypta streptocarpa.
Aulacomnium palustre.
Anomodon viticulosus.
Isothecium myurum.
Eurhynchium myosuroides.
Eurhynchium crassinervium.
Hypnum chrysophyllum.
Hypnum molluscum.
Hypnum uncinatum.
Hypnum riparium.

From Kirk Sandal, by Thorne, to a point near Cowick Park (where *Eranthis hyemalis* has abundantly naturalized itself), the Don flows through uninteresting flats of marsh-land. At Newbridge its artificial channel begins. Small natural alterations in the course and direction of rivers, even larger ones, occasioned by inundations, are not rare ; yet amongst those of the West Riding the Don runs pre-eminent as the river with a history. Within historic times its place of outfall has been thrice changed. At first it seems to have taken a circuitous route to the Humber, from Thorne eastwards to near Crowle, and thence along the county boundary—seemingly a conventional one now, but not so then—where lies the ancient river channel marked "Old Don River" on our map, into the Trent at Adlingfleet. The river Idle, from Bawtry, now drained into the Trent by dykes, was a tributary of it at that time. More recently, instead of turning sharply to the east at Newbridge, the Don kept onwards to fall into the Aire between Snaith and Rawcliffe. Lastly, not very many years ago, to facilitate navigation by vessels of the barge type, its curves from Thorne were straightened, and from New Bridge, by cut and embankment, an entirely new channel was made for it to Goole, where it now enters the Ouse. From an artistic view-point, its last condition is worse even than its second; for now, in the last few miles of its course, it is merely a canal of uglier and larger kind than usual, that quickly got the name of the Dutch river, because the engineer who planned and carried out the work chanced to be a Dutchman.

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intersected by numerous dykes of almost stagnant water, diversified by a few pools or "wells," and relieved in a few places only by oases of soil, a foot or two higher than the plain, on which grow a few Firs, or a thicket of Birch and Alder, or a few bushes of Bog-myrtle and Sallow. Nevertheless, however depressing on a hot summer-day, from its lack of shelter and rare opportunity for quenching thirst, the Waste offers at such a time a rich harvest to the botanist sufficiently enthusiastic to spend a dozen hours in the gathering of it, undeterred by the many discomforts the investigation undoubtedly entails.

The flora of the peat itself is remarkable in several respects. Upon its surface, species are few, and individuals repeat themselves monotonously. There is a scarcity of Gramina—*Triodia decumbens* and stunted *Molinia* are the most notable species—and plants with yellow flowers, as on all bogs, are replaced by kinds with pink or blue ones. The exceptions are aquatic in their habit. *Andromeda polifolia* occurs in the greatest profusion and luxuriance; and when in bloom, the tip of every spray hung with *thyrsi* of waxen bells is very ornamental. All the three British Sundews may be found growing side by side to a size rarely met with elsewhere, but they do not seem to hybridise. In the more sphagnous hollows, *Scheuchzeria palustris* and *Viola lactea* have both undoubtedly occurred. They are now very scarce, but are perhaps less likely to be really extinct, since they grow in parts not yet reached by drainage alteration, than are *Lathyrus palustris*, *Peucedanum palustre*, and *Lastrea cristata* (all seen by the writer *in situ*), which occurred rather on the border of the waste, in swampy, thickety places, and which must be the first to suffer transformation under those processes for reclamation of the land that encroach from the circumference. *Empetrum nigrum* is found on the Waste only sparingly, and near one of the "wells;" and has been, in the opinion of Dr. Parsons, introduced by waterfowl that frequent these pools on their way from the hills inland to their breeding-places in other lands. Another view of the occurrence of this montane species on this lowland waste may be taken, seeing that alpine lichens and other plants occur on the Waste, but there is something to be said on both sides, no doubt. The lesser Bladderwort may occasionally be found in the pools, but more frequently appears on the surface of the water in the dykes or drains that have been newly cut or cleaned out, but seems to be impermanent in its stations. *Rhynchospora alba* is frequent in the sphagnous hollows, along with several species of Bog-Moss, whilst *Carex curta* and *limosa* are apparently confined to the vicinity of the "wells."

On the oases of drier soil that stand out like islands in the Waste, *Rhamnus Frangula*, *Epilobium angustifolium*, *Lastrea spinulosa* and *Osmunda* (now almost extermi-

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dykes in the more immediate vicinity of Thorne, and the old Don river on the south-east of the Waste, is as follows :—

Ranunculus circinatus.
Nuphar luteum.
Nasturtium amphibium.
Viola palustris.
Viola flavicornis, var. lactea.
Drosera rotundifolia.
Drosera anglica.
Drosera intermedia.
Stellaria glauca.
Rhamnus Frangula.
Rubus Idæus.
Rubus fissus.
Rubus affinis.
Lathyrus palustris.
Vicia angustifolia.
Epilobium angustifolium.
Epilobium tetragonum.
Hippuris vulgaris.
Peucedanum palustre.
Œnanthe fistulosa.
Œnanthe Phellandrium.
Galium uliginosum.
Taraxacum palustre.
Andromeda polifolia.
Erica tetralix.
Vaccinium Oxycoccos.
(Mentha sylvestris ?)
Myosotis cæspitosa.
Pinguicula vulgaris.
Utricularia minor.
Lysimachia vulgaris.
Lysimachia Nummularia.
Polygonum mite.
Empetrum nigrum.
Alnus glutinosa.
Betula pubescens.
Salix Smithiana.
Salix cinerea.
Salix aurita.
Salix repens.
Myrica Gale.
Hydrocharis Morsus-Ranæ.
Typha angustifolia.
Potamogeton eu-natans.
Potamogeton heterophyllus.
Potamogetom ericetorum.
Narthecium ossifragum.
Scheuchzeria palustris.
Rhynchospora alba.
Scirpus fluitans.
Carex pulicaris.
Carex curta.
Carex limosa.
Carex stricta.
Carex acuta.
Carex riparia.
Agrostis alba.
Arundo Calamagrostis.
Molinia cærulea.
Osmunda regalis.
Lastrea spinulosa.
Lastrea cristata.
Lastrea Thelypteris.
Sphagnum compactum.
Sphagnum fimbriatum.
Sphagnum cuspidatum.
Sphagnum papillosum.
Dicranum scoparium.
Polytrichium commune.
Polytrichum formosum.
Aulacomnium palustre.
Agaricus grammopodius.
Agaricus sericeus.
Lactarius rufus.

Xerotus degener?	Cladonia cornucopioides.
Hypoxylon concentricum	Cladonia rangiferina.

The point of most importance, however, in connection with Thorne Waste, yet remains to be indicated. Before the Peat Age, a bed of alluvial sand formed the surface over the area that Thorne and Goole Moors now occupy, and this sand rested upon retentive clay. Upon this the peat was gradually deposited, and is now to be found varying in thickness from one to twenty feet. In cutting through it for various purposes, cones of the Scotch Fir have been plentifully found; and in its lower layers stumps of trees *firmly rooted* into the sand, proving that a forest once grew there. A large proportion of these stumps are easily recognizable as those of the Scotch *Pinus* by their peculiar scaly bark. Professor Phillips makes mention only of "innumerable oak trees" as having been found bearing marks of rude tools and of fire, used to cut or burn them down; but the cones leave us no doubt that the forest felled by human agency consisted in great part of fir.

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which the fir-tree stumps are rooted, is below high-water mark, hence it would be much wetter than at Skipwith, where it is some twenty feet higher; and the growth of peat would be in consequence more rapid there than at the latter place. The thickness of the strata covering the fir-stumps proves their destruction to have been many centuries ago, and it is highly improbable that they were planted by man. It is conjectured that the forest was cut down by the Romans to dislodge the Britons, to whom it afforded shelter." Dr. Parsons, in his communication, goes on to say, "If I remember rightly, it was asserted by Julius Cæsar that there were no pine trees in Britain: Cæsar, however, never came so far north as Yorkshire, and can hardly be expected to have exhausted the botany of the country during the short stay he made in it. The weight of evidence would thus seem to indicate that we now see upon Skipwith Common a condition analagous, as to surface soil and fir-tree growth, to that occurring upon Thorne Waste before its peaty deposit was laid down in its basin of sand, and before the forest which once grew there had attained maturity. If this be a warrantable analogy, the Scotch Fir may, perhaps, be considered a native of the county in some few of its existing stations, and upon what, in the present state of our knowledge, seem the safest of all grounds, viz., geological."

In the neighbourhood of Goole and Rawcliffe, and upon the banks of the Ouse and the many warping drains into which the tide flows, eastward from the outfall of the Don towards Swinefleet, Whitgift, and Ousefleet, some interesting maritime and aquatic species of plants have occurred. *Hordeum maritimum* is on record as having been found formerly near Whitgift, though recent search has failed to re-discover it; but the species given in the following list have all been noticed very recently:—

Thalictrum flavum.
Ranunculus circinatus.
Ranunculus trichophyllus.
Ranunculus hirsutus.
Ranunculus sceleratus.
Sinapis nigra.
Nasturtium palustre.
Thlaspi arvense.
Senebiera Coronopus.
Viola canina, Bab.
Cerastium arvense.
Stellaria glauca.
Spergularia neglecta, Syme.
Radiola millegrana.
Geranium phæum.
Trifolium fragiferum.
Vicia tetrasperma.
Rubus rhamnifolius.
Lythrum Salicaria.
Peplis Portula.
Carum Carui.
Pimpinella magna.
Sium latifolium.
Œnanthe Phellandrium.
Œnanthe Lachenalii.

