

On the geology of the lower or northern part of the province of Moray : its history, present state of inquiry, and points for future examination / by George Gordon.

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THE GEOLOGY

OF THE NORTH-WEST CORNER OF THE TROUSDALE
OF MOUNTAIN

HISTORY, PRESENT STATE OF THE GEOLOGY, AND THE
FOR FUTURE EXAMINATION

BY GEORGE HENRY, M.A.

LONDON: J. H. KNOX, 1851.

On the Geology of the Lower or Northern Part of the Province of Moray: its History, Present State of Inquiry, and Points for Future Examination. By the Rev. GEORGE GORDON, A.M., Birnie.

From the Edinburgh New Philosophical Journal, New Series, for Jan. 1859.

Last month the lengthened chain of rail was completed which connects the Capital of the Highlands with the Metropolis of the British Empire—Inverness with London. The latest formed links of this chain were laid on a portion of the North of Scotland, neither uninteresting nor altogether unknown to the naturalist, particularly if geology be the object of his recreative pursuits. This district having thus lately become so accessible to the most remote inhabitant of our island, and as the meeting of the British Association at Aberdeen next autumn must bring many of its members within some sixty miles, or three hours' run of its centre, a short outline of its geological features may not be deemed altogether unacceptable.

The extreme southern or upper portions of the counties of Elgin and Nairn abound in what has hitherto been considered metamorphic and plutonic rocks; but it is not of them, or of their subordinate beds and masses, that we are now to write at any length. Suffice it then, as regards them, to refer the inquirer to Professor Nicol's "Guide to the Geology of Scotland," an admirable manual and a fit companion for every geological wanderer in "the land of the mountain and the flood." The lower or northern portions of these counties, with an adjoining and narrow strip on either side, from Banff and Inverness-shires, form the district here to be described. It extends from the east bank of the River Spey to the west bank of the River Nairn, a distance of about forty miles, and has the out-cropping beds of gneiss and the protruding granites as its southern boundary, and the waters of the Moray Firth as its northern limit. The greater part, if not, indeed, the whole of the "formations," in this district may be comprehended, at least provisionally, in two widely-separated divisions of the great geological scale,—viz., the Old Red Sandstone formation, and the Northern Drift. For although there are several masses, and even regularly-formed strata of wealden and oolite, yet a strong doubt has arisen as to

their being actually *in situ*; while the rocks here introduced as silurian are alluded to rather with a view to direct the attention of other and more competent observers to the several localities, than to give any great assurance that our own suggestions are correct. Two circumstances tend materially to render the examination of this part of the province of Moray difficult to the geologist. There are such vast accumulations of the boulder clay, of the gravels and sand-banks of the drift, and of the debris of ancient sea-margins, that few sections of the underlying strata are fully exposed; and, even where they are best seen, there seems to have been so great and so extensive a denudation during the time of their deposition, that a complete or uninterrupted sequence of strata and their beds has not been detected. Still, notwithstanding these difficulties, there is much in the formations of this district worthy of attention, both on account of the discoveries that have already been made and described, and of those which assuredly remain to be ascertained and determined by resident observers and geological visitors.

Any observations on the province of Moray which we might select from the writings of earlier tourists and naturalists, such as Williams' description of the cherty rock and galena of Stotfield,* refer to the mineralogy rather than to the geology of the district. We therefore at once begin by narrating what has been written on the subject by two early and leading members of the modern English school of geology. Thus, the first notice of the geology of this locality is contained in a paper laid before the Geological Society of London, by Messrs Sedgwick and Murchison, so early as 1828, and published in the Transactions, Vol. III., second series. The leading object of the authors having been, to make known and describe the "deposits lying between the primary and oolitic series," on the opposite or northern shore of the Moray Firth; their equivalents on the southern shore (although minuter notices of the sections on the Findhorn and at Quarrywood, near Elgin, are given) are passed over with less detail. It is in this paper that we have a division made of the Old Red Sandstones of Caithness, Sutherland, and Ross

* He calls it a "composite granite."—"Mineral Kingdom," vol. i. p. 401.

into three parts—viz., the coarse conglomerates or fundamental strata, the middle schistose or fish-bearing strata, and the superior or sandstone strata. No such division, however, was carried out by them in reference to the rocks on the southern shores of the Moray Firth; the conclusion come to, representing the whole conglomerates, cornstones, and sandstones, except the Leys-ridge, near Inverness, is, that they formed but one of those three divisions—namely, the lowest. This member, or lowest division, as seen in the province of Moray, is indeed subdivided into three parts, as the following extract from this valuable paper shows:—"The secondary deposits on the southern shores of the Moray Firth, it appears, may be divided into three groups, the lowest of which is composed of red sandstone and conglomerate; the middle of sandstone associated with variegated marls and sandstone; the highest of light-coloured silicious sandstones. These three portions are, however, very ill defined; and, as in our examination of this part of the country, we did not visit all the successive formations to the east of Burghead, there may be other beds, superior to the white sandstone, not noticed in this transverse section. A peculiar character is given to the deposits here described by the great abundance of cornstone, which may perhaps be considered to replace the lower portions of the calcareo-bituminous schist. Whatever be its relations, its appearance is not to be regarded as altogether anomalous; for, in the county of Sutherland (especially in the immediate neighbourhood of Golspie, and between that place and Loch Fleet) there are several examples of this peculiar concretionary limestone associated with red sandstone, which alternates with and overlies the old conglomerate. And there may be many other examples of cornstone, with similar relations, which in the transverse sections through the secondary series entirely escaped our notice." These learned and experienced geologists in this paper* distinctly affirm,—what we believe to be the case,

* Much of this, and of another paper by the same authors on the Formations of the Moray Firth, with other information on the geology of the north of Scotland, will be found in the first edition of "*Anderson's Guide to the Highlands*," &c., a work which, says a good judge, "is not to be mentioned without honour."

although it has been denied by some resident observers,—that the cornstones under and around the town of Elgin are surmounted by the great system of sandstone strata. These sandstone strata, which contain in some places “small specks of kaolin,” they truly state to be, in some of their beds, “the most beautiful light-coloured building-stone of the north of Scotland.” Linksfield and Lethenbar, now two interesting and fertile fossil localities, are mentioned by Messrs Sedgwick and Murchison; but their curious contents were then undetected, at least unknown to the scientific world.

Mr Martin, of Anderson’s Institution, Elgin, in 1835, wrote an “*Essay on the Geology of Morayshire*,” for which he obtained a gold medal from the Highland and Agricultural Society of Scotland. It is published in the fifth volume, new series, p. 417, of their Prize Essays and Transactions. In this essay, Mr Martin, after a short sketch of the physical geography of the district, describes its geology in the descending order, treating, 1st, of the alluvium, including the sedimentary deposits,—the peat (subterranean and submarine), the sand drift, and the change by the sea; 2d, the diluvium; 3d, the limestone; 4th, the sandstone; 5th, the gneiss; and concludes his paper, which is illustrated by the first published map of the geology of the district, by some interesting remarks on its minerals, and on the relation between the underlying rocks and the soil. In 1836 Mr Martin made the most important discovery in the geology of Moray, by detecting organic remains (plates and scales of fish) in the now widely-celebrated locality of Scāat Craig, four miles south from Elgin, and near the road that leads to the Glen of Rothes. The commencement, in that year, of that large and multifarious collection which forms the contents of the Elgin Museum, by the presentation to his native town of a valuable assortment of armour, birds, &c., from New Zealand and New South Wales, by John Masson, Esq. of London, gave a stimulus to others to add whatever antiquities, curiosities, and specimens in natural history they could procure, either at home or abroad. The Scāat Craig, from the time of Mr Martin’s discovery, became a point

of attraction for this purpose. One of the largest ichthyolitic plates, and still one of the best ever dug from that locality, was soon found and presented to the museum, by the Rev. John Allan, of Peterculter, then acting as its efficient curator. Indeed, the Scāāt Craig may be regarded as the starting point of a successful search for fossils in the sandstones of Moray,—strata which had hitherto been looked upon as entirely devoid of any such interesting relics. Numerous and varied were the conjectures ventured upon as to the nature of the animals to which the remains at Scāāt Craig had belonged, and to the relative age of the rock in which they were found embedded. Some geologists, both of the north and south, supposed they were bones of gigantic reptiles,—saurians of enormous dimensions,—and that their matrix was so recent as the greensand of England. The late Dr Fleming, to whom we sent some specimens from this locality in March 1838, stated that “these organisms had a very strong resemblance to those found in the sandstone series immediately below the mountain limestone and coal measures of Fife.” Thus the great similarity of the fossils to those of Fife, and the better known geological position of the rocks of that county, gave the first clue to the true allocation of the Scāāt Craig beds among those of the Old Red Sandstone series.

Early in 1838, Dr John Malcolmson, of the H.E.I.C.S., most opportunely appeared on this field. By his own geological knowledge, zeal, and experience, by an example so animating, and a bearing so encouraging to others, a large, decided, and firm step was made in elucidating the structure of the country, and in placing its formations before the scientific world in a light worthy both of the advanced state of geology and of the interest which the nature and contents of the rocks themselves were calculated to produce. In January 1838, in company with Patrick Duff, Esq., he paid a visit to the Scāāt Craig; but owing to the unfavourable state of the weather he was unsuccessful in obtaining fossil remains. He also visited Linksfield with a like unpromising result.

