TRANSACTIONS

OF THE

PERTHSHIRE SOCIETY OF NATURAL SCIENCE.

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PERTHSHIRE SOCIETY OF NATURAL SCIENCE

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1886 TO 1893.

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Page 39, line 17 from foot, for "Capella" read "Capsella."
Rubus Ammobius, recorded on pp. 33 and 40, is not that species.

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AND

PROCEEDINGS

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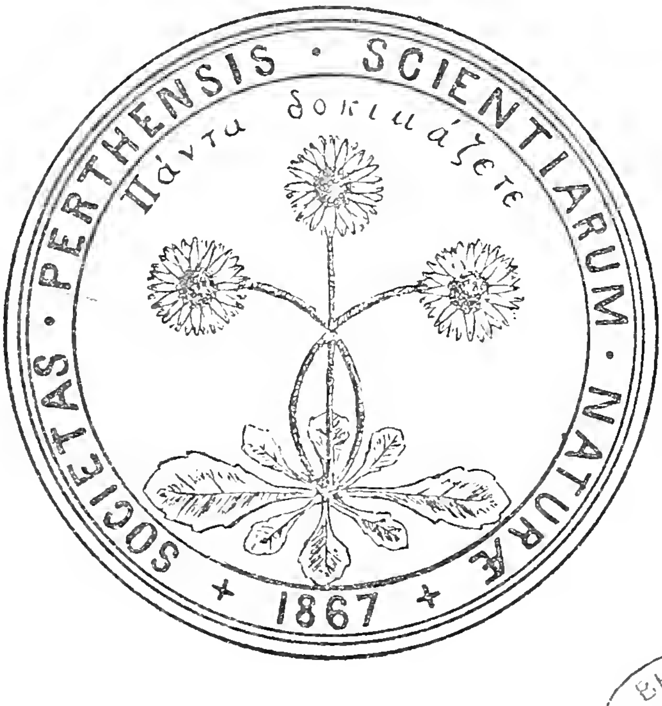

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PERTHSHIRE SOCIETY OF NATURAL SCIENCE.

I.—*Notes on some Rare Perthshire Birds lately placed in the Museum.* By Colonel H. M. Drummond Hay, C.M.Z.S.

(Read 4th February, 1886. This Paper was held over from the "Proceedings" of 1885-86; *q. v.*, p. 256).

In laying before you some notes on the rarer birds recently placed in the Museum, I may mention that it is still the intention of the Council to issue a series of papers on the Natural History of the district, as indicated by the President in a paper on the Mammals of Perthshire, the first of the series to be continued under the title of "Museum Notes," which will eventually form the groundwork of a handbook to the Museum. With this in view, I hope shortly to be in the position to draw up a full and descriptive list of the whole of the birds of Perthshire and basin of the Tay, revised up to date from the former list, which appeared some years ago in the *Scottish Naturalist.* Since this list was published many additions have been made and further information obtained. To make the list useful to those visiting the Museum, it is proposed to issue it as a guide to the ornithological department, and, to do this effectually, it would require to be recast and arranged according to the classification and scientific nomenclature there adopted. As I in no way wish to anticipate this in my remarks this evening, I shall confine myself to a very few species, especially noteworthy for their rarity in the district, and shall refer to these in somewhat fuller detail than there would be room for in the forthcoming list.

1. The Hawfinch.—The specimen now before you is not a very recent acquisition; on the contrary, it has been some years in the possession of the Society, but not till very recently exhibited in the

bird-cases upstairs. Having been, as it happened, badly mounted, and the feathers much ruffled and displaced, the stuffing was taken out and the specimen placed in that part of the collection devoted to skins (not as yet sufficiently advanced for public inspection), in the hope that thereafter a better specimen might be obtained; but, as that was not the case, and as it was particularly desirable to exhibit it in completion of the series, it was put into professional hands, and, by careful manipulation, has been most successfully restored. This bird was obtained, along with another (probably out of a small flock, but I did not get the particulars), near Murray's Asylum, Perth, in the very severe winter of 1860-61, and was kindly presented by Dr. M'Intosh of Murthly, now Professor of Natural History at St. Andrews, to whom the Society is much indebted for the gift.

The Hawfinch, or Grosbeak as it is sometimes called, can only be considered as a mere straggler in Scotland, though there are very few counties in which it has not at one time or another been found, and, as these instances mostly occur in winter, the probability is they are wanderers from the continent on their way south, and not British-bred birds, which would not move north in winter. Mr. P. D. Malloch, of Perth, however, informs me that in May of last year (1885) he saw five Hawfinches near the roadside close to Kinross. These were in all probability foreigners on their passage north, otherwise so shy a bird would scarcely be found so near a public place of resort, and I know of no instance of their breeding in Scotland. The case is different in England, where it is resident all the year round, breeding in many of the southern and central counties, as far north as Sheffield, but rarely extending much further; but its great stronghold is in Epping Forest, where it breeds abundantly, and is said to be greatly on the increase. It builds a well-constructed nest, something in form of that of the Bullfinch, but much larger and somewhat flatter and more bulky, though the cup, in which the four or six eggs are deposited, is not particularly shallow. The eggs, strange to say, do not resemble those of any other British finch, being distinguished therefrom by being streaked, and resembling more those of the Buntings, of which, from the dark ground, the Reed Bunting may be taken as the type. Its nesting sites are various, sometimes on high trees, and though at other seasons an exceedingly wild and shy bird, it is frequently to be found building in orchards and other places not far removed from houses.