Plantago Coronopus.
Chenopodium rubrum.
Rumex maritimus.
Orchis Morio.
Typha angustifolia.
Iris Pseud-acorus.
Allium vineale.
Zannichellia pedicellata.
Triglochin maritimum.
Juncus Gerardi.
Carex divisa.
Scirpus maritimus.
Scirpus Tabernæmontani.
Sclerochloa maritima.
Sclerochloa distans.
Avena pratensis.
Avena fatua.
Lepturus filiformis.
Pilularia globulifera.
Osmunda regalis.
Botrychium Lunaria.
Dicranum heteromallum.
Grimmia pulvinata.
Orthotrichum diaphanum.
Orthotrichum affine.

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Agaricus fascicularis.
Coprinus comatus.
Marasmius oreades.
Merulius lacrymans.
Stereum hirsutum.
Caloceia cornea.
Didymium melanopus.
Fegatella conica.
Pellia epiphylla.
Aneura multifida.

Of course, at Goole, like most towns to which sea-going vessels have access, in the places where ship-ballast has been deposited, foreign plants, seldom permanent, partly because often disturbed, are from time to time to be met with; and in the fields around Goole, where the "Warp" has been deposited, either by natural agency or artificial processes of irrigation, certain other species, rare in most parts of the Riding, are here not uncommon. The more interesting, of both classes, hitherto noticed are—

Erysimum Cheiranthoides.
Erysimum orientale.
Camelina sativa.
Diplotaxis muralis.
Senebiera didyma.
Bupleurum rotundifolium.
Carduus tenuiflorus.
Cichorium Intybus.
Echinospermum Lappula.
Atriplex Babingtonii.
Atriplex littoralis.

Contrasting the great drainage district of the Don—with its 600 square miles—with the others, something not uninstructive may be learnt. Largest in surface area, it ranks only third in the aggregate number of its species; yet of these the species *peculiar* to it, occurring only in it in the West Riding, are more numerous than are those of any other river-basin. Its hills nowhere reach into the Upper or infer-arctic zone: it therefore shows poorly in regard to high alpine plants. The xerophilous Montanes are nearly all wanting from the lack of the combination of limestone with altitude which species of that category require. Its calcareous region is confined to the strip of Permian strata running across it from Conisboro' to Wentvale. In this may be seen how little the accident of size, or the natural clearly defined character of its basin, has to do with the distribution of plants within an area so comparatively small as West Yorkshire; and we are reminded how (within such narrow limits) the great features upon which plant-distribution depends are geological and climatic—related to soil and altitude. Its southern position in the Riding counterbalances its paucity in mountain species to some extent, however. It lies adjacent to Notts, Derby, and Lincoln, and so gets some few forms just "running out" in their northern extension. The accident of its possession of a tidal river-board must also not be forgotten, for that gives to its flora a dozen or more species with maritime preferences. By way of summing up its broad features in another way, it may be said that to a botanist from the South, from Kent, Wilts, or Gloucester, its flora would offer comparatively little that was new or striking; but that, on the other hand, a botanist from the Scotch lowlands or Cumberland and Cheviotland, walking through it from Goole to Dunford, would meet with [redacted]

CHAPTER XI.

THE TRENT DISTRICT.

SAVING that of the Mersey, this is the smallest of the ten drainage districts into which the West Riding is divisible. It is situate to the east of Sheffield, against the Nottingham border of the Riding, and its superficial area is only some fifty square miles. It is the only district without upland reaching into the middle or super-agrarian zone; all of it lying considerably below five hundred feet in elevation. Its area is almost wholly included within the belt of Permian strata stretching N.N.W. from Notts to Ripon, and its surface is without greater geological diversity than is presented by the deposits of the Upper and Lower Magnesian Limestone and Red Marls of which it is composed. Its scenery is pleasing, even though its views are limited, and not grand; the gentle elevations of the limestone wolds, broken through by pleasant streams, wooded to their edge or bare, and revealing miniature crags of crumbling stone, give to the district a ridged undulate appearance. The beech woods are fine, the villages quaintly rural, and the high-banked elm-arched lanes rich in floral garniture.

In the hedgerows and woods, and on the craggy slopes, the Yew is the most conspicuous tree. Fine, abundant, and evidently indigenous, its Yew trees are probably what impress strangers most; although they are not the only example the district can show of a plant or shrub growing with greater luxuriance than elsewhere in the Riding. In the coppices and hedgerows that partition off the well-tilled fields the Spindle tree (*Euonymus europæus*), with its rosy-lobed and scarlet-seeded fruit, that "in the winter woodland looks a flower," is far more plentiful than anywhere else in Yorkshire; and the Privet (*Ligustrum vulgare*), indigenous here if anywhere, flings its arching branches, laden with pyramidal clusters of creamy bloom or black berries, far and wide in thicket, lane, and hedgerow, disputing supremacy with the red-twigged Dogwood (*Cornus sanguinea*), *Rhamnus catharticus*, and the ubiquitous Wayfaring Tree (*Viburnum Opulus*), whose leaflets at the first touch of autumn frost turn every shade of red from pink to crimson.

At the extreme north-east corner of this district, as defined upon the map, is Tickhill, an old-fashioned market town, with a quaint stone structure—reminding one of the Temple of the Sibyl at Tivoli in miniature—in the market-place, in lieu of the more customary "cross"; and also the remains of an old Castle, the tower

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Pastinaca sativa.
Parietaria officinalis
Lactuca virosa.
Verbascum Blattaria.
Hottonia palustris.
Atropa Belladonna.
Colchicum autumnale.
Allium vineale.
Carex acuta.
Asplenium Ruta-muraria.
Barbula subulata.
Weissia cirrhata.

The rivulet running through Tickhill is a branch of the Thorne, itself little more than a dyke, but has outside the Riding a connection with the river Idle by means of the Idle North Drain In the level district about Bawtry, and north-east towards the Lincolnshire "Isle of Axholme," the water-parting is often nothing more than an artificial embankment; so that in mapping out the district hereabouts, the division—a straight line drawn due east from Braithwell to the boundary line of the Riding—has been of necessity more or less arbitrary. The principal stream of the Trent district, however, is a tributary of the Ryton, which joins the Idle at Bawtry. It takes its rise on Ravenfield Common, and after receiving the water of the Bramley and Kingsforth brooks, runs east to the pretty village of Maltby. From here, with the limestone escarpment of Hooton Cliff to the south-west, and for its northern bank Wood-Lea Common—a slope of rocky pasture, picturesquely studded with weathered limestone rocks, on which grow *Alsine tenuifolia* and other plants—the Maltby stream runs south-west in a bed cut through the Lower Limestone and red marl down to the Coal Measure shales. They may be easily studied on the steep craggy slopes bordering the stream. About Maltby, in the woods, grow *Pyrola minor*, with the rare *Centunculus minimus* in the sandy ruts of the open glades; in wet clayey soil, *Equisetum hyemale;* by the brookside, *Gagea lutea ;* and in a very wet boggy place near is the sole Yorkshire station for *Carex distans*, discovered by the Rev. Gerard E. Smith—a sea-coast species, very rarely found so far inland, possibly a survivor from the time when a sea filled the valley of the Trent. Another plant—*Sclerochloa distans*—a grass of estuaries and tidal river banks, occurs (or did occur) in Maltby Churchyard, and is traceable all along the low valley country from Gainsborough to Sheffield.

But here is the Maltby list—the rarer plants of its woods, streamside, limestone escarpments, the Wood-Lea rocks, and neighbouring boggy places :—

Adonis autumnalis.
Arenaria tenuifolia.
Arenaria serpyllifolia.
Sagina ciliata.
Hypericum montanum.
Geranium pusillum.
Onobrychis sativa.
Astragalus hypoglottis.
Euonymus europæus.
Rubus affinis, W. and N.
Rubus carpinifolius, W. and N.
[redacted]

Eupatorium cannabinum.
Pyrola minor.
Ligustrum vulgare.
Senecio erucifolius.
Calamintha officinalis.
Centunculus minimus.
Veronica Buxbaumii.
Linaria Elatine.
Taxus baccata.
Habenaria chlorantha.
Convallaria majalis.
[redacted]

studded with noble examples of elm and beech. Here are the ruins of the famous Abbey of Roche, crumbling in glorious decay, to the accompaniment of woodland murmur alone; and in no conflicting proximity to the whistle of locomotives, or the heavy thud of ponderous steam hammers, as is the case at Kirkstall, to spoil contemplation and disturb the general impression. The sides of the valley, in part craggy, in part grassy slopes, are everywhere covered with wood, most of which is undoubtedly indigenous, though planted trees occur. The Yews are especially noteworthy: there are several that spread their roots over the rocks, and more than one does not enter the earth at all. Nowhere would it be possible to see the lesser blue Periwinkle (*Vinca minor*) more thoroughly naturalised than in these woods. To suppose it indigenous would be a pardonable error, when so abundant that acres of surface are covered by it, and seeing that it is even *said* to *fruit* here.

The Roche valley proper is formed by the junction of the ravine from Maltby with another from the south-west, looking up which from the Abbey the spire of Laughton Church may be seen. The Laughton, or Slade Hooton stream, flowing down it, forms a pretty piece of water known as Laughton Pond, half a mile in length, on the border of which *Symphytum officinale* grows in some profusion, with a greater appearance of being native than in any other station in the Riding, though it was probably of monkish introduction. The following are the rarer plants of the rocks, wooded slopes, and lake and waterside at Roche Abbey, and of the lanes and limestone quarries between there and the villages of Firbeck and Letwell, two miles further east, past which, to the Firbeck paper-mill, the Maltby stream runs until the county boundary is reached.