Dr Malcolmson had now to go to London, and, anxious that the savans of the metropolis should know and determine the value of Mr Martin's discovery at Scāāt Craig, we fur-

nished him with as characteristic a selection of fossils from that locality, and also from Linksfield, as the short interval permitted, accompanying the specimens with a few notes and illustrative sections of the district. Mr Martin greatly enhanced this selection by contributing, among other specimens, a fine large tooth, which was immediately figured for Sir Roderick Murchison's great work on the Silurian Rocks. The exhibition of these fossils at the Geological Society excited much interest among its members. Their views, and his own researches among the specimens and books of the Society, with the comparisons he was then enabled to make, fully satisfied Dr Malcolmson that the fossils from Scāat Craig were of the Old Red Sandstone formation. He was then confirmed in an opinion formerly expressed by him, that the deposit at Linksfield, of which he read a notice to the Society on 25th April, was of the wealden, and not of the lias formation. From London, Dr Malcolmson went to the Continent in April 1838, carrying along with him some of the Morayshire, and also of the Cromarty specimens. He returned to Forres in the end of the autumn of the same year, and then commenced that more extensive and minute examination, the result of which is given in his most valuable, but little known paper,—read before the Geological Society of London, on 5th June 1839,—“On the relations of the different parts of the Old Red Sandstone system in the counties of Moray, &c.” Ere this paper was completed, he had visited many parts of Scotland, and especially those localities which might present illustrations and examples for enabling him to unravel the state of the southern shore of the Moray Firth. The district itself was of course known to him in every spot where the underlying rocks crop out. Well do we recollect the many excursions in which we fondly joined him,—such as by the shores of the Firth, tracing its ancient levels, its regular and far-spreading shingly beaches,—by the margin of the Loch of Spynie, picking up the remains of its salt and of its fresh-water mollusca, and marvelling at the extent of its now extinct oyster-bed,—by the rocky channels of the Lossie, and by those of its tributaries, marking in them the contortions

of the more ancient rocks, the bluff projections of the conglomerates and their sandstones; here, in their fractures, with angles well defined and sharp as at first, there the rock crumbling before the slightest touch,—or by the upper stretches of moorland, finding on them traces of morains and lines of smoothed boulders, resembling what he had seen among the Alps. Never can we forget the entrancing joy with which nodule after nodule was broken, on 14th November 1838, at Dipple, on the Spey, as all the while evidence of embedded organisms slowly, gradually, surely increased, as the light of the rising sun. Great, however, as was the pleasure of discovering fossil fish in this locality, where, indeed, they are in the worst state of preservation, that pleasure was exceeded on a subsequent day when we came upon those at Tynat, where the fish are well defined and in a better state of preservation than in any other locality in the north of Scotland. Residing in its immediate neighbourhood, Dr Malcolmson paid many visits of discovery to the peerless banks of the Findhorn, where the largest sections of the strata are to be met with. Accompanied by Mr Stables, of Cawdor, he examined the valley of the Nairn, and that of the Burn of Brodie. Perhaps Dr Malcolmson's noble heart reached the acme of scientific satisfaction on the 27th March 1839, when his friend and fellow-labourer, Mr Stables, laid open in his presence a nodule, at Lethen Bar, that first revealed a form clearly distinct from any previously known fossil. Yes; "that singular creature," as he soon afterwards read to the Geological Society, "which, notwithstanding its anomalous form, I believe to be a fish." This was what was afterwards named by Agassiz, *Pterichthys*. We have a letter from Dr Malcolmson, dated the next day (28th), in which he says, "Stables got a magnificent *coccosteus*, showing the tail and wings, and also a fine small specimen of the species with the large tubercles, showing the tail as I saw it in some of Trail's Orkney fish." On the day following (29th), he writes to Mr Stables, "The more I think of our discovery the more important it seems. You must let me have the two tailed species of *coccosteus*, and the large tuberculated fish found by Dunbar, to have drawings of them made; and the first, I fancy, must be

sent to Agassiz." And, in a letter Dr Malcolmson sent us from London, of date the 13th May following, he says, "He" (Mr Murchison, who then paid a visit to Paris) "took the winged creature with him—two specimens. If you can get the use of any others showing its structure, I should like to have them here before the first week of June. I have promised to draw up a short account of our discoveries, &c." "P.S.—Agassiz is to be here in a few weeks, and his painter is now here." Of the same date (London, 13th May 1839), he writes to Mr Stables, "I was sorry to find Mr Murchison setting off this morning for the Continent. He, however, met Mr Lonsdale on Saturday, and we looked at a few of our discoveries, and he was astonished beyond measure, urged an immediate memoir, which I have promised for Wednesday four weeks, the last meeting—the next one being full. Mr Murchison said he and Sedgwick had no notion that organic remains lay under their feet;—admits all my inferences as to relation of rocks. The *strange creature* excites more of their surprise and interest; and I have allowed Mr Murchison to take two good specimens to afford work for the Parisians, and also Steven's drawings," &c. "If you have any good winged creatures, pray send them by next steamer." The following extract from his paper, read before the Geological Society of London, 5th June of the same year, will show how broadly he had drawn the line of demarcation between "the winged creature" and any previously known form of fossil from the Old Red Sandstone:—"I have ascertained, by comparisons with numerous specimens, that they (viz., the fossil fish of the Old Red Sandstone of Moray) belong to the same genera and species which are found in Orkney, Caithness, Cromarty, and Gamrie—the most common belonging to the genera *Dipterus*, *Diplopterus*, *Cheiracanthus*, *Cheirolepis*, *Osteolepis*; a very important fossil, belonging to an undescribed genus of Ray, to be named by M. Agassiz, *Coccosteus*; and the singular creature figured (No.), which, notwithstanding its anomalous form, I believe to be a fish. Regarding this very remarkable fossil I propose to submit some observations at another time; but would now call attention to the part of the bony structure on which the arms rest, resembling

that of some fishes of the cornstone series and mountain limestone, and to the resemblance in form of the convex plate on the back to those of the Findhorn and Clashbinnie already referred to. I saw one specimen of this fossil from Orkney in Dr Trail's collection. Imperfect specimens also occur at Cromarty; and two from Gamrie are in the Society's museum." A few days after this paper had been read,—viz., on 12th June 1839,—Dr Malcolmson writes to us:—"The fossils I presented in our names, jointly with Mr Stables and I propose leaving most of the specimens here for the present, as Agassiz is expected the end of the summer; and those belonging to Martin, and such of our own as it may be expedient to keep for the north, can be packed up after he has had the use of them." "Mr Lyell gave into the idea of the winged creature being a fish." "Nobody in Paris could make anything of it." In a letter to Mr Duff, dated London, 2d March 1840, among other compliments he meant to pay, he says, "I propose naming the winged creature after our friend Miller." In this letter he also states, that Valenciennes could make nothing of the creature, whether fish, crab, or tortoise; "but I don't care for that," he adds; "I shall spend a day or two" (he was then on the eve of returning to India) "in describing the fossils slightly, a selection of which will be engraved for the Transactions of the Geological Society, to illustrate my paper. I hope you will have no objections to some of yours being selected for this purpose." A manuscript copy of Dr Malcolmson's paper is now in the possession of Mr Stables. From it we have been able to give much information, without which these pages would have been comparatively of little value.

It is, indeed, much to be regretted that this valuable paper did not at the time obtain a place in the Transactions of the learned Society before which it was read, and by whose members it was so highly and justly applauded. Its discoveries and conclusions were characterized as most important; and the illustrations which accompanied it (chiefly the fossils themselves laid on the table) were declared to be singular, wonderful, unknown. Dr Malcolmson himself fully expected that it was to be given to the scientific world under the auspices of

the Society, in those printed records that so well and fully preserve an account of the progress of geology in Britain. It is still our surprise that so a long a time has elapsed during which this omission has neither been remedied nor accounted for by the officials of the Society. The memory and merits of the author, as well as the great importance of the discoveries his paper made known to them, surely deserved a better fate at their hands.*

Dr Malcolmson in his paper divides the Old Red Sandstone rocks, as seen on the southern shores of the Moray Firth, into,—1, the inferior or great conglomerate; 2, the central or cornstone; and, 3, the silicious conglomerates or sandstones. He makes known, and identifies, the fish-beds of Tynat, Dipple, and Lethen Bar with those of Gamrie, Caithness, Orkney, and Cromarty. Of the last locality he says,—“A careful examination of the ichthyolite beds discovered by my friend Mr Miller on both sides of the South Sutor of Cromarty, satisfies me that they were subordinate to, and interstratified with, the Old Red Sandstone, and I soon had an opportunity of identifying several species of the fish found there with those of Gamrie, Caithness, and Orkney. M. Agassiz confirmed this with respect to the Cromarty species of *Cheiracanthus*, *Diplopterus*, and a very remarkable fossil to which he has

* In Hugh Miller's world-widely known, and justly appreciated, “Old Red-sandstone,” p. 165, 3d edition, it is said a right was “challenged at the late meeting (1840?) of the British Association at Glasgow, by a gentleman of Elgin, to be regarded as the original discoverer of the Pterichthys.” Now, no gentleman of Elgin or of its neighbourhood attended at Glasgow on that occasion, and of course could not have thus preferred a claim for the discovery of this animal. The repetition, or rather the stereotyping of this, which, with Mr Miller, we believe to have been a groundless claim, in the pages of his lasting work, demands a notice here in order to disabuse the public of any false impression on this point. Upon inquiry, it turned out that this claim was made by Mr Kier, a stranger, who delivered some lectures on Geology in Elgin. How much he had examined or come to know of that locality, either in a lithological or palæontological view, we have never ascertained. His claim seemed to have dropped dead at Glasgow, and we have to regret that it was resuscitated by Mr Miller, and kept alive in his pages, as if it had ever been made “by a gentleman of Elgin.” Perhaps, had Dr Malcolmson's paper, read to the Geological Society of London, been printed at the time, with its illustrations, this *contretemps* would not have occurred. Is it now too late to publish it in their Transactions?

given the name of *Coccosteus*, and of which he had only seen specimens from Orkney and Caithness." This quotation is made to show that Dr Malcomson's correct eye and tried experience elsewhere made discoveries, and for the first time fixed the position of other fossiliferous beds than those of Moray. While afterwards referring to the different places where the strata are best seen, and describing them in their lithological and fossiliferous aspects, and, in short, while giving a condensed account of the present state of our geological knowledge of this district, we shall quote largely from the paper of Dr Macolmson, and be much influenced and guided by his opinions.

In 1842 was published the "Sketch of the Geology of Moray, by Patrick Duff, Esq." It is an excellent guide, amply descriptive of the superficial and underlying formations of the province. We shall afterwards refer to this treatise, and to the geological conclusions at which its accomplished author arrives. But we cannot let the opportunity pass without now stating that Mr Duff merits the best regards and warmest thanks, not only for having thus given to the public, in a separate form, the first general view of our local geology, and for having illustrated it by many expensive plates, but also for his indefatigable zeal in personally working out many a rare fossil from Scāāt Craig and Linksfield, now preserved in his cabinet, which is ever open to all who can in any degree appreciate its valuable contents. To him we are indebted for having secured and made known to the scientific world the *Stagonolepis Robertsoni*, and the still unique *Telerpeton Elginense*, which were brought to him,—the former from Lossiemouth in August 1844, the latter from Spynie in 1851,—by the observant workmen who found them, as offerings not less on account of Mr Duff's affability and gentlemanly bearing to all, than of his well-established reputation for scientific attainments.

A clear and correct epitome of the geology of the country around Elgin will be found in a note, p. 344 of the third edition of "Anderson's Guide to the Highlands," a valuable work already referred to. This note was drawn up by the late Mr Robertson of Woodside, formerly of Inverurie. We

heartily recommend it to the attention of all, specially of tourists through this district, who would desire, at the least expense of time, to obtain an acquaintance with the formation of the ground on which they wander, and with those localities, around their track where the most striking and instructive sections, and the various fossils, are to be met with.

Some footprints were noticed in the sandstone beds at Cummingston, near Burghead, in 1850, by Mr Anderson, tenant of the quarry. Some of the slabs were procured by Captain Lambert Brickenden, and exhibited by him to the Elgin Scientific Association. A notice of them he also communicated to the Geological Society. A plate of one is given in the postscript to the third edition of "Lyell's Manual." Captain Brickenden, during his residence at Elgin, prepared a paper on the Wealden beds of Linksfield, published in the "Proceedings of the Geological Society" of London, Vol. VII., Part I., p. 289.