The shape of the bird is peculiar—stout, thick-set, and rather clumsy, from the enormous size of its bill and head in comparison to its body. At the same time, the colouring of its plumage, being bright and in pleasing contrast, makes it a bird rather to be admired than otherwise, and this more particularly in more southern specimens, which are somewhat brighter, as I have particularly noticed in those I have shot in Albania and Greece, which were more vivid in their colouring than those got farther north.

My first acquaintance with this bird was in Switzerland, where in the vicinity of Geneva at certain seasons it was pretty common, and where I had many opportunities of observing its habits. This is not always an easy matter to do, for, as before observed, it is one of the most wary and shy of birds, either avoiding notice by quickly hopping out of sight with its short strong legs into the densest of foliage, or perhaps perching on some high tree-top (its frequent habit, especially before roosting), from whence it can take a survey of all around, and from whence, on detecting the slightest sign of danger, it will suddenly launch itself, and, with strong rapid flight, quickly make for the nearest coppice, into which it suddenly drops and is lost to view, and there remains for the night. Of all the British finches it has the most powerful bill, with muscles so strong as to enable it to crunch the hardest of cherry stones, on the kernels of which it freely feeds. In opposition to the Blackbird, who eats the fruit and rejects the stone, the Hawfinch eats the stone and rejects the fruit. At other seasons, beechmast, the fruit of the hornbeam, alder, and other hard seeds, form its usual food. But perhaps one of the most striking peculiarities of the bird are its highly polished metallic-looking wing feathers, shaped like a bill-hook or a sickle, entirely peculiar to this species, and a form unknown in any other of the tribe. Whether this peculiar shape be for ornament, or to assist its flight in suddenly dropping into a place of security, naturalists do not seem to have investigated; but, as these birds have the same peculiarities in both sexes, and at all stages of plumage, doubtless nature has supplied it for a purpose, which may perhaps, as science advances, be some day determined.

2. THE ROSE-COLOURED PASTOR.—This bird is closely allied to the Starling, in whose company individuals are frequently to be found when visiting this country. In "Notes of the Birds of the Basin of the Tay," with regard to this bird, are the following remarks:—

"Though there are several instances, but not of late years, of the Rose-coloured Pastor being noticed in the district, it can only be considered as an accidental visitor. Mr. Horn makes mention of one obtained at Dunkeld on the 29th September, 1831, and a very fine specimen in full rose-coloured plumage was shot in August, 1832, sitting on some pea-stakes in the garden at Megginch, and another specimen, also in full plumage, was obtained just ten years afterwards, in 1842, at the same season and at the same spot, and exactly under similar circumstances. Another was shot at the same place a year or two afterwards." That bird is the one now before you. Unfortunately, not being at Megginch any of the times that these different specimens were shot, none of them fell into my hands, and it was only very lately that by chance, on talking with Mr. Kinmont, of Errol, he informed me he was in possession of one of these birds, which, through his assistance, I was enabled to identify as the last of the three shot by his father-in-law, the late Mr. Duncan, who was then gardener at Megginch. As far as could be calculated, the bird was shot about September, 1846, and given to him, and was stuffed by Mr. James Ogilvy, then serving at Megginch, now living at Errol, who informed me only the other day that he had a perfect recollection of setting the bird up just about that time. Mr. Kinmont most kindly presented me with the bird, which I have much pleasure in placing in the Society's Museum as an authenticated Perthshire-shot specimen.

In this country, as well as in central and western Europe, only solitary examples make their appearance from time to time, but not so in the countries farther to the east, though even there they are nomadic and gipsy-like in their habits, assembling in certain spots in myriads, and not seen there again, perhaps, for several years, or never again. Nesting often in large colonies, they never seem to have a fixed abode, visiting sometimes one country and sometimes another. Their nesting-grounds in Europe seem to be confined to parts not far removed from the western shores of the Black Sea, certain districts of the Debrudscha and Bulgaria, and occasionally Northern Italy. Many years ago they were found nesting in countless myriads at Verona, and more lately at Villafranca in 1875. In Asia Minor, large colonies are described as breeding at Broussa and at Smyrna. In the Ionian Islands, where these birds seem often to make their appearance, I had not the good fortune to fall in with them, excepting a chance specimen in the Island of Cerigo (the most southern of the group), which I obtained there in 1843, and which is now in the collection at Megginch. In Corfu, where I resided for several years, the bird was never seen by me, or even heard of. Lord Lilford, however, President of the British Ornithological Union, who subsequently visited those Islands, was more fortunate, as he found these beautiful birds to arrive at Corfu occasionally in great numbers early in June, and haunt the orchards, feeding almost entirely on mulberries. In 1857 very few, he says, visited the Island, but in June, 1858, the mulberry gardens were full of them for some days, when he obtained specimens in abundance in all their different stages of plumage. He further states that these birds remain only a few days, and are well known to the Corfiote peasantry by the name of Mulberry-eaters (*σκαμνοφάγοι*).—Ibis, Vol. II., p. 137. In some parts of Northern India, also, they go under the name of the Mulberry-eater.

My friend, Canon Tristram, of Durham, informs me that in Syria the bird is known only by the name of the "Locust Bird," its movements being almost entirely guided by the motions of those pests of the East, and his description of a scene which presented itself to him in one of his numerous journeys in that country is so graphically told that I make no excuse in quoting it:—"The most interesting ornithological sight I was privileged to enjoy in Syria was the Rose-coloured Pastor on migration. On May 26 I was on the ruins of Kelat Seijar, the ancient Larissa, a romantic and isolated fortress on the banks of the Orontes