Clematis Vitalba.
Helleborus viridis.
Berberis vulgaris.
Fumaria Boræi.
Viola odorata et hirta.
Astragalus glycyphyllus.
Sagina ciliata et nodosa.
Rhamnus catharticus.
Euonymus europæus.
Arenaria tenuifolia.
Potentilla verna.
Silene noctiflora.
Geranium columbinum.
Pyrus rupicola.
Cerastium arvense.
Hippuris vulgaris.
Saxifraga tridactylites.
Rubus leucostachys.
Rubus macrophyllus.
Rubus rhamnifolius.
Rubus carpinifolius.
Rubus saxatilis.
Rosa micrantha.
Rosa urbica.
Rosa frondosa.

Hieracium murorum.
Carduus eriophorus.
Verbena officinalis.
Chlora perfoliata.
Lactuca muralis.
Vinca minor.
Ligustrum vulgare.
Atropa Belladonna.
Verbascum Thapsus.
Antirrhinum Orontium.
Calamintha menthifolia.
Lithospermum officinale.
Symphytum officinale.
Echium vulgare.
Primula variabilis, Goupil.
Daphne Laureola.
Humulus Lupulus.
Taxus baccata.
Lycopus europæus.
Colchicum autumnale.
Ophrys apifera.
Ophrys muscifera.
Epipactis palustris.
Neottia Nidus-Avis.
Convallaria majalis.

[redacted]

the river known as the Ryton from below Shireoaks, but in its earlier windings from Laughton, Brampton, and Donington Commons, where its three sources have their birth as Laughton, Erlsmire, and Carfil dykes, it passes as Stones Dyke until Shireoaks is reached. It is only interesting from where it (like the Maltby beck) breaks into the Lower Limestone at South Anston, and runs south-east in a very narrow rocky ravine to Lindrick Bridge. The cliffs of Lower Limestone that rise above the stream near Anston are sufficiently pronounced to have received distinct names—Oliver's Crag and Jackdaw Crag. On these rocks the Limestone Polypody (*Polypodium calcareum*) was discovered by Mr. J. Hardy, of Manchester (*Phytologist*, vol. i. p. 450), growing in plenty—and is remarkable as being a somewhat low station for a Montane species—but now nearly if not quite extinct.

To the east of Lindrick Bridge, and on the north of Stones Dyke, in which, near Wood Mill, grows *Ranunculus fluitans*, stretches still unenclosed one of the few fine old "Commons," once so plentiful, left in West Yorkshire. Across this rocky open limestone plateau runs the high-road from Anston to Worksop, and here (at an altitude of about 300 feet), along with *Spiranthes autumnalis* and other xerophilous plants, grows the Stemless Thistle (*Carduus acaulis*) in tolerable plenty. This is the sole West Riding station in which it can be said with certainty that the plant exists. Mr. A. Carr, of Sheffield, was the first to discover it here. The "Heath" record in Gissing's Wakefield Flora was an error; and in the "Cadeby Common" locality (much of it enclosed and altered of late years) of Salt's Herbarium at Sheffield (gathered in July 1800) the plant has not been noticed since early in the present century. This plant is given (with a query) in Watson's *Compendium Cybele Britannica*, as restricted in its range, in England, to the lowest (infer-agrarian) of the six climatic zones into which the surface of Britain is divided: and is in its distribution somewhat similar to *Clematis Vitalba* and *Viburnum Lantana*, also restricted as Native species to the lowest zone. Both these occur in this district, as well as the *Carduus*, and all three may pretty safely be considered indigenous in this southern corner of West Yorkshire, although in all stations further north they must be classed as Denizens only. The whole area of the West Riding is usually considered, however, as coming within the second or mid-agrarian zone; which would involve a contradition, if accepted as the fact any longer; for if the three species named are indigenous, then they ascend into the second zone, or else this part of Yorkshire should be considered, like Notts, with which it is conterminous geologically and topographically, as lying within the lowest zone. The latter supposition must be accepted as the true one, seeing how unlikely it is that the three species named should ascend into the second zone at a point (about Lat. [redacted] error to so regard it, since its climate as expressed in mean annual and high summer temperature is nearer that of Nottingham and Leicester than of York. Moreover no part of the surface in this Trent district lies above 300 feet in elevation from sea-level. West Yorkshire, then, in its climatic range, is, from a botanist's view-point, highly favoured: it embraces within its limits *four* climatic zones—infer-arctic, super-agrarian, mid-agrarian, and infer-agrarian—and it is possible to find an expression of the influence on plant distribution, exerted by a wider range of altitude, temperature, and soil, than could be shown by almost any other county of Great Britain.

The following species may be found in the vicinity of Kiveton, South Anston, Lindrick Common, and Thorpe Salvin, with many other limestone-loving kinds:—

Anemone ranunculoides?	Helosciadium nodiflorum.
Ranunculus fluitans.	Scabiosa columbaria.
Aquilegia vulgaris.	Galium Mollugo.
Viola hirta et odorata.	Inula Conyza.
Helianthemum vulgare.	Lactuca muralis.
Reseda lutea.	Carduus acaulis.
Hypericum montanum.	Arctium intermedium.
Hypericum hirsutum.	Ligustrum vulgare.
Rhamnus catharticus.	Ballota fœtida.
Euonymus europæus.	Hieracium sylvaticum.
Astragalus glycyphyllus.	Chlora perfoliata.
Spiræa Filipendula.	Gentiana Amarella.
Poterium Sanguisorba.	Erythræa Centaurium.
Rosa dumetorum.	Verbascum Thapsus.
Rosa arvatica.	Linaria minor.
Rosa coriifolia.	Salvia Verbenaca.
Geum rivale.	Mentha sativa.
Hippuris vulgaris.	Calamintha officinalis.
Callitriche hamulata.	Calamintha acinos.
Saxifraga granulata.	Rumex Hydrolapathum.
Daucus carota.	Colchicum autumnale.
Pimpinella magna.	Paris quadrifolia.

Taxus baccata.
Potamogeton obtusifolius.
Potamogeton pectinatus.
Potamogeton perfoliatus.
Potamogeton pusillus.
Potamogeton mucronatus.
Alisma ranunculoides.
Butomus umbellatus.
Spiranthes autumnalis.
Orchis ustulata.
Orchis pyramidalis.
Ophrys apifera.
Ophrys muscifera.
Carex pendula.
Carex divulsa.
Brachypodium pinnatum.
Sclerochloa rigida.
Scolopendrium vulgare.
Polypodium calcareum. Now?
Cystopteris fragilis.

Botanically the leading characteristic of this partial river basin is the abundance of its xerophilous, or limestone-loving species, and the almost total absence of plants of the montane (or descending) type. The prevailing soil—a rich, warm, friable loam—has, of course, more to do with this than the climate, although that is favourable—hot in summer, never very severe in winter, and with a greater average rainfall than one would expect. But in explaining the greater luxuriance of most of the species of South-English or Germanic type, and the presence of some not found elsewhere [redacted]

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EXPLANATION OF PLATES.

PLATE I.

FIG. 1.—Section in Bannisdale Slates at Crook of Lune.

FIG. 2.—Mountain Limestone resting unconformably on Silurian Rocks at Thornton Force, near Ingleton.

a. Mountain Limestone.
b. Silurian slates.

PLATE II.

FIG. 3.—Section in Dryrigg Quarry under Mountain Fell.

a. Mountain Limestone.
b. Pocket of Red Conglomerate filling a hollow at the junction of the two series.
c. Silurian Slates and Grits.

FIG. 4.—Synclinal axis at Stainforth, in a cutting in the Settle and Carlisle Railway.

a. Slates dipping respectively N.E. and S.W.
b. Drab shale or rotton slate.
c. Veins of quartz.
d. Slates curved and broken.

FIG. 5.—Diagrammatic section across the Lothersdale Anticlinal.

a. Mountain Limestone.

<table>
<tr><td>b. Bowland Shales.</td><td rowspan="3">Yoredale Series.</td></tr>
<tr><td>c. Yoredale Grit.</td></tr>
<tr><td>d. Upper Yoredale Shales.</td></tr>
<tr><td>e. Kinderscourt Grit.</td><td rowspan="3">Millstone Grit.</td></tr>
<tr><td>f. Shale.</td></tr>
<tr><td>g. Kinder Grit.</td></tr>
</table>

PLATE III.

FIG. 6.—Mountain Limestone Quarry at Raygill in Lothersdale, with the Bone-cave from which the remains of mammoth, etc., were obtained, at present deposited in the Leeds Museum.

FIG. 7.—Fence End Quarry near Thornton, showing the junction of the Mountain Limestone and Yoredale Shales, highly inclined.

a. Mountain Limestone with band of shale.
b. Loose black shale with beds of sandstone.
c. Sandy limestone full of carbonaceous matter smelling strongly of petroleum, and containing numerous remains of molluscs, corals, and encrinites.
d. Shale with ferruginous masses of stone.

FIG. 8.—"Slickenside" in Mountain Limestone at Skipton Rock Quarry. Limestone much contorted and at the line of fault smooth and highly polished.

PLATE IV.

FIG. 9.—Section of contorted limestone in a quarry between Skipton and Draughton. The limestone is much bent without fracture.