In this Journal we need not do more than remind our readers of Mr Martin's graphic article on the "Northern Drift," published in the number for October 1856, as containing much information of that deposit so largely developed in the plains of Moray. An article, entitled "Morayshire," in the "Westminster Review" for January 1858, written by M. E. Grant Duff, Esq., M.P., contains not only an admirable *resumé* of the present state of our local geological knowledge, but also several very pertinent suggestions as to its advancement on this field of inquiry. When to this list we add the various articles and paragraphs that have appeared in the local press, we shall have mentioned all that at present occurs to us that has been published or printed regarding the geology of the province of Moray, and enumerated the several sources whence information on this subject is to be derived by the inquirer.

Present State of Inquiry.—So much ; and we suspect our readers will say "hold, enough !" for the historical part. We now come to the next division in the plan proposed for this paper, viz., to give a short outline of the views which local observers and other inquirers seem to entertain at the present moment regarding the geology of the lower or northern por-

tion of the province of Moray. We shall take the formations in the ascending order.

Upon the publication, in 1828, of Messrs Murchison and Sedgwick's paper above alluded to, it was seen that the northern and southern shores of the Moray Firth exhibited some of the subordinate beds of the Old Red Sandstone in common. Dr Malcolmson's examination of, and his discoveries in, these two regions confirmed this, and carried out the resemblance or equivalents in many other particulars.

Professor Nicol's late researches among the rocks of the north of Sutherlandshire and of the north-west of Ross-shire, as detailed in his paper published in the "Quarterly Journal of the Geological Society of London," for February 1857, and the report, published in the "Geologist" for April last, of Sir Roderick Murchison's views of the same rocks, have induced us to re-examine what has hitherto been considered the unquestioned and unquestionable line of demarcation between the so-called primary and secondary rocks of the old geological school, or between the gneiss and the sandstones of Moray. This re-examination leads us to suspect that the *Silurian* formation may be found largely developed in the district under review.

In three of the river beds, and in some intermediate localities which we have lately revisited, the rocks that underlie the Old Red Sandstone are found of the same general aspect. They are for the most part gneissose, but contrast greatly with the coarse-grained, well-defined gneiss, as seen in the boulders scattered over the country, and occasionally met with in the very ravines that expose the gneissose strata. They lie unconformably under the Old Red Sandstone strata, having their dip to the east of north, and at a much more acute angle than the overlying conglomerates which dip to the west, at a low angle, of the same cardinal point. Their beds are much fractured, and present many cleavage surfaces, to such an extent, and so regular, that in some places these surfaces are apt to be taken as indications of the lie of the strata. The southern boundary of this underlying rock, which we would venture to presume is *Silurian*, we have not yet had an opportunity of ascertaining. Taking into account the wide range

which Sir Roderick Murchison contemplates for this system on the west and south-west of Scotland, it may be found most likely to extend many miles southward from the localities to which we have as yet traced it,—viz., Craigellachie on the Spey, Kellas on the Lossie, and Logie on the Findhorn.

Lower Craigellachie, the hill of Conrack, and the ravines which radiate from the village of Rothes, are good points for the examination of these rocks on the eastern part of the province of Moray. Conrack is interesting on account of the extent and varieties of quartz that are found there. Although of considerable thickness, so as to form the body of the strata, yet it resembles that generally found in veins. It is white, with iron-shot streaks, and at times coarsely fibrous or radiating. Drusy cavities, lined with rock crystal and amethystine quartz, are also found in it. In a ravine, running westward from the north end of the Glen of Rothes, large sections of this portion of Silurian strata are to be seen. About half way up this ravine more traces of hæmatitic iron ore are to be met with than in any other known locality in Morayshire, but still not of that amount or quality as would encourage the idea of its having been the mine whence this metal was taken at some distant period, when the smelting of it must have been carried on to some extent, as is proved by the heaps of rich slag so frequently found along the face of the Manoch Hill, and in other places. It is a problem yet to be solved where the ore was dug, although there is little doubt it was brought hither in order to be smelted by the charcoal made from the then abounding remains of the "*Sylva Caledonica*." In this ravine the veins that contain these traces of iron may be easily discovered. They are indicated by the strong chalybeate springs that issue from them, and by the bog-iron ore deposited where these springs emerge from the rock. On the Lossie, and in the ravines through which its tributaries, the Shoggle and the Lenock burns flow, from five to eight miles south from Elgin, these strata are best developed, and exhibit large sections well adapted for their study. On the west side, and above the fall of water at the linn of the Shoggle, the overlying conglomerate is seen resting unconformably. Some hundred yards further down the stream, on the same side, the upper surfaces

of some of the thinner strata are recently laid bare, so that not only the dip but the flexures, and the apparent effects of side pressure, are distinctly seen over a considerable space. The upper beds of this series on the Lossie, as at the Dun Cow's Loup, are of a hard, compact flinty nature. As we descend they become less quartzzy and more gneissose; the latter being their prevailing character. Some of the strata, however, are coarsely micaceous. Veins of white quartz cut across the strata at all angles. Pluscarden Hill presents the same series of strata, and with the same dip as seen on the Lossie. Beginning at the east end we have the flinty, and, occasionally, brecciated rock as the uppermost beds. Then they pass into those that have a gneissose appearance. In this hill, and nearer the Priory, a second set of beds present the quartzzy appearance again, which in its turn gives place to the gneissose character. Immediately north of the Priory a bed of mica-slate of no great thickness crops out. The strata that underlie the well-developed Old Red Sandstones of the Findhorn begin at Sluie. Lithologically, these rocks (Silurian?) on the Findhorn, from Sluie to Logie, do not differ from those of the Lossie. They contain, however, many granitic veins which are absent from the former locality, and their dip is not so uniform and distinct. Immediately above the junction of the two formations at Sluie the older rock seems, from some under pressure, to have assumed the saddle-shaped form, the beds dipping in opposite directions at no great distance asunder. In no part of this district have the granitic or quartz veins been seen to enter the overlying sandstones. Hence, as Dr Malcolmson suggests, it may be inferred that these sandstone beds have received their present inclination from forces that bore upon them from a greater depth than has generally been alleged.

Many other localities might be instanced; but those now noticed are the points where the character of those (Silurian) rocks best appears. How far southwards they extend we have not had the opportunity of tracing. But in no part of the district examined have we found limestone beds or strata, or any vestige of an organism. This latter deficiency must for a time leave the exact geological age of these rocks undecided,—at least until they be inspected by those geologists who are so

well versed in all the phases of the Silurian formation as to say, from evidence other than fossils, whether or not they belong to that series of rocks. The mere suggestion that they are Silurian is here given with the view rather of inviting inquiry from others, and of pointing out localities to them, than of fixing their position in the geological scale. Mr Cunningham, in his paper on the neighbouring county of Banff ("Prize Essays, &c., of the Highland and Agricultural Society of Scotland," Vol. XIV., p. 447), considers the floetz rocks there as of the Transition series, which is now generally held to have been but another name for Silurian and Cambrian. Yet there are other differences, than the absence of limestones from the rocks now under consideration, that seem to exist between them and those of Banffshire. The dip is materially different. In the province of Moray we have neither such clay-slates nor grauwackes as are there to be seen. The hornblendes and the serpentines are wanting on this side of the Spey. And here the quartz rock itself is met with in a very inferior scale of development.

Old Red Sandstone or Devonian.—We now come to safer, because more frequently trodden ground, when we would speak of the age and sequence of the next series of strata in the ascending order,—the Old Red Sandstone or Devonian rocks of the province of Moray. As this is the formation that Dr Malcolmson, in the above-mentioned paper, so fully discusses, we shall best consult not only our own wishes, but the profit of the readers, by giving his views in pretty full outline, occasionally introducing some observations of our own as we go along.

Inferior or Great Conglomerate.—"The great conglomerate," says Dr Malcolmson, "forming the lower part of the Old Red system in Sutherland and Ross, extends into this district, and is seen in various ravines on the right bank of the River Nairn, to the east of Inverness, where, however, it attains no great thickness. But on passing the spur of gneiss which crosses the river at Kilravock Castle, it is seen, in the ravines above Cawdor Castle, to form the sides of deep and inaccessible chasms, from 100 to 200 feet in depth, resting unconformably, a mile above the castle, on gneiss traversed by granite veins.

Before it disappears under the drift near the entrance of the castle, it alternates with gray sandstones and sandstone conglomerates. Two and a half miles to the eastward, at Geddes, and near the junction of granite and gneiss at Rait Castle, the upper fine-grained sandstones rest directly on the edges of the contorted primary rocks. I am therefore satisfied that this important member of the Old Red Sandstone system has suffered great and extensive denudations previous to the deposit of the upper parts of the series, a fact not sufficiently indicated by its being said to thin off, or to appear in a 'degraded form.' On the eastern side of the hill of Rait they again occur, extending along the burn of Lethen for several miles. They cannot be traced on the Findhorn; but at Birnie, and in the vale of Rothes, to the south of Elgin, and along the Spey, they form considerable round-topped hills, enveloping the sides of the gneiss. This conglomerate consists, as in other parts of Scotland, of a vast accumulation of imperfectly rounded fragments of primary rocks, mostly derived from the gneiss, granite, &c., of the neighbourhood. These fragments are often greatly decomposed, and cemented by a small quantity of ferruginous sandstone with more or less carbonate of lime. In some places small portions of a hæmatitic red sandstone are interposed in interrupted lines, which show the dip of the beds. The conglomerate is traversed by many nearly vertical joints and fissures; and many of the large imbedded blocks are fractured, the rents being for the most part vertical, and their edges almost always sharp. In most cases it wastes rapidly when exposed to the weather, being cut into deep chasms, or mouldering into turret-shaped cliffs and projections, forming a great quantity of wreck, and, on the right bank of the Spey, ravines of the most singularly desolate aspect. The soil covering it is usually fertile. In no part of the district are any fine-grained sandstones interposed between it and the primitive rocks, as is the case at Gamrie, and at Stonehaven and some other places to the south of the Grampians. But on the banks of the Spey above Fochabers the lower beds pass into a small-grained, very hard conglomerate." We would here suggest that these last-mentioned hard conglomerate beds are likely to be found the upper quartz beds of

the underlying formation, which, together with the gneiss to which Dr Malcolmson refers, we presume are Silurian. No organic remains have as yet been detected in this inferior or great conglomerate within the province of Moray.

The Central or Cornstone is the largest of the three divisions made of the Old Red system by Dr Malcolmson. It extends over a wide area, as indicated by its different beds cropping out at distant localities through the superincumbent clays and sands of the drift. These beds are best seen on the Findhorn, from Sluie to Cothall. At the former place they abut against the side of a fissure of the underlying strata (gneissose) of about twenty feet. Dr Malcolmson says, "The appearance is exactly what would be produced by the deposit of sandstone against any of the ancient elevated shores near the coast. It would also be caused by a fault. The strata next to the older rocks consist in great part of unrolled fragments of the micaceous gneiss on which they rest (the felspar being in a state of decomposition), cemented together by a red argillaceous sandstone, the bands of which alternate with the conglomerate. No fossils have been found in this part of the strata. They pass rapidly through micaceous thin-bedded strata, with ripple marks, into a soft laminated freestone without pebbles, but full of deep-red clay-balls, and alternate with laminated clays of the same colour. In the upper part of this portion one or two scales have been found. Then it passes rapidly into, and alternates with, a coarse-grained, pretty hard sandstone conglomerate, containing rolled pebbles of common gneiss and quartz, and of a greenish quartzose gneiss common to the higher mountains to the west. Partially rolled fragments of the fine red felspar of the neighbouring granite veins also occur, as they do in all the other strata below the cornstone and in the upper silicious sandstones near the coast. In these beds a few scales, teeth, and bones, have been found. A good deal of iron is diffused through these strata in streaks, and portions of brownish-red sandstone, spotted with round white or yellowish markings, forming a round compact case around the organic remains. The sand, as in almost every part of the central division of the formation, is coarse and angular, and more resembles that of rivers or of temporary

floods than that of a permanent sea. The same fossils occur in great abundance higher in the series, above a stratum of a very coarse conglomerate, twenty feet thick, containing rounded pebbles of great size, united by calspar, and a small quantity of red sandstone which is composed of a ferruginous cement and coarse particles of white quartz and mica. The lower part of this conglomerate is irregular, filling up the hollows that had been worked out of the inferior sandstone, of which it contains a few angular fragments. Several remarkable faults are seen below Sluie, where contiguous masses of this conglomerate have been raised or depressed a few feet, by which movement the larger boulders near them have been split in the manner so often observed throughout the inferior great conglomerate. Much saline matter is diffused through this and other parts of the formation. A specimen from the soft sandstone under the Cothall cornstone consisted of common salt and a little sulphate of soda, much of which is also diffused through the silicious conglomerates of Burghead. This bed of coarse conglomerate acquired a fictitious importance, from no fossils having for some time been found under it; but its occurrence cannot be considered unimportant, as it shows the violence of the changes that were in progress during the period in which the animals lived whose bony armour is entombed in these rocks, and which we cannot believe to have been given them without an object. The cuirass of one species appears to have consisted of very solid bone, one-third of an inch thick. No remains have been found in this conglomerate; but they occur abundantly immediately above in the coarser strata of a series of white and reddish sandstone conglomerates, and may also be detected by their plum-blue colour for nearly a mile down the river, through a succession of soft calciferous conglomerates, containing small rounded concretions of carbonate of lime, more compact yellowish and reddish beds, and soft crumbly marls and incoherent red, brown, and variegated sands. Everywhere indications are afforded of the various and sudden changes in the force and direction of the currents of waves of the ancient sea by the interposition of nests of gravel, sand, and clay among the other strata, by their thinning off, and by the various directions of their laminæ consti-

tuting their false bedding. Between these beds and the cornstones of Cothall other similar strata occur in which I have not yet found fossils. This limestone of Cothall has been so accurately described by Professor Sedgwick and Mr Murchison, that it is only necessary to add, that its lower beds pass into a conglomerate, in which I observed some angular fragments of a yellow sandstone. This limestone is also seen a mile down the river at the Suspension-bridge, beyond which the country is covered by drift, alluvial gravel and blown sand. But in a morass behind the House of Moy, and within the line of ancient shore, under a stratum of recent sea shells, a reddish-brown silicious sandstone, containing no lime, has been quarried.

“The red conglomerate, forming the lower part of the strata of the section just described, has very much the appearance of a local deposit; and, accordingly, in the burn of Forres, two miles to the north-east of the Findhorn, and three quarters of a mile from Altyre, red, white, and gray marly sandstones are exposed for a hundred and eighty paces resting on the gneiss, of which fragments are seen in a thin bed of limestone, three feet thick, forming the base of the secondary rocks. In the upper part of these marly beds I have found fragments of scales identical with those of the Findhorn.”

In order to show the position, in this part of the series, of the nodular fish-beds of Lethenbar and Clune, in Nairnshire, Dr Malcolmsen then describes the sections as unfolded in the Meikleburn and burn of Lethen—a continuation of the same stream—which at Boghole approaches within two miles to the north-west of the Findhorn, and ultimately falls into its estuary. “This burn,” says Dr Malcomson, “is separated from the Findhorn higher up by the hill of Cairnbar, which is in part composed of gneiss; and on the south side, near Coulmony, of granite, in which portions of the gneiss are entangled. To the east of this hill the sandstones extend between the river of Findhorn and the burn of Lethen, over a slightly undulating plain, encumbered with drift, much intermixed with fragments of sandstone, and covered by the forest of Darnaway, which is one of the finest in the kingdom; the soil, like that of the cornstone districts in Herefordshire, being favourable to the

growth of oak. Along the burn from Earlsmill to Cauldhame fine sections of sandstone, calciferous conglomerates, and marls of the same character as the Findhorn beds, with which they are continuous, are laid open, and the same organic remains are found in considerable numbers and variety. In addition to these, the singular buckler-shaped bones, allied to *Cephalaspis*, were procured near the Chapel of Boghole, from a soft yellowish sandstone, which dips under marly sandstones, and rests on a structure of red laminated micaceous schist and conglomerate. In a compact part of the same rock, a little higher up, the very remarkable impression and smooth bones (—— *Randolphi*) were found, to which I am inclined to refer many smooth bony plates found at Scāat Craig and on the Findhorn." In a note, he here adds—"Remains were first discovered on the Findhorn 6th October 1838, and in the course of the same month I found them here (Lethen Burn). I would suggest that this specimen should be named after the celebrated Randolph, Earl of Moray, one of the most distinguished leaders in the wars of Robert the Bruce, and to whom the neighbouring domains belonged. It was in the adjoining forest that he baffled Edward III.'s army, as described in 'Winton's Chronicle.'" So completely seems this paper to have been unknown to those into whose hands Dr Malcolmson's specimens fell at London, that even this simple patriotic wish of his does not appear to have been realized. For in none of the lists of the fishes of the Old Red Sandstone do we find *Randolphi* as one of the specific names. Again we ask, why was it so?

"At Cauldhame these fossiliferous rocks rest on thin bedded sandstones, alternating with harder bands of conglomerate; and from underneath these, and having the same dip and direction, a considerable thickness of hæmatitic red schistose sandstones crop out in several places, and appear to rest on the Clune limestone, containing ichthyolites, which is situated on the eastern slope of Cairnbar, about five hundred feet above the level of the sea. Where these slaty beds appear to wrap round the eastern extremity of the hill, they dip to the eastward of north; but they resume their usual dip a little west of north, when traced along the lengthened ridge which ex-

tends from Cauldhame to the gneiss hill of Rait. They resemble the upper red sandstones of Cromarty and Ross, and decompose readily into a fertile argillo-calcareous wheat soil. In a small quarry in the grounds of Lethen, thin beds of shale and clay dip under the red sandstones, and contain nodules like those of Gamrie, except in being of a darker colour. Many of them contain black elastic bituminous layers, arranged like the scales of fish, which burn with a bright flame. At a subsequent visit Mr Gordon found portions of fish sufficiently well preserved to be identified with the *Cheiracanthus*, and two other species found at Clune, &c. The shales abound with remains of plants resembling *fuci*; imperfect specimens of which we also found in the nodules. They appear to have been compressed. The more solid part, forming the centre of the impression, is sometimes so well preserved that it retains its elasticity, and can be removed from the stone, while a soft coaly powder marks the softer structure. These plants I have identified with specimens associated with the ichthyolites of Gamrie and Cromarty. A fact of much greater importance is their appearing to belong to the same plants recently discovered by Professor Sedgwick and Mr Murchison in the Old Red Sandstones of Devonshire. These fucoids, and all the other fossils in this neighbourhood, and in the valley of the Nairn, were discovered by Mr Stables, jun. of Cawdor, and myself, between the 25th January and the 4th ult. (May 1839).

“ There are a few feet of soft white freestone visible below the shales; and, on the opposite side of the burn, and dipping under them, the great inferior conglomerate appears in its most characteristic form, and can be traced in a series of steep cliffs and rounded slopes several miles up the stream, and is in one or two places covered by fine-grained sandstones. If the shales were prolonged across the stream in the line of dip, they would pass over this conglomerate, and strike the hill of Cairnbar near an excavation lately made at Lethenbar, from which the finest fish have been procured. At Lethenbar the fossils occur in large nodules, which are thickly deposited in a soft reddish-brown schist, which is intersected by numerous vertical joints, many of which pass through the nodules,

and hence the corresponding parts of many of the finest specimens are lost. These fractures were probably the effect of the same movements which rent the boulders of the great conglomerate. The nodules are flattened, and, when they contain a fish, are generally of a lengthened form. The colour of the fish is pale blue when first extracted, but they soon acquire a reddish tinge when exposed. At Clune, a mile to the eastward, nodules and flat slabs of limestone occur in a stratum of clay and decomposed shale, which abound in the same fish. Five hundred yards up the hill, the slop of which corresponds to the dip, the same beds were formerly quarried. Under them, at this spot, there are a few thin strata of gray conglomerate, which have a dip of 12° N. The conglomerate rests on gneiss. As has been already mentioned, these strata (of Lethenbar and Clune) dip under the red schistose beds of Cauldhame, and the other members of the series on the Findhorn. It is hoped that the minuteness of these details will be excused on account of the great importance of establishing by actual sections the superposition of the central or cornstone division of the Old Red Sandstone to these beds, from which so many beautiful and characteristic fossils have been procured, not one of which has yet been found in the upper series." "The beautiful specimens of *Dipterus macrolepidotus* from Clune and Lethenbar, and the plants found along with them, connect the whole of these fossils with the English strata of the inferior division of the Old Red Sandstone, and render it probable that the fish, about which so many discordant opinions have been entertained, inhabited salt water. We also found these plants at the termination of the ridge of red schistose sandstone near the hill of Rait, where there are some thin beds of limestone containing nodules exactly resembling those of Lethen.