[redacted]

b. Yoredale shale.
c. Millstone grits.
F. Fault.

PLATE VI.

FIGS. 15 and 16.—Kinderscout Grits weathered into isolated masses in Kex Gill, near Blubberhouses.

FIG. 17.—Section exposing the Third Grit Rocks in the Railway Cuttings between Spofforth and Harrogate.
a. Shell-bed of Rhodes House.
b. Shale and sandstone, with worm tracks.
c. Shale.
d. Follifoot grit.
e. Shale.
f. Plumpton red grit.

PLATE VII.

FIG. 18.—Quarry at Wray House, near Harrogate, in the Cayton Gill series of the Third Grits.
a. Thin-bedded, jointed limestone.
b. Marl, white and clayey.
c. Thin-bedded limestone, with a few fossils.
d. Thicker-bedded limestone with marly partings.

FIG. 19.—Section exposed in Ramsden Clough, near Holmfirth, of the Third Grit Series.
a. Third Grits, thick and massive at top, but becoming divided by shales lower down.
b. Sandstone weathering into cubical blocks.
c. Shale.
d. Sandstone.
e. Shale with thin sandstones.
f. Kinderscout Grit.

PLATE VIII.

FIG. 20.—Section across the Craven Fault, near Settle.
a. Mountain Limestone.
b. Millstone Grit.

FIG. 21.—Denuded or water-washed mass of the Third Grit Rocks at Brimham.

FIG. 22.—Section in the Flagrock at Barkisland, showing excessive current-bedding. Two or three beds of shale are intercalated.

PLATE IX.

FIG. 23.—Upper bed of Flagrock near Dunford Bridge.

a. Rough rock.
b. Thin seam of coal.
c. Shale and rag.
d. Flagrock.

FIG. 24.—Flagrock in quarry at Mount Tabor, near Halifax.

Alternations of shale and flagstones in the upper part, with a lenticular bed of sandstone dovetailing into the shale.

FIG. 25.—Flagstones at Coldedge, near Halifax, very false-bedded.

FIG. 26.—Section in the new railway at Pontefract, exhibiting the unconformity of the Permian Limestone to the Coal Measures beneath.

A fault divides thick-bedded, soft sandstone on one side from alternations of shale, coal, and sandstone on the other; the limestone lying horizontally above each.

a. Sandy marl.
b. Fragmentary limestone and marly partings.
c. Thin-bedded limestone, with thin beds of clayey marl.
d. Yellow sand, inclined to the plain of deposition.
e. Sand, with quartz pebbles.
f. Coal shale.

FIG. 31.—Quicksand at Scriven.
a. Soil, etc.
b. Pebble breccia.
c. Yellow limestone.
d. Yellow limestone containing sand.
e. White sand.
f White sand, with beds of clay of a yellow colour.

PLATE XII.

FIG. 32.—Permian Limestone at Micklefield.
a. Soil, etc., 2 ft.
b. Fine white sand, with thin beds almost hardened to a sandstone, 4 ft.
c. Grey limestone, 2 ft.
d. Limestone, with cavities containing yellowish crystals, 2 ft.
e. Very stiff, extremely fine green clay, very much resembling till, 4 to 6 in.
f. Limestone similar to *d.*, 2 ft. 6 in.
g. Whitish thin-bedded limestone, with partings of marl, the surface showing ripple marks, 50 ft. exposed.

FIG. 33.—Section of current-bedded limestone in Warmsworth Quarry.

FIG. 34.—Junction of the Bunter Sandstone and Alluvial Deposits exposed in an excavation at Great Heck Station.
a. Gravel, 7 ft.
b. Stratified sand, 2 ft. 6 in.
c. Gravel, with alternations of sand, 2 ft.
d. Alternations of sand and gravel, with a thin bed of cemented sand—"pan sand"—at their base, 5 to 7 ft.
e. Red Bunter Sandstone.

PLATE XIII.

FIG. 35.—Section in glacial deposits in a cutting of the Settle and Carlisle Railway.

a. Sandy clay, with boulders, 10 ft.
b. Layer of sand and boulders cemented together, 3 ft.
c. Glacial clay or till, containing large boulders of Silurian Grit, finely striated, 5 ft.

FIG. 36.—Section in Boulder Clay. Settle and Carlisle Railway.

a. Gravel and boulders, 18 ft.
b. Glacial clay, with scattered boulders covered with scratches, 12 ft.

FIG. 37.—Glacial drift resting on Silurian slates in the Settle and Carlisle Railway.

a. Boulder clay, 5 to 12 ft.
b. Highly inclined Silurian slates.

PLATE XIV.

FIGS. 38, 39, 40.—Stranded erratics of Silurian Grits on the Mountain Limestone at Norber, near Clapham.

PLATE XV.

FIGS. 41, 42, 43.—Masses of ice-borne Silurian Grits stranded on the Mountain Limestone at Norber, near Clapham.

REFERENCE

TO

COLOURS INDICATING GEOLOGICAL GROUPS IN THE FOLLOWING PLATES.

⁂ *The coloured sections have been derived to some extent from the horizontal sections of the Geological Survey.*

New Red Sandstone.

Permian Series.

Upper Coal Measures.

Lower Coal Measures.

Millstone Grit.

Yoredale Series.

Mountain Limestone.

Silurian Group.

Eruptive Rocks.

Plate I.

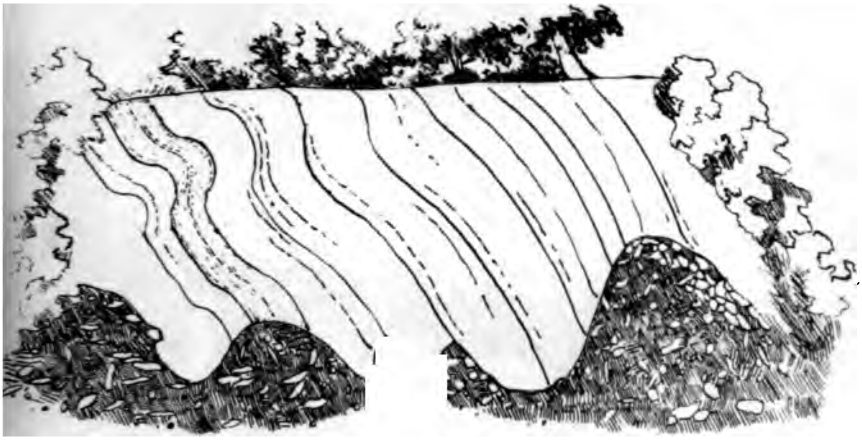


Fig. 1.—Section in Bannisdale Slates—Crook of Lune.

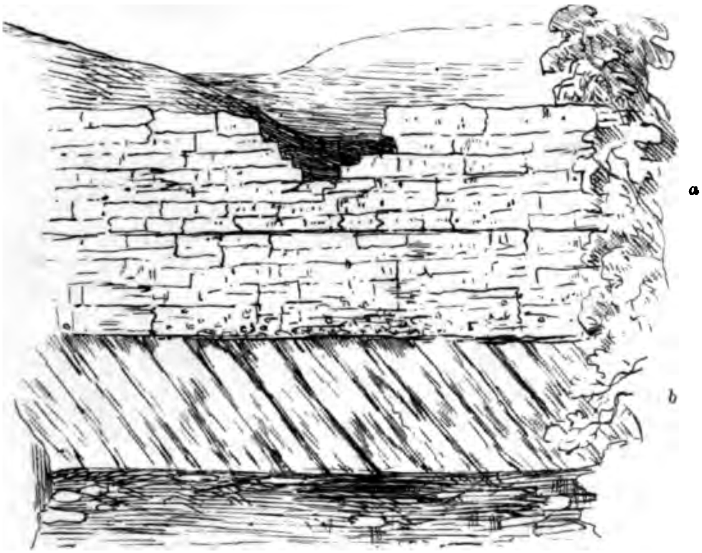


Fig. 2.—Thornton Force—Limestone unconformably above Silurian Rocks.

PLATE I.

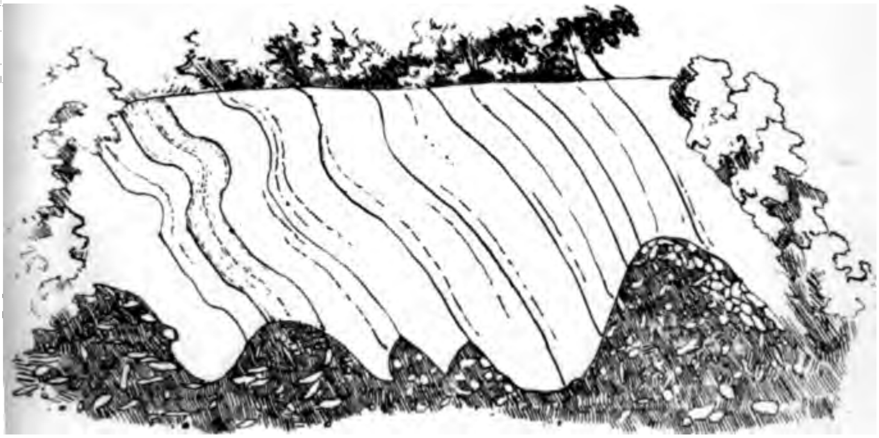


FIG. 1.—Section in Bannisdale Slates—Crook of Lune.