"In the valley of the Nairn, although none have hitherto been found in the conglomerates and sandstones that lie between the granite of Park and the gneiss hill to the west of Cawdor Castle, yet fossils appear at Balfriesh on the confines of Invernesshire. On the south bank of the river, opposite Cantray House, the great conglomerate appears in the bed of a small stream resting unconformably on the gneiss, which

is traversed by several thick dykes of a beautiful red felspar and veins of granite, fragments of which abound in the conglomerate. This rock passes into a compact blue limestone containing many angular fragments of the neighbouring gneiss, porphyry, &c. The limestone is still worked at Balfriesh, where it is about ten feet thick, and is covered by a very hard red conglomerate. A deal of heavy spar occurs in layers, and is disseminated through the limestone and conglomerate; and an imbedded angular fragment of porphyry, which had been previously fractured, had the rents filled with it. Through this limestone, and the conglomerate immediately covering it, we found fragments and casts of tuberculated scales and bones resembling some of those at Lethenbar." "These beds dip, west of north, at an angle of about 10° , under black slates and sandstones exposed on the opposite side of the river. Above them, again, there is a fine reddish freestone, which has been quarried for the erection of the neighbouring mansion. Higher up the river, at the south-east extremity of Culloden Moor, and opposite the Druidical temples of Clava, the same bituminous beds occur. Their upper strata consist of very fissile shales, passing into a black compact calcareous rock formerly burned for lime, extremely foetid when struck, and having all the characters of the Caithness pavement. Of this many slabs have been employed in the erection of the Druidical circles. In some of these beds nodules occur, in several of which are found scales of fish and ill-preserved vegetable impressions of the same general character as those of Lethen. Many of the nodules are very small, appearing to have been formed around single scales, and others are studded with smaller nodules, or composed of a congeries of them. These appearances are explained by what occurs at Dipple on the Spey, where all the fish have suffered some degree of decomposition previous to their being included in the stone, and many of the nodules are studded in the same manner with little excrescences, each of which contains a scale. This fact is in accordance with the opinion of those who ascribe the foetid bituminous character of the Caithness rocks to putrescent animal matter. These strata rest on a coarse compact conglomerate, which reposes in the usual manner on the gneiss.

This bituminous rock is no doubt continuous with that at Inches, four miles to the west, and two miles south-east from Inverness, described by Professor Sedgwick and Mr Murchison, and which they showed to be a continuation of the bituminous schists of Caithness and Strathpeffer. The relations of these strata are therefore established, not only by similarity of lithological and zoological characters, but by careful investigation of numerous sections along the shores of the Moray Firth from Caithness to the Findhorn."

Between the rivers Findhorn and Spey, except at the Scāat Craig and at the influx of the Shoggle Burn into the Lossie, where we discovered many years ago casts of large scales in a coarse whitish sandstone, no fossils of the central division have been met with. Indeed, few of its beds appear at the surface of this wide drift-covered plain, save the cornstone itself, which is singularly devoid of organisms, none having yet been detected in it. The cornstone crops out, or is quarried, at the following places, where, so far as its beds have been laid bare, it dips at a low angle a little to the west of north. The localities are named as they succeed each other, beginning at the most westerly. All of them, save the last two, are in the immediate vicinity of the town of Elgin, which stands on this part of the system. They are Sheriffmill; Palmercross; Wood of Main; the limeworks of Bilboahall, Ashgrove, and Linksfield; Waulkmill; Stonewells, near Innes House; and the Boar's Head, a rock in Spey Bay. The cornstones of the province of Moray, although burned and used both for building and agricultural purposes, are not properly limestones. They are rather to be regarded as concretionary sandstones.—the matrix being sand and marl, and the concretions of lime being largely developed throughout such of the beds as have been quarried for the kiln. Some of the lower beds have so little lime that they are used for dykes, fences, and even for the inferior sort of housebuilding. The debris of these limestone quarries is admirably adapted for binding the loose metal, whether of the public road or garden walk. The cornstone, unlike the rocks with which it is associated, maintains, even in its most widely separated localities, a striking lithological character, so that the description of one escarpment or

quarry may serve for the rest. Generally of a yellowish grey colour, the solid portions are compact or sub-crystalline. They are seldom of great extent, but are mixed with and pass into masses which are less coherent, and have a greenish, reddish, or variegated colour, derived from the marls with which they are associated. Where the softer parts are wasted away, the forms become so irregular as to give the rock a brecciated appearance. Some parts of the beds are cherty, containing chalcedonic veins and small flattened cells, coated over with mammilated reddish chalcedony. Dendritic stains are not unfrequent, of some size, and of beautiful tracery. Crystals and radiating concretions of calcspar are abundant. Agaric mineral, iron pyrites, and galena (the last at Sheriff-mill), may be mentioned as some of the accompanying minerals. The pieces of calcspar that have long been lying near the surface of the rock are not unfrequently found decomposed into a dark powdery substance which leaves stains not unlike plumbago. For fuller particulars of this portion of the series, we refer to the paper by Messrs Sedgwick and Murchison, already noticed, and published in vol. iii., second series, of the Geological Society's Transactions.

The fish-beds of Dipple, on the left bank of the Spey, where the great north road crosses the river at the bridge of Boat o' Bog, lie on the inferior great conglomerates which are seen so largely developed on the opposite or right bank. These conglomerates extend from near Fochabers to near where the railway now crosses the Spey, and where they rest upon the quartz beds of the still older rocks. The fish nodules are found at Dipple imbedded in a soft unctuous argillaceous schist, containing a good deal of iron and very little lime, and which has proved injurious to the soil to which it was applied as a manure. Although several species have been determined, yet this locality does not invite the collector for the cabinet, as its specimens of fishes are ill preserved, compared with those at Tynat and at the Nairnshire localities. We have here, however, a fine section of the beds that overlies the ichthyolites, running down to and passing the bridge, and sinking under the gravel and river terraces about half a mile to the north. These overlying beds consist chiefly of thick

bands of red sandstone passing into conglomerate, with some thin layers of red and grey micaceous shales. The harder and more compact varieties, although quarried to some extent, do not well withstand exposure to the weather, and hence, for purposes of building, are greatly inferior to the white and yellow silicious sandstones around Elgin.

"Following," says Dr Malcolmson, whose views we have chiefly adopted in the two foregoing paragraphs, "the strike of the Dipple beds into Banffshire, we discovered at the burn of Tynat, four miles from Fochabers, another series of beds containing ichthyolites. They consist of thin bands of shale, interstratified with red sandstones and conglomerates, which dip to the north in the usual manner. The fossils occur usually in small, flat, compact, nodules of the same outline as the fish. Fragments of the tuberculated bones have also been found in the finer conglomerates. There are two beds containing ichthyolites, separated by about twenty feet.

"The burn of Buckie, descending from the hills near Letterfurie, passes through great beds of northern drift, containing many angular fragments of the Morayshire sandstones and cornstones, and at the mains of Buckie runs over strata of gneiss and fine micaceous chloritic schists, dipping to the south at a high angle. A little lower down, a thin vein, resembling serpentine, crosses the strata (of which it contains fragments) at right angles. On the sharp edges of these underlying rocks, and filling up the depressions between the projecting ledges, a coarse hæmatitic red conglomerate rests, inclined to the north at a low angle. Near high-water mark some of its beds pass into a coarse limestone, which is occasionally worked. The conglomerate does not exceed thirty feet in thickness, and the only strata seen resting on it are a few patches of a red schistose sandstone, in which we found a distinct fragment of a tuberculated bone, and some scales."

The following list, drawn up from Agassiz's monograph, gives the names and the provincial localities for the fish chiefly imbedded in the strata just described. Although but one locality is mentioned for a species, yet we believe that Clune, Lethenbar, Dipple, and Tynat hold many of them in common.

<i>Pterichthys latus</i> , Lethenbar.	<i>Holoptychius giganteus</i> , " Dans le
<i>Pterichthys Milleri</i> , Clune.	couches de Old Red en Escosse à
<i>Pterichthys productus</i> , Lethenbar.	Elgin."
<i>Pterichthys cornutus</i> , Lethenbar.	<i>Holoptychius nobilissimus</i> , Elgin.
<i>Pterichthys major</i> , Findhorn and	<i>Actinolepis tuberculatus</i> , Findhorn.
Scäät Craig.	<i>Dendrodus latus</i> , Scäät Craig and
<i>Placothorax paradoxus</i> , Scäät Craig.	Findhorn.
<i>Coccosteus oblongus</i> , Lethenbar.	<i>Dendrodus strigatus</i> , Scäät Craig.
<i>Coccosteus maximus</i> , Lethenbar and	<i>Lamnodus bifurcatus</i> , Scäät Craig.
Boghole.	<i>Lamnodus Panderi</i> , Scäät Craig.
<i>Acanthodes pusillus</i> , Tynat.	<i>Lamnodus sulcatus</i> , Elgin.
<i>Cheiracanthus microlepidotus</i> , Le-	<i>Cricodus incurvus</i> , Scäät Craig.
thenbar.	<i>Asterolepis Asmusii</i> , " Environs de
<i>Diplacanthus striatalus</i> , Lethenbar.	Elgin."
<i>Diplacanthus longispinus</i> , Lethen-	<i>Asterolepis minor</i> , " Environs de
bar.	Elgin."
<i>Cheirolepis Cummingia</i> , Lethenbar.	<i>Asterolepis Malcolmsoni</i> , Elgin.
<i>Osteolepis major</i> , Tynat and Le-	<i>Bothriolepis favosa</i> , Elgin.
thenbar.	<i>Bothriolepis ornata</i> , Monachtyhill,
<i>Diplopterus macrocephalus</i> , Leth-	and also near Nairn.
enbar.	<i>Cosmacanthus Malcolmsoni</i> , Scäät
<i>Stagonolepis Robertsoni</i> (a reptile?),	Craig.
Lossiemouth.	

The silicious sandstones and conglomerates form the third or upper division that has heretofore been commonly made of the Devonian or Old Red Sandstone formation, as it appears within the province of Moray. But we must here premise that it is not yet finally settled that they are really superior to the cornstone beds. Mr Duff, in his "Sketch," p. 24, says, "Great difference of opinion exists among geologists as to the exact position in the scale of this bed (cornstone)—some thinking that it passes under the yellow sandstone, in the usual manner, with cornstone, and I believe I stand single in maintaining that it does not do so; and I am so far safe in my assertion of the fact, that no instance can be pointed out in Morayshire of its passing under the sandstone, while it certainly overlies and passes into it. The town of Elgin stands on this limestone; and it is to be traced following the undulations of the surface two miles to the south of that town in a continuous scurf, and three miles to the eastward, without a single particle of sandstone covering it. At Cothall again, it is to be seen cut through by the course of the River Findhorn, and lining it northwards for at least a mile, during which stretch no sandstone rests on it." Mr Martin, also, in his

"Essay," takes the same view, and states that, "above the sandstone an extensive deposit of limestone is found. Its structure is sub-crystalline, compact, and of a bluish grey colour. It inclines with the sandstones to the north." Even Dr Malcolmson himself did not reckon it a fixed point, for on 2d March 1840 he writes to Mr Duff,—“I own the force of your remarks on the abstract (of his paper); yet I think I am entitled to speak with the hesitation I do on the relation of the silicious sandstones to the cornstone. I own it to be the weak part of my paper, and fortunately it is the part of least consequence.” Although it be a question not to be settled by names or numbers, yet, following Messrs Sedgwick and Murchison, and the late Mr Robertson of Inverugie, we would here venture to state an opinion long held, that it is far more probable that the silicious sandstones of Bishopmill and Quarrywood do rest on the cornstones of Elgin. The strike and the dip of the beds clearly indicate this position, which is one not the less likely, from the absence of any apparent disturbance or fault from trap dykes or otherwise, to alter the appearance of the order in which we suppose them to have been deposited. The beds that lie under the cornstones of Cothall have few visible representatives in the neighbourhood of Elgin save at Scāat Craig, while the silicious strata above the cornstone so largely developed in the eastern parts of the county may be represented in the west by the sandstones of Moy, and, possibly, of Boath, near Nairn.