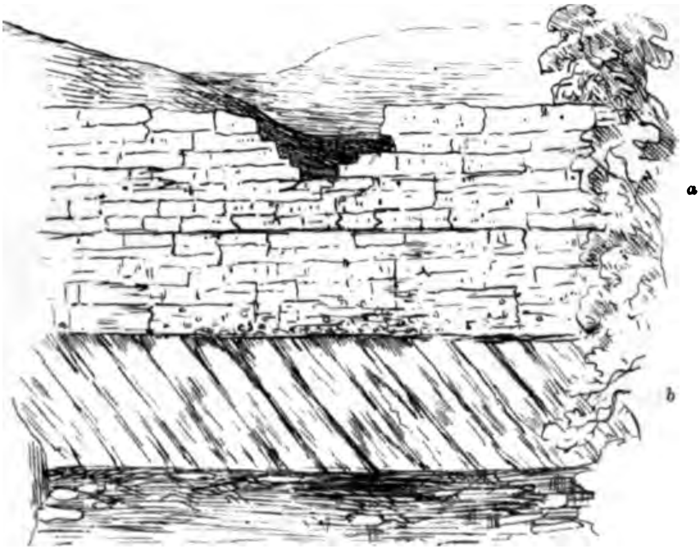


FIG. 2.—Thornton Force—Limestone unconformably above Silurian Rocks.

Plate II.

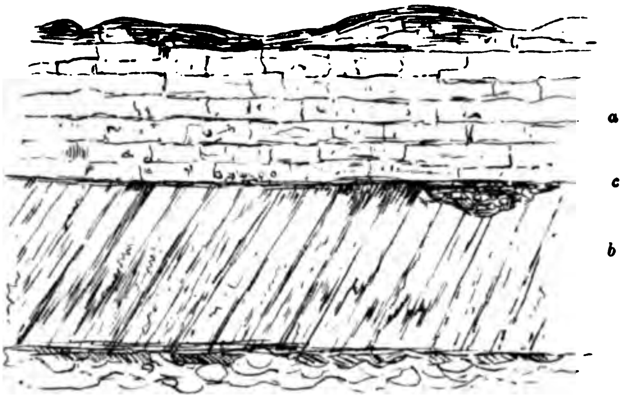


Fig. 3.—Moughton Fell, in Ribblesdale.

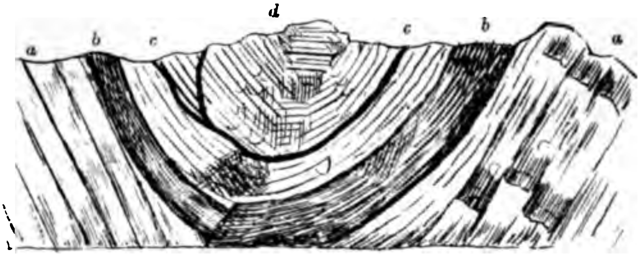


Fig. 4.—Synclinal Axis in Silurian Slates.—At Stainforth, in cutting for the Settle and Carlisle Railway.

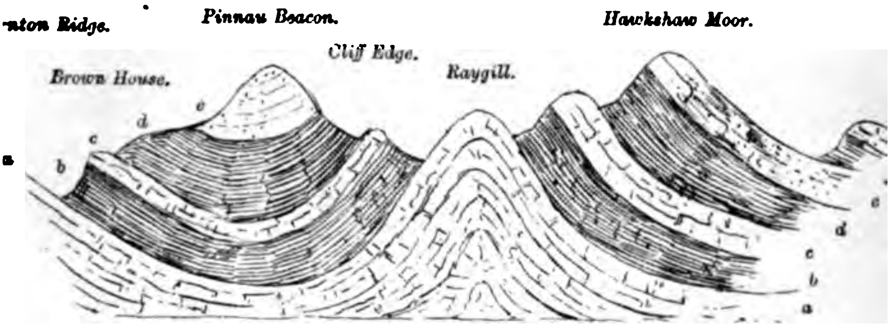


Fig. 5.—Diagramatic Section across the Lothersdale Anticlinal.

PLATE III.

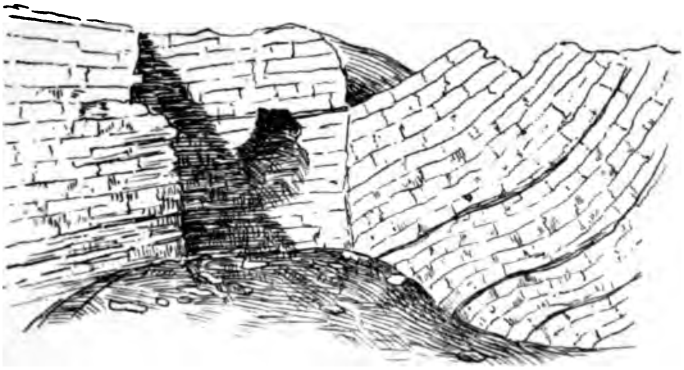


FIG. 6.—Raygill Quarry, shewing entrance to Bone-cave.

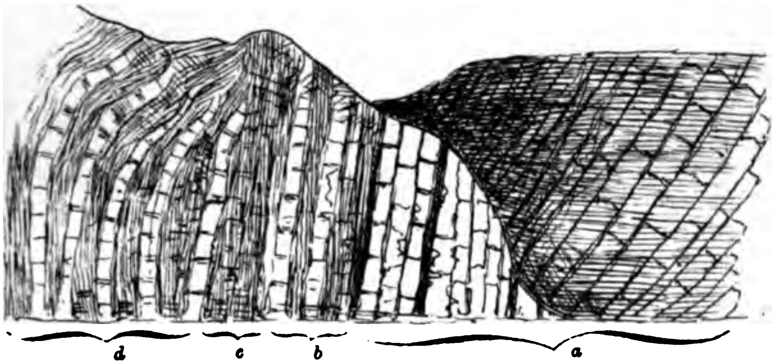


FIG. 7.—Fence End Quarry.—Junction of Mountain Limestone and Yoredale Shales.

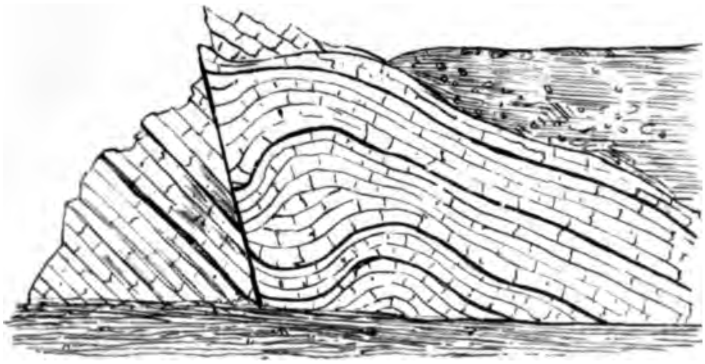


FIG. 8.—Skipton Rock Quarry.—Slickenside in Limestone.

PLATE V.

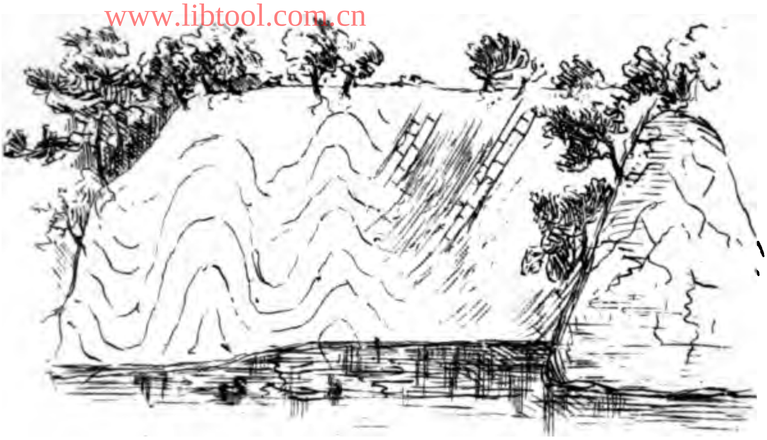


FIG. 12.—Section at Bolton Abbey.—Contorted Yoredale Shales.

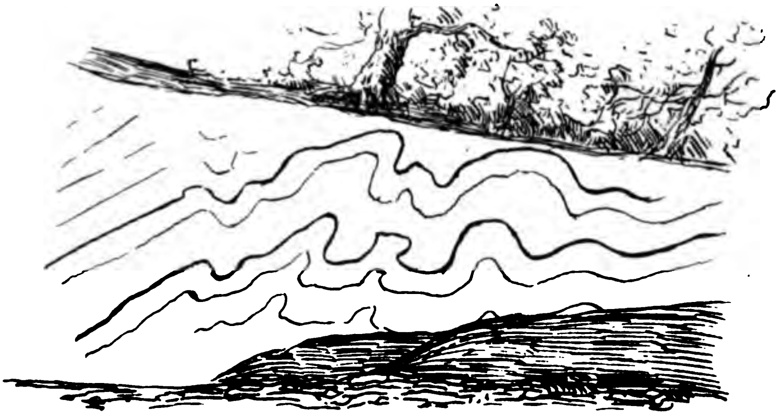


FIG. 13.—Section on the roadside between Bolton Bridge and Addingham. Yorodale Shales.

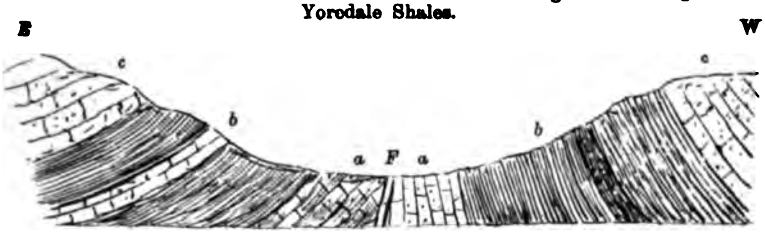


FIG. 14.—Penine Anticlinal, at Diggle.

Plate VI.

Fig. 15—Weathered Rocks at Kex Gill, near Blubberhouses.

Fig. 16.—Kinderscout Grit.—Kex Gill, near Blubberhouses.

Fig. 17.—Section in Railway Cuttings, between Spofforth and Prospect Tunnel.

PLATE VII.

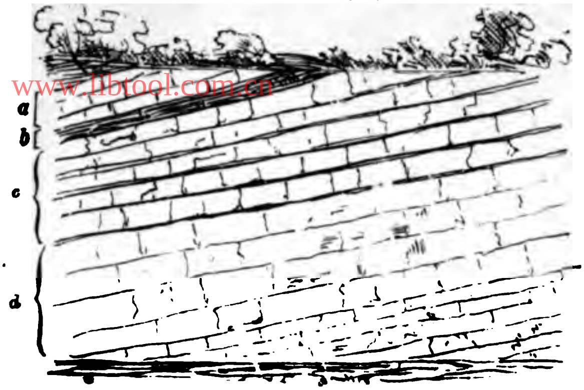


FIG. 18—Quarry in Cayton Gill Series.—Wray House, near Harrogate.

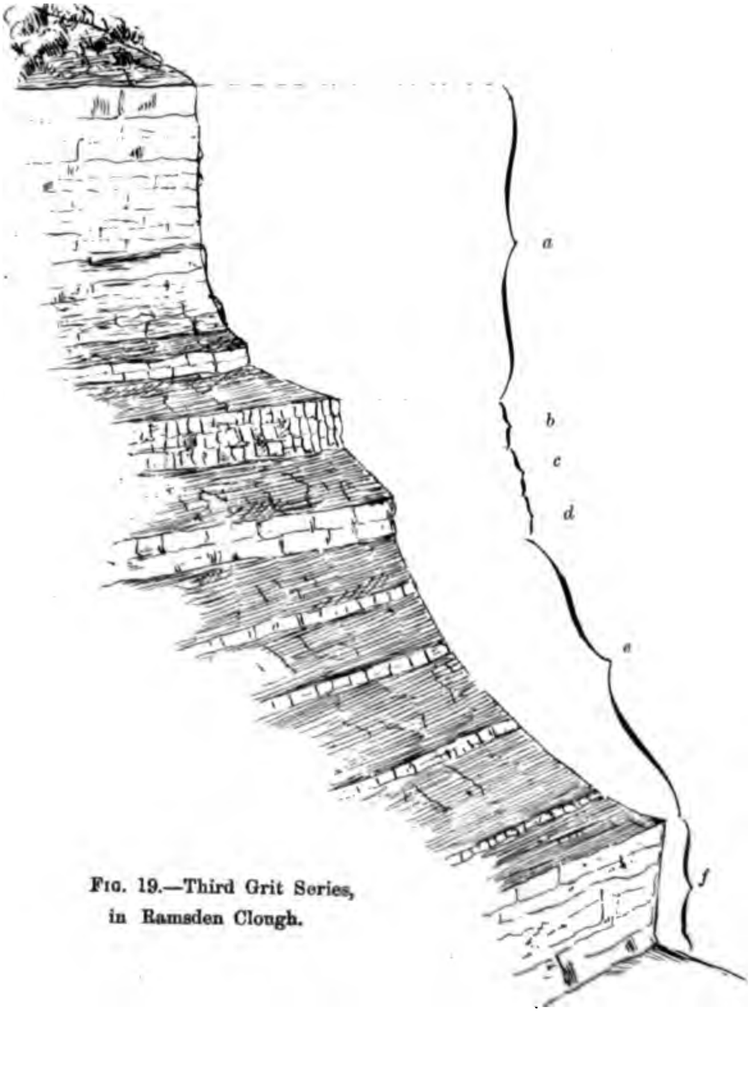


FIG. 19.—Third Grit Series, in Ramsden Clough.

Plate VIII.

Fig. 20.—Section across Craven Fault, near Settle.

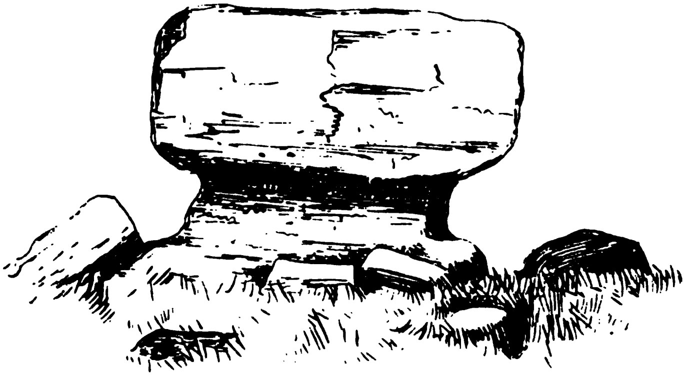


Fig. 21.—Denuded Rock at Brimham.

Fig. 22.—Wave-bedding in Flagrock.—Barkisland.

PLATE IX.

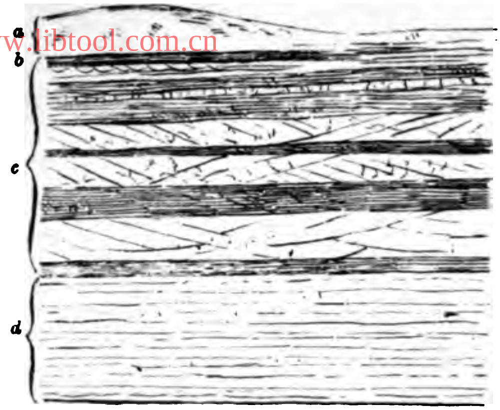
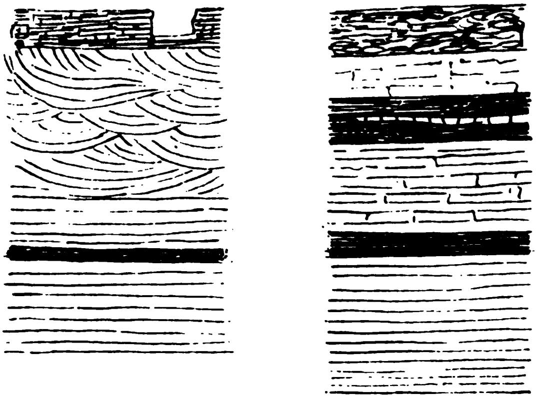
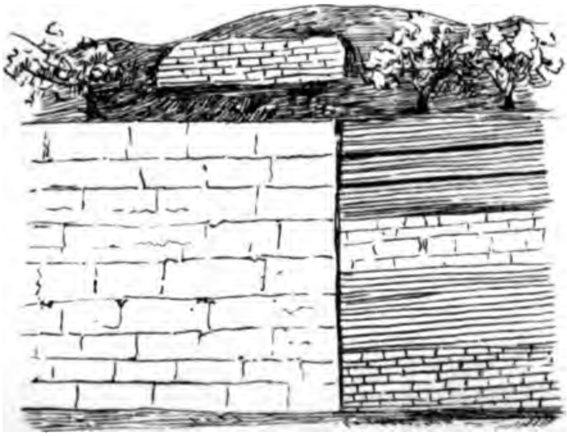


FIG. 23.—Upper Beds of Flagrock, near Dunford Bridge.



FIGS. 24 and 25.—Flagrock, at Mount Tabor and Cold Edge, near Halifax.



s. 26.—Section at *Pontefract*.—Unconformability of Coal Measures and Permian.

Plate X.

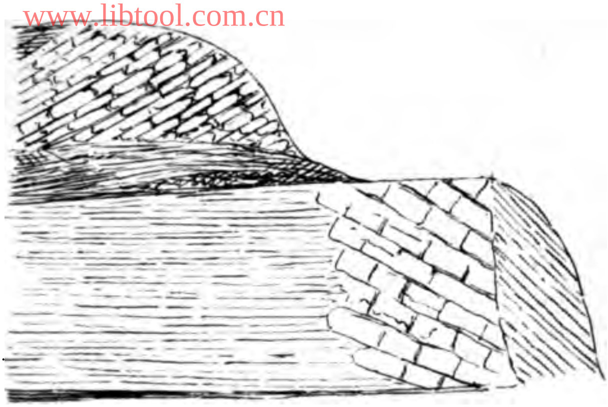


Fig. 27.—Section at Bardsey.

a

b

c

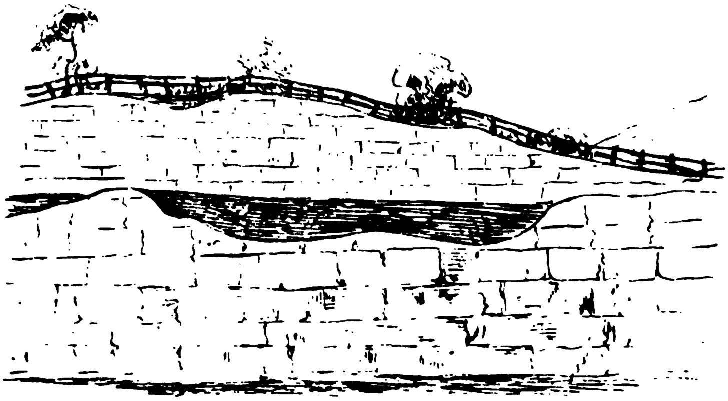


Fig. 28.—St. Helen's Quarry, near Spofforth.

a

b

Fig. 29.—Knaresborough —Permian Limestone resting on Millstone Grit.