The first, the most extensive and valuable escarpment of these silicious sandstones, lies immediately to the north-west of the town of Elgin. It runs from Bishopmill westward, continuously for four or five miles, to the moor at Alves. The joints, false bedding, and cleavage of the strata are apt to mislead the unpractised eye. But wherever the real surfaces of the strata appear, and are distinctly seen, they take the usual dip at a low angle a little to the west of north. This large and elevated ridge or escarpment, in its various beds, exhibits every degree of consistence, from the hard, pebbly, quartzzy sandstones of the Millstone quarry, to the friable yellow beds of Bishopmill; and of colour, from the dull yellow brown of the latter place, to the rosy tints of the quarry at the foot of

the Knock of Alves. Mr Duff justly remarks, "As building materials, the sandstones of Moray are unrivalled; nothing, for instance, can exceed the beauty of the masonry in the ruins of the Elgin Cathedral, where the finest and most minute carving has preserved its edge during four hundred years of exposure to the weather, and its warm cream colour in the landscape gives it a peculiar charm in the painter's eye." Of this part of the geology of the province, Dr Malcolmson says, "Resting on these Elgin cornstones, a series of very beautiful white and yellow silicious sandstones occurs, associated with a very hard conglomerate, composed of a paste of silicious grains, through which many completely rolled pebbles of white quartz, and a few of gneiss and granite, are scattered. This silicious conglomerate and sandstones, which appear to form the upper division of the Old Red system, extend over a considerable part of the north-east district of Moray, the great fertility of which depends on the rich alluvium within the ancient coast-line; the soil derived from these rocks being for the most part very sterile. Within the limits assigned to these sandstones a limestone, resembling the cornstone of Elgin and Cothall, occurs, which is extensively worked at Inverugie. On the coast, near Lossiemouth, it is in a great part composed of silica, which is often finely crystallized. At Inverugie and Lossiemouth a great deal of galena, with which, at Stotfield, Mr Gordon found specimens of blende, is disseminated through the rock. The galena is most probably of contemporaneous formation, although in one or two places the ore is most abundant along the lines of fracture. A shaft was recently driven through the limestone at Inverugie into the white silicious sandstones below; but no ore was found in the inferior rock." Two large isolated masses, apparently identical with the sandstone of Quarrywood, and which we believe are *in situ*, are to be met with, the one on the south-east flank of the Hill of Pluscarden, the other at Rinninver, about three miles south-west from the Pluscarden Priory. They have been both worked for building-stone. It were curious to ascertain the cause of their isolation from the great deposit of the same nature. The supposition of a vast and repeated denundation going on

during the depositing of the sandstones of Moray seems a probable explanation.

Few fossils, and these chiefly casts or scales of *Holoptychius*, have been found scattered throughout the various beds of these silicious sandstones that form the lengthened and elevated ridge from Bishopmill to Alves. We however no sooner leave these beds in what we believe to be the ascending order of the strata, than we arrive at that portion of the provincial deposits which at the present excites so much interest in the geological world. Ever since the discovery of the *Telerpeton Elginense*, Mantell (*Leptopleuron lacertinum*, Owen), a strong suspicion has arisen, and prevails with many, that between the *Holoptychius*-bearing beds of the above-mentioned ridge, and the sandstone of Spynie, there must here exist a wide hiatus or blank in the great geological scale of the earth's crust, filled up in other areas of its surface by the whole of the Carboniferous and Permian, and no small portion of the Triassic, formations. It may be so. Still, this we affirm, that, so far as has yet appeared from repeated and careful inspection of the strata where accessible, they conform so closely in their strike, dip, position, and lithological character, as would, in the absence of these reptilian remains, have induced the most practised observers to infer, with little doubt or hesitation, that the sandstones of Spynie, Lossiemouth, and Cummington, were but the upper beds of one and the same formation as the sandstones of Bishopmill, Quarrywood, and Alves. Another circumstance, which certainly tends to show at the same time a marked difference in the age of these beds is, that, so far as has yet been ascertained, as soon as the reptilian remains appear, those of fishes disappear,—no impression of *Holoptychius*, or, indeed, any other organism, has hitherto been found associated with them.

About a couple of years ago, lying on the surface of the Bishopmill silicious sandstones, near the east entrance to Findrassie House, and among the debris of a pit opened up for road material, Alexander Young, Esq., Fleurs, found a most interesting and valuable slab containing casts of bones and scales. He presented it to the Elgin Museum, where it

is now to be seen. Although not actually taken from the living rock, the lithological features of the stone, and the freshness of its angles, lead us to infer that it had not travelled far from its original bed. The scales seem to be generically, if not specifically, the same as those of the specimen from Lossiemouth, which Agassiz considered to belong to a fish, and to which he gave the name of *Stagonolepis Robertsoni*. The casts, however, of the bones, which lie in such close juxtaposition to the scales as to leave no doubt of their belonging to the same animal, give good ground, we think, for raising it to the higher class of reptiles. The surface of the slab is about eighteen inches square. One bone measures three inches across the two condyles, and the scales $2\frac{1}{4}$ inches by $1\frac{1}{2}$ inches. But a verbal description here is of comparatively little use. We trust that at least a cast of this slab, and that other fossils from this now so interesting a locality, will be sent to Aberdeen, by the time the British Association meets in that city, for the inspection of those able to decide as to the character and position which these animals should have assigned to them among the vertebrata. Dr Taylor, H.E.I.C.S., at the same locality, subsequently found some casts of vertebræ, which are now in the cabinet of Mr Duff.

The Hill of Spynie, which we would suggest as coming next in order, stands about two miles to the north-east of that part of the Bishopmill sandstones which disappears under the alluvial deposits and drift. Between the two the drift, as is so frequently the case in this district, prevails and hides their junction. The hill itself, the site of the far-famed and still unique *Telerpeton*, rises from a sea of this drift, or from the deep sedimentary deposits of the Loch of Spynie, so that at no point in its whole circumference is any actual connection to be traced with any other rock. On the north-east corner of the hill, and close by the ruins of the Episcopal palace, there are masses of a hard, flinty, concretionary, sandstone, pervaded by decomposing iron pyrites, not otherwise differing from the cornstones at and around Elgin. Whatever may be said of the *Stagonolepis* at Findrassie, there can be no doubt as to the *Telerpeton Elginense* being found *in situ*. It was extracted from the living rock, deep in a quarry opened on

the west end of the hill, and as yet is the only organism that the Hill of Spynie has yielded, although the workmen have had their eyes open ever since to any similar appearances that might present themselves.

After those now described, the nearest out-cropping rock to Spynie are the strata at the Coularthill, or Lossiemouth, about three miles distant, nearly north. They have all the same dip as the sandstones of the interior of the country, and do not, when taken as a whole, differ in their lithological nature. The lowest beds, as seen near the back of Rockhouse garden, are of a shaly nature, approaching to a red unctuous clay. They soon pass through a yellowish soft sandstone to a hard, whitish, compact rock, which extends down to the new harbour of Branderburgh, and which has been extensively quarried. It was immediately under this hard silicious sandstone, in a quarry half-way to the new harbour from Rockhouse, and in the face of the wall of rock that overhangs the houses fronting the old harbour, that Mr Martin, to whose discoveries in the fossil geology of the county science is already so much indebted, detected last week (1st September 1858) a bone, possibly the scapula of a reptile. This discovery will tend to throw much light upon our provincial geology. It was near the same place that Mr Duff's specimen, now in the Elgin Museum, of *Stagonolepis Robertsoni* was found, and we trust that those two interesting relics are but an earnest of what are to follow from the same locality. Overlying these beds of hard, compact, white silicious sandstone, we find at the new harbour, and thence extending as far as Burra Westra Cottage at Stotfield, a singular flinty or agaty rock well worthy of attention. At Stotfield it is seen to rest on a thin bed of limestone resembling the cornstones. Portions of the same deposit are seen to underlie it, or pass into it on the shore within high-water mark. At first sight this rock seems to be a series of strata set on their edges; but a more close inspection will show that this appearance is caused by the bed being pervaded by numerous perpendicular rents or fractures. Galena and other minerals, as noticed in the extract from Dr Malcolmson's paper, are found in this rock, which also yields beautiful small rock crystals, often in drusy cavities, and

having an amethystine tint. It is this rock which Williams, in his "Mineral Kingdom," calls a composite granite. At least two attempts, both abortive, have been made by miners from the south to work the galena profitably. The ore is said to be a rich one; but being in a hard rock, in small disseminated masses and not in veins, the labour of extracting it would be expensive. Moreover, the matrix bed itself being of no great depth, even had the disseminated masses been larger and of more easy extraction, the whole would have been soon exhausted. For there is no appearance of the lead ore extending to the underlying sandstones. The strike of this bed, which in some respects resembles the cornstones of the interior, if prolonged, would pass near to Inverugie, some six miles to the westward. At all events, at this place (Inverugie), we have a well-developed and an undoubted cornstone, which has been quarried to a considerable extent. It has the usual dip, so often noticed in the other cornstones and sandstones of the country, and has galena disseminated throughout it. The occurrence of the Inverugie cornstone, as well as that which lies on the sandstones of Spynie, becomes another element, indicating that the whole of the beds lying between it and the cornstones of Elgin are but subordinate to one great formation—the Devonian or Old Red Sandstone.

We had thus far written, when Sir Roderick Murchison (7th September 1858) visited this district. His views regarding it will probably be communicated to the Geological Section of the British Association now sitting at Leeds, and published in the third edition of his "*Siluria*," just about to issue from the press. With these materials before us, we shall be enabled to speak more fully and confidently of the geological order of the whole, and specially of the age of the upper or reptilian-bearing beds of Spynie and Lossiemouth, than could have been done in the absence of his unequalled experience and acknowledged authority in all that relates to the Old Red Sandstone system. We shall, therefore, reserve the description of the few remaining beds that lie along the shore, from Covesea to Burghead, including those of Cummington, that contain the singular foot-prints already referred to, for an appendix to this paper, in which we hope also to give the re-

sult of this most recent and most authentic examination, and, at the same time, to add to and correct some of the statements advanced in the foregoing pages. Therefore, in the meantime, we turn to the next or highest system, in the province of Moray, which we were provisionally to regard as coming after that of the Old Red Sandstone, namely,

The Northern Drift or Boulder Clay.

Throughout the district under consideration, particularly its eastern half, there have been found many masses of fossiliferous shales and clays, which have been assigned to the Liasic, Oolitic, and Wealden formations. However, as suspicions have arisen in the minds of local observers, that even the largest and best stratified mass—of Wealden at Linksfield—is not *in situ*, it is better, in the meantime, to treat them as all lying in the same category, namely, the Drift or Boulder Clay. At various times, specimens from Linksfield have been laid on the table of the Geological Society of London, and papers on this deposit read before its learned members; but no hint was given, or doubt expressed, regarding its being a transported mass. Hence, when the Telerpeton was found at Spynie, the natural idea was entertained by not a few, that the reptile must belong to some system lying between the widely separated Wealden and the Devonian, the two acknowledged formations of the district. If it then turn out, as we think it will, that the Linksfield Wealden owes its present locality to glacial action (icebergs), the opinion, if any further proof be necessary, is the more confirmed, that the Telerpeton, the Stagonolepis, and the foot-prints of Cummingston, are of the Old Red Sandstone era.

On the 25th April 1838, Dr Malcolmson read a paper “On the Wealden beds at Linksfield,” before the Geological Society of London. Mr Martin having favoured us with his manuscript copy of it, we give the following extract:—“The principal beds at Linksfield, in the ascending order, are,—1. Immediately above the cornstone, and unconformable to it, a bed, several feet thick, of red, nearly incoherent, sandy marl, effervescing with acid, and abounding with rolled pebbles of granite, gneiss, &c. I also detected unrolled fragments of the fine-grained yellow and gray sandstones, forming the hills to the

west. This sand appears to be less inclined than the upper beds, and it becomes more argillaceous, and of a redder colour above. 2. Laminated green clay, with a network of fibrous carbonate of lime. 3. Compact gray limestone without shells, with clay between the laminae and strata. The central parts of these bands are mostly broken across the planes into rhomboidal masses, preserving their parallelism. 4. Blackish clay or shale, some specimens very black, others turning green on exposure, not bituminous. Between one and two feet thick. 5. Narrow bands of limestone and clay. 6. Blue clay, with thin bands of compact limestone, mostly composed of bivalve shells, of a dark-green colour, occasionally tinged with pyrites. The blue clay abounds with crystals of selenite and argillo-calcareous nodules, and its lower laminae are intermixed with satin spar. The fossils have been found principally in the lower part of the bands. The shells are rarely well preserved, and cannot be separated from the rock. They consist of few species, but the individuals are very numerous, constituting nearly the whole rock. The most remarkable is a *Cyclas* that cannot be distinguished from the *C. media* of the Wealden in the Isle of Skye. With them are mixed a few individuals of a new species of *Avicula*, fragments of *Astarte*, and *Venus elegans*, and a microscopic univalve. The clay below the limestone is full of the valves of a species of *Cypris*, ascertained by Mr J. D. Sowerby to be new. A saurian bone, and numerous scales and teeth of fish, have also been found. The character of these beds differs so much from the Lias, to which they had been referred, that I was reluctant to admit the conclusion, that this rock has assumed so different an appearance, not only from that exhibited by it in England, but from the same strata on the opposite side of the Moray Firth. This suspicion was confirmed by none of the chambered or other remarkable shells so abundant at Ethie having been found at Linksfield, and by the discovery of the fresh-water shells and *Cypris*. Having stated my belief that the deposit belonged to the Wealden beds, the gentleman who had discovered and collected the specimens kindly favoured me with them; and Mr Murchison was immediately struck with the similarity to the lower part of the Purbeck beds at

Swanage, between which and the several variety of clays and limestone bands at Elgin there appears to be a perfect identity. That this does not extend to all the species of fossils might be expected from the distance of the locality, the beds having been probably deposited in different estuaries."

In Mr Duff's "Sketch," Plate III., there is a coloured section of this deposit, which distinctly exhibits the order of the strata, and to which we would refer our readers. Mr Duff divides and enumerates the beds thus, in the ascending order. Lying on the cornstone—1, A red till, the same as again occurs at the top of the Wealden strata; 2, Green-clay; 3, Limestone; 4, Dark blue clay, with fossils; 5, Green-clay; 6, White-band; 7, Limestone; 8, Green-clay; 9, Red till, same as No. 1; 10, The surface soil. He says (p. 61),—"The remarkable alluvial stratum (No. 1) of red till forming the bottom of the series, being easily worked, enables the labourers to undermine the tenacious clay and marl beds above, and to bring them down in masses; were it not present, it would be almost impossible to remove the upper beds from the limestone below." The late Mr Robertson of Woodside and Inverugie, in his valuable note in "Anderson's Guide to the Highlands," 3d edition, p. 348, states, that "the remains obtained from these strata are,—a femur of *Trionyx* (Prof. Owen); vertebræ of *Plesiosaurus subconcaus*; scales of a species of *Semionotus*, *Lepidotus*, *Pholidophorus*, and *Eugnathus*; teeth of *Ilybodus Lawtoni*, Duff, and *H. dubius*, Agass.; and of *Sphenonchus Martini*, Agass.; and an *Acrodus*. The shells are of the genera *Melanopsis*, *Paludina* and *Planorbis*, *Ostrea*, *Avicula*, *Modiola*, *Mytilus*, *Astarte*, *Unio* and *Cyclas*. There are also valves of *Cypris*, fragments of carbonized wood, and two or three species of Ferns."

Such, then, being the nature of the deposit itself, and of its contents, a most interesting point is, to determine the character of the red sandy clay stratum (No. 1) on which the undoubted beds of Wealden rest. Dr Malcolmson seems not to have been aware of its differing so much as it does from the beds that lie immediately upon it, and inferred that it was of the same series; and some still continue to think that it is contemporaneous with, and is here the base of, the Wealden. Mr

Duff, however, in 1842, stated that it appeared as if it had been interjected between the Wealden beds and the cornstone. "This bed at first sight might be held to belong to the Wealden, but, on minute examination, it is found to contain not only rounded masses of the cornstone below, but also water-worn portions of the Wealden beds above, thus giving undoubted proofs of its having been an alluvium gathered from both deposits, and introduced between them by means difficult to account for" ("Sketch," p. 16). Mr Robertson, in the note already quoted, says of the same stratum,—“Between the Wealden beds at Linksfield and the subjacent ‘Old Red’ Limestone, a mass of boulder-loam is intercalated. The surface of the limestone is scratched and polished, and the thickness of the loam varies from an inch or two to about five feet. Besides the usual boulders, the loam contains nearly angular fragments of both the subjacent limestone and overlying Wealden beds, and sometimes includes considerable seams of the clays and limestones of the latter. The Wealden beds have suffered considerable disturbance, and are irregularly curved. In explanation of these appearances, it is supposed that the terminal portion of a vast glacier, in the course of its resistless march, inserted itself between the surface of the underlying limestone and the yielding beds of the Wealden, scratching the former, elevating the latter, and introducing a mass of subglacial detritus (the boulder-loam) beneath them. On the melting of the ice, the Wealden beds would fall down in flexures, force the plastic loam to accommodate itself to their sinuosities, and finally rest upon it, as they actually do. It may be mentioned that M. Agassiz gives his sanction to this hypothesis.”

Captain Lambart Brickenden adopts much the same hypothesis. In the “Proceedings of the Geological Society” for June 1851, he gives a ground-plan and sections of this interesting locality. After affording data to show that the intercalated stratum of boulder-clay extends over an area of about twenty acres, and stating that the height of the beds above the limestone is about forty feet, he writes—“That the drift has been forced into the place it now occupies is the opinion generally entertained by those who have examined it; and this appears to be fully sustained by certain peculiarities which

the bed discloses, though it is not very easy to conceive the exact manner in which such an extensive and marvellous intrusion was effected. The surface of the boulder-clay, and also the strata between which it has been propelled, is hardened, abraded, and marked with polished striæ, indicating the direction in which the mass has moved." "We can imagine a mass of yielding clay, arrested at the base of an escarpment or outcrop of strata, might have been injected between them, in much the same manner as igneous or molten masses between some of the stratified formations, provided that certain conditions were fulfilled." "I therefore presume that the boulder-clay, having originally accumulated at the base of the oolitic outcrop at Linkfield, and having gained an entrance into the position held by its softer and subjacent beds, had been subjected to the action of vast and extensive masses of ice, which, by continuing to press onwards, the accumulations of clay retained beneath it had, by superior force to that which the oolitic beds could offer in resistance, eventually produced the phenomenon at Linkfield." Since these views were published by their respective authors, another has occurred to some local observers,* namely, that the whole mass of this Wealden at Linkfield, and all the Lias and Oolites found on the southern shores of the Moray Firth, as well as the chalk flints of Peterhead and ~~Delgaty~~, are but so many boulders transported hither by icebergs from some northern locality. This hypothesis is not only of more general application, but one which, we think, with all its attending difficulties, meets the phenomena at Linkfield as fully as any that has been propounded. Meantime, we trust we have said and quoted enough regarding this interesting locality to arrest the attention of geologists from a distance when they visit this part of the country, and to draw out their opinions, not only of the formation itself, but of the causes that have placed it where it now lies. Small patches, the same as the Linkfield beds, were long ago seen at the edge of the Loch of Spynie near Pitgavenny, and at Waulkmill. In addition to these, Mr Duff mentions, "the bank at the west end of the

* See Mr Martin's paper on the "Northern Drift," vol. iv. p. 223, October 1856.

town of Elgin, on which the house of Maryhill stands, and the bank on which the ruins of the castle of Spynie are situated."