Plate XI.

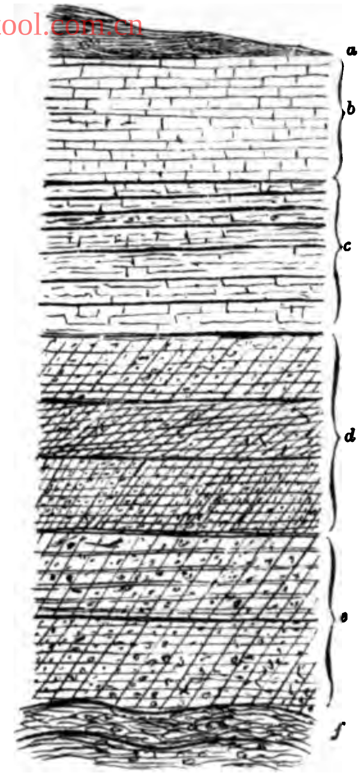


Fig. 30.—Quicksands at the base of the Permian Limestone.—Garforth.

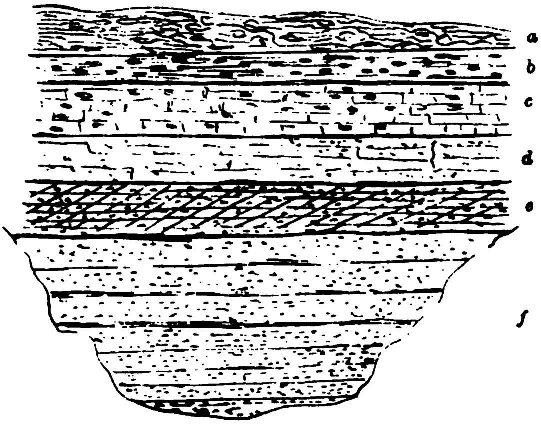


Fig. 31.—Quicksands at Scriven.

PLATE XIII.

FIG. 35.—Section in Glacial Deposit.—Settle and Carlisle Railway.

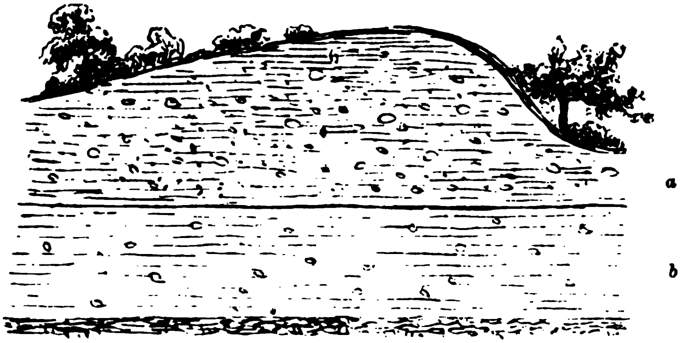


FIG. 36.—Section in Boulder Clay.—Settle and Carlisle Railway.

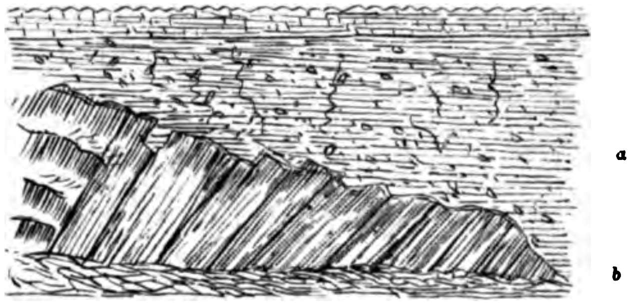


FIG. 37.—Glacial Drift resting on Silurian Slates.—Cutting in Settle and Carlisle Railway.

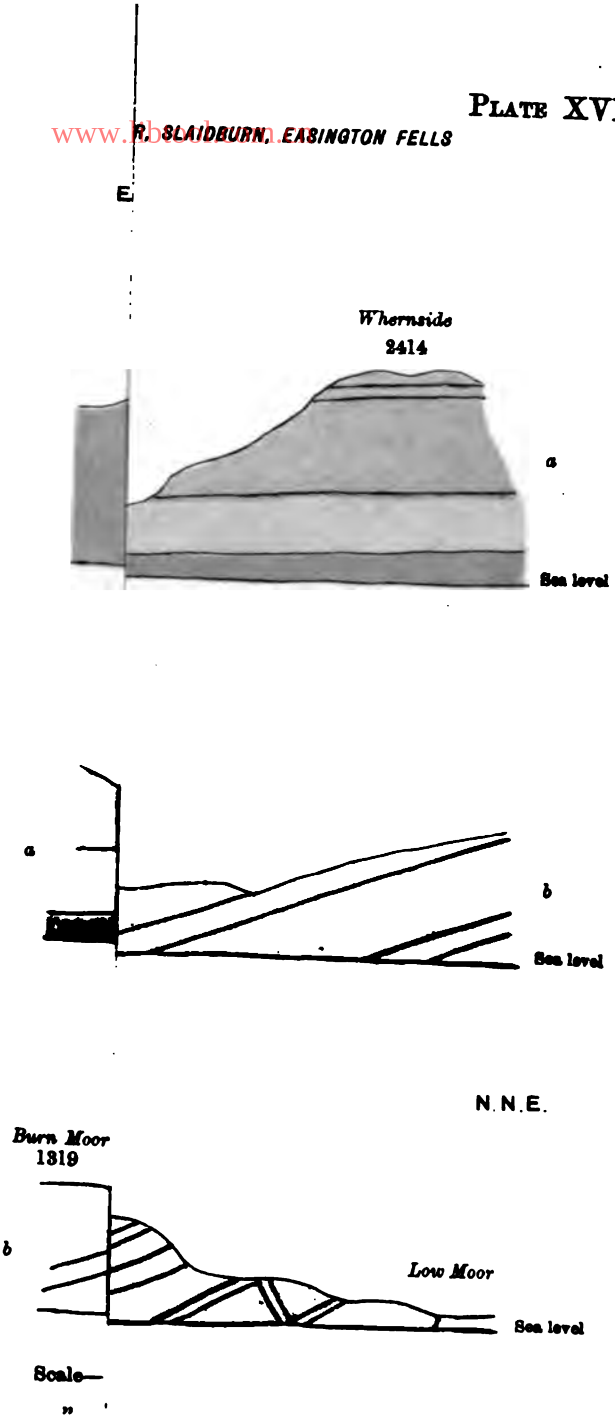
PLATE XV.

FIG. 41.—At Norber, near Clapham.

FIG. 42.—At Norber, near Clapham.

FIG. 43.—Silurian Blocks at Norber, near Clapham.

Plate XVII.



R. SLAIDBURN, EASINGTON FELLS
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a
b
Sea level
N.N.E.
Burn Moor
1319
b
Low Moor
Sea level
Scale—
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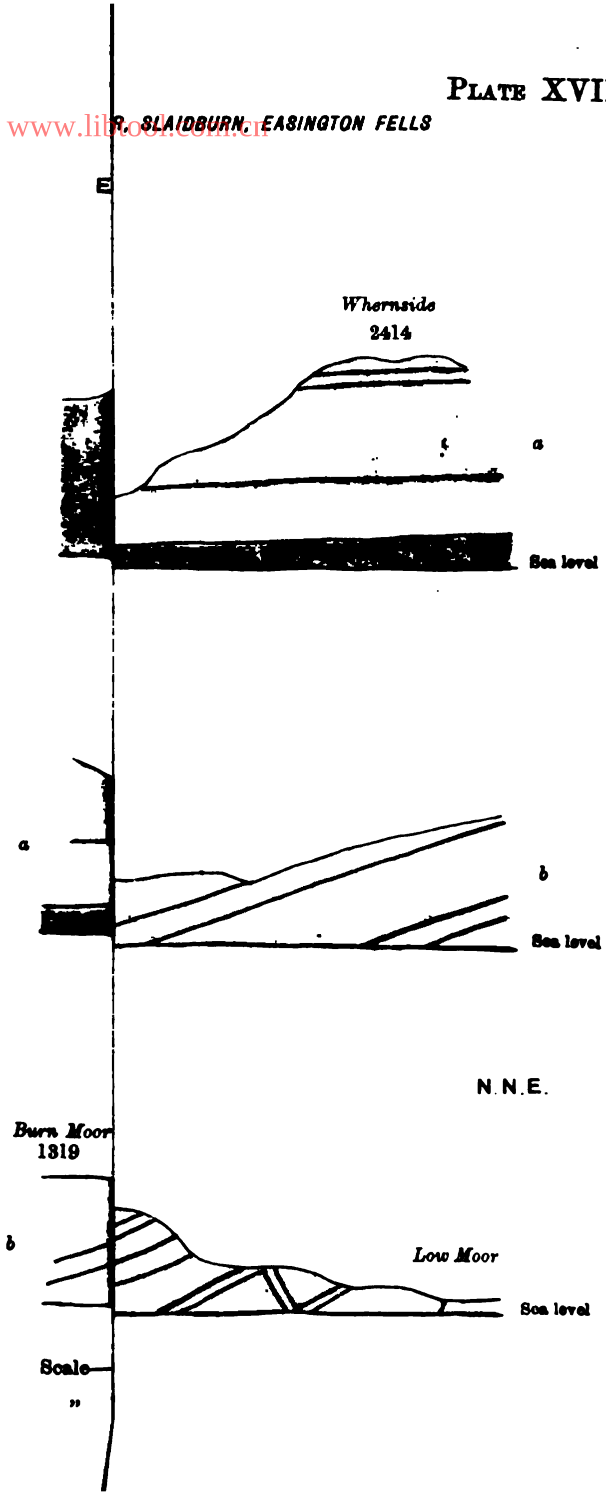
Plate XVII.


R. SLAIDBURN. EASINGTON FELLS
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a
Sea level
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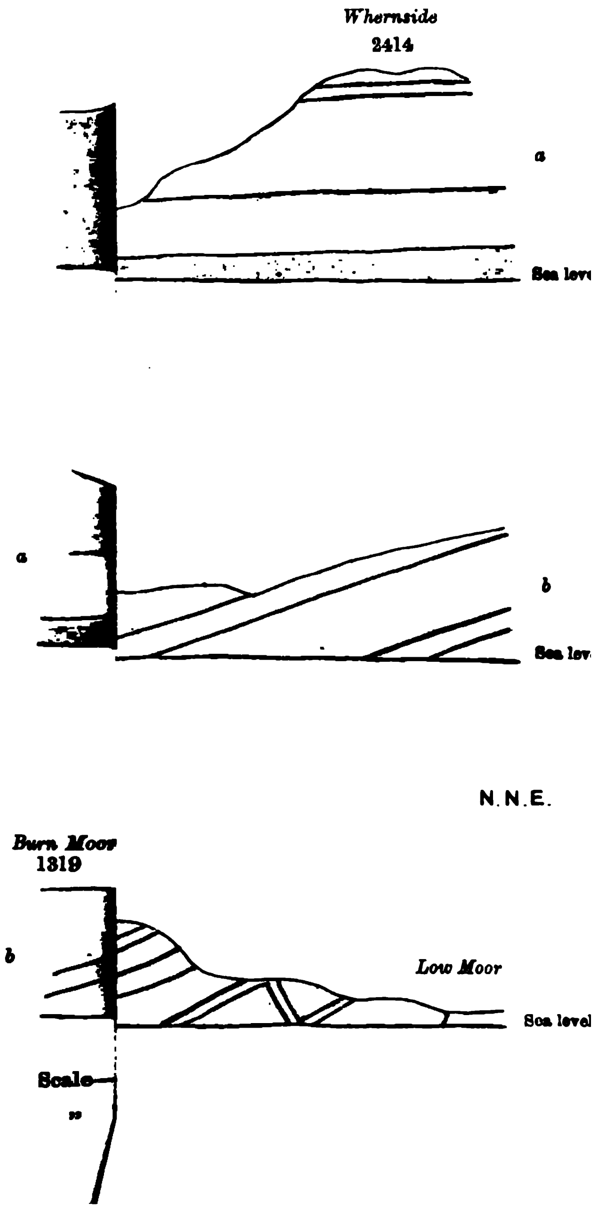
Sea level
N.N.E.
Burn Moor
1319
b
Low Moor
Sea level
Scale
"

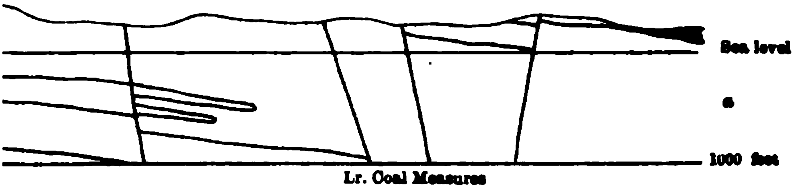
PLATE XV

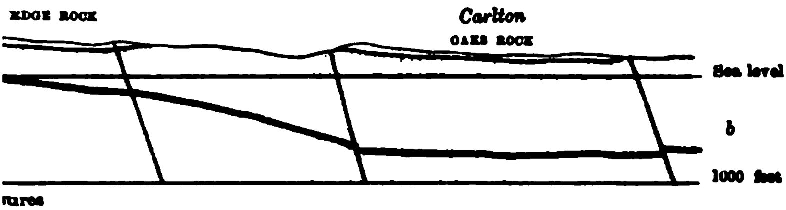
R, SLAIDBURN, EASINGTON FELLS



ꞏN COMMON, NEAR BARNSLEY.

PLATE XVIII.





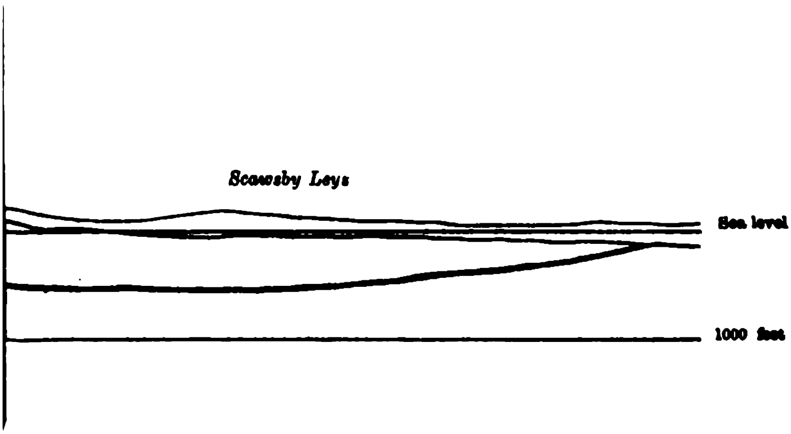



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PLATE XXI.

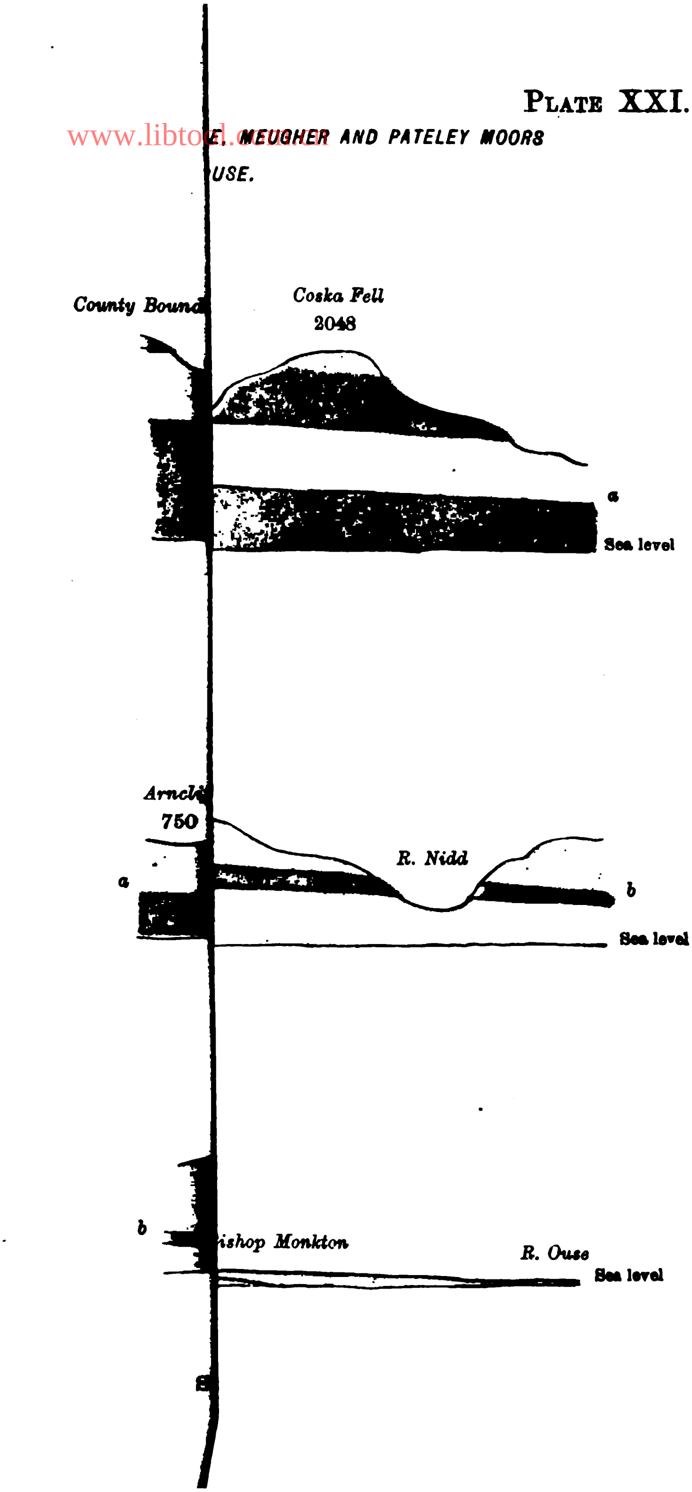
E. MEUGHER AND PATELEY MOORS
USE.
County Bound
Coska Fell
2048
a
Sea level
Arncli
750
a
R. Nidd
b
Sea level
b
ishop Monkton
R. Ouse
Sea level

Plate XXI.

E. MEUGHER AND PATELEY MOORS

USE.