Inverugie, Duffus House, Coulart Hill, and Lhanbryde, are given as localities of the inferior oolite. To the last of these, at the west end of the village, and some hundred yards below where the turnpike road crosses the burn, we well recollect being conducted nearly thirty years ago by the venerable Mr Leslie, late minister of the parish. Having observed some ammonites in a stone used in erecting an adjoining farmhouse, and ascertained whence it had been taken, he thus, from his well-known observation and spirit of inquiry, became its discoverer. "Although," writes Mr Duff, "the oolite appears *in situ* only at Lhanbryde, isolated masses are found strewed over the plain, formerly the Loch of Spynie. About twenty-five years ago, the workmen, in cutting the canal intended to drain the lake, touched on a bed of bituminous shale, of which they threw out large quantities, with fragments of that kind of coal called lignite, and in the shale numerous belemnites and ammonites, and occasionally masses of the oolite." Immediately below the church of Urquhart, on the flat between it and Innes House, the same formation has been met with in several spots. From one of them the Rev. Mr Morrison has extracted as fine a suit of fossils as has yet been made from the oolites in this quarter. They are of such number and quality as will enable those versed in this department of science to say whether they more resemble the oolitic forms of the south of the island, or those of more northern regions, as the flints, &c., of Aberdeenshire are said to do.* For this purpose we trust that Mr Morrison will have a series of his specimens ready for inspection by the savans who are to meet next year at Aberdeen. Many of the oolitic masses are unquestionably boulders. It were well that the bases of others of a more doubtful substratum were thoroughly examined, as we think there is much

* "There has also been made an important discovery in Aberdeenshire of Neocomian fossils. It appears that flint and greensand, containing greensand fossils, have been found in that county; and what is still more remarkable, some of the fossils resemble more those of Scandinavia than of Britain. This points to a connection between the northern cretaceous system and that of Scotland."—Lord Talbot de Malahide's "Address to the Geological Society of Dublin," 1857.

truth in what that accurate observer, the late Mr Robertson, says,—“Nor is it certain that any of the oceanic members of the oolitic series occur absolutely *in situ*. Detached blocks belonging to several of the divisions, from the superior oolite to the Oxford clay, both inclusive, are found in the boulder loam, as well as in the overlying stratified deposits; and in some places, as near Lhanbryde, they are associated with a sandy gray clay. Their angles are in general but slightly rounded, and they are very abundant in certain localities, from which circumstance it may be inferred that their parent sites are not far distant from the spots where they now rest. The fossils, which have been extracted from these masses, include many new shells; (*Hybodus undulatus*, Ag.), erroneously stated in “Poiss. Foss.” to be from Linksfield, and another undescribed tooth of another species of the same genus.”

Mr Martin having, so lately as October 1856, laid before the readers of this Journal full and graphic details regarding what is, strictly speaking, the Northern drift, so largely developed in the province of Moray, we need only here remind them that he represents it as ranging from the sea-shore level to the height of 900 feet. He divides it into three portions,—1. In the ascending order, immense deposits of very coarse gravel, chiefly to be seen in the elevated slopes of the hills to the southward. 2. The till, of a reddish colour, very tenacious, and is void of the least appearance of stratification; it is composed of fragments and comminuted parts of the older rocks, and also contains boulders, many of them of immense size. 3. The beds of sand which accompany and overlies the till, and which present undoubted marks of stratification. This last portion, chiefly in the lower parts of the country, forms extensive elongated ridges and wide-spread plateaux. “The remains of no animal or plant, supposed to have been alive when the drift was being deposited, have yet been found in any of its subdivisions in this district.” Several distinct and far-extending terraces, or old sea margins, are seen on the surface of the drift, as on the northern slopes of the Manoch and Quarrywood hills. In almost every gorge or valley, through which water has flowed, the debris of the drift, increased by fresh materials from the newly-worn chan-

nels, has been moulded and shaped into bluff banks or river-terraces. Shell marl occurs in many places where modern improvement has drained off the fresh waters in which the mollusca that formed it disported themselves; and the bed of the Loch of Spynie, in its alternately showing strata of fresh and marine remains, records the changes that have taken place in bygone eras, when at one time it was an arm of the sea, and at another an inland lake. "All the different kinds of peat," says Mr Robertson, "with the exception perhaps of the maritime species, are met with in Morayshire. In some elevated and exposed mosses, as those of the Brown Moor, which are from 600 to 1100 feet above the sea, the stools and trunks of oak and other trees are found of a size which the climate now existing at such heights in this district does not admit of." "In the autumn of 1849, the horn cores and part of the frontal bone of a large *Bos primigenius* (Boj.), together with the shed horn of a stag, were found in cutting a drain at Westfield. These specimens are now in the Elgin Museum. A little to the west of Burghead there is a submarine forest, which must, from the circumstance of trees being occasionally dragged up by the anchors of ships riding in the bay, extend for a considerable distance beneath the sea. Part of it is exposed at low water. It is a combination of forest, lake, and marsh peat." "Ventose accumulation of sand or dunes are largely developed at Culbin, to the west of the bay of Findhorn, where they have buried an extensive area of what was once the most fertile cultivated land in the county, and attain a height of 113 feet above low-water mark. Similar deposits, though on a less conspicuous scale, are found all along the seaward zone of the district, the sand in some cases, as at Inverugie (as also at Culbin), alternating with seams of vegetable soil."

The extent to which this paper has now reached admits but the simplest notice of these superficial deposits; but we must not close it without giving Mr Robertson's observations on the shingle beaches which have often been remarked as a striking peculiarity of the southern shores of the Moray Firth. "Where the coast is not rocky, as is the case from the western extremity of the county to Burghead, between Craighead and Stot-

field, and from Lossiemouth to the Spey, the present beach is bounded by a series of ridges, externally of shingle, but showing rudely saddle-shaped alternations of gravel and shingle when a transverse section is made. The ridges vary in size, and the distances between them are unequal. The breadth to which they extend inland is sometimes, as near Inchbroom, a mile and a half, and their number is occasionally from twenty to twenty-five, as near the Blackhill of Spey. They are in general nearly parallel with the existing coast line; but at Culbin and Speyslaw they are so contorted as in some places to run at right angles to it. The ridges are due to the piling action of waves during storms. From their mode of distribution they may be regarded as rings of growth, showing the intermittant nature of the elevation of the land. To the east of Hopeman Lodge, and also on a terrace about half a mile west of Craighead, similar series of ridges, though on a smaller scale, are found about forty feet above the present high-water mark." That these ridges are the effect of causes similar in their action to those now in operation, distinctly and strikingly appears from the manner in which the debris, excavated from the harbour at Branderburgh, has been carried westward, laid down and arranged on the shore within the last quarter of a century, by the currents of the Moray Frith. These newly-formed ridges are of such extent and regularity, become gradually more and more water-worn and rounded as we trace them westwards, and at the place where they encounter and cross a spur of hard, flinty, and concretionary sandstone, are so much raised above the level of high water, that they must delight, as a fit study, all who in geology explain past effects by an appeal to present forces, even not excepting their able and acknowledged leader, Sir Charles Lyell.

At the late meeting of the British Association at Leeds, Sir Roderick J. Murchison laid before the Geological Section "The results of his researches among the Older Rocks of the Scottish Highlands;" and in noticing the yellow sandstones of Morayshire, in which the *Telerpeton Elginense* was found, stated his conviction that they are part and parcel of the Old Red or Devonian series. "In exploring the coast range from

Burghead to Lossiemouth, he observed that the strata had been thrown up on an anticlinal, trending parallel to the more inland ridge with the *Telerpeton*; and that whilst the inland ridges are associated with hard sub-crystalline cornstones (limestones) first described by Professor Sedgwick and himself as analogous to the Old Red cornstones of England, so the coast ridge, folding over dips on the sea-shore beneath another band of similar cornstone, which in its turn is overlaid by flag-like deep red sandstone, clearly seen in reefs at low water. In this Morayshire series there is not a trace of a carboniferous plant, and the strata are so bound together by mineral characters and fossil remains that they must be all grouped as Old Red or Devonian."

Since this paper was read at Leeds, we have been fortunate enough to secure and forward to its learned author many specimens of impressions or casts from Findrassie, of footprints from Mason's-haugh quarry, near Cummington, on the property of C. L. Cumming Bruce, Esq. of Roseisle, &c., M.P., and of veritable plate and bone from Lossiemouth. These specimens are now in the hands of Professor Huxley, who, we understand, has expressed an opinion that they belong to reptiles of a high order. We must still, however, wait for the further elucidation of these interesting relics, and for more details regarding the Old Red formation, as developed on the southern shores of the Moray Firth, until the publication of Sir Roderick's additional memoir, about to be laid before the Geological Society of London.

Having thus brought down the history of discovery to the present day, and stated the opinions now entertained regarding the geology of the lower or northern part of the province of Moray, it remains but to enumerate some of the points which still call for inquiry from resident observers and scientific visitors.

1. What are the geological position and extent, &c., of the crystalline rocks that underlie the undoubted Old Red conglomerates?
2. What relation, if any, does the limestone near Grantown in Strathspey bear to these crystalline rocks?
3. To which of the sections in the Old Red system do the

conglomerates near Tomintoul (Banffshire), and the sandstones of Auchindoir (Aberdeenshire), belong ?

4. The same question may be asked regarding the sandstones of the Nairnshire coast.

5. What account is to be given of the outlying masses of yellow sandstones at Rinninver in Dallas, and on the south-east flank of the Hill of Pluscarden ?

6. What proof is there that our (boulder) oolites, &c., are of the same nature as those of Sutherlandshire, and not of the Scandinavian formations ?

The chief purpose of this paper has been to record what Dr Malcolmson had, twenty years ago, accomplished in the geology of the province of Moray, and to point out to those who may visit this now interesting district the several localities where the different strata can be best studied, and where the various fossils are to be met with. Much remains to be done, for the queries above given could easily be multiplied ; and some others have no doubt already suggested themselves to our readers. But of a more local and urgent nature would it be to procure complete, or at least better, specimens of the many singular creatures of which as yet only fragments have been discovered and collected. Of the multitude of scales, bones, and casts, &c., that have been extracted from the Scāāt-Craig, the Findhorn, the Meikle Burn, Findrassie, and Lossiemouth, not a single specimen has appeared or been constructed so as to show in full outline the animal itself.

Even in this utilitarian age, when the exercise of the bodily or mental powers, while not followed by direct and profitable, if not pecuniary, results, is too often regarded with coldness, disrespect, or ridicule, a claim may be urged on this low basis for the support and countenance of the community of the provincial capital for the further elucidation of the local geology. Thus, many foresee that the smaller towns will not be so enlarged and improved by the railway trains running up to and passing them as was at one time anticipated ; and some regard even Elgin in this respect as for the present in a problematical state. Neither a terminus in itself, nor the source of large or varied manufacture, it has mainly to depend on its climate, its society, its schools, its cathedral, for securing for a few

days or hours the sojourn of the traveller, and perhaps for ultimately fixing him as a permanent resident. To these attractive objects and motives may now be added the circumstance, that the country around Elgin is yearly rising in the estimation of the scientific world as a good field for the study of an important part of that series of rocks of which the crust of the earth is formed, as well as of other departments of learned research. If a Murchison and an Egerton this autumn deemed their time well spent in examining it, there are doubtless many more to follow on the same instructive ground. The chief object of attraction, or the starting point for such visitors, is the museum, where they naturally expect to find in its specimens not a heterogeneous mass of objects from foreign lands, but rather an outline or epitome of the surrounding country;—hence a strong reason why this institution, in its local department, should have a large share of civic patronage. We can here but barely hint at other reasons, of a more powerful, lasting, and ennobling nature, such as the diffusing of a taste and affording materials for one of the most rational and laudable recreations to which a person's spare hours could be devoted,—expanding the powers of the mind, and cultivating the habit of correct observation, enlarging the views of creation, and for bringing more fully before the eye the power, the wisdom, and the goodness of Him in whom we live, and move, and have our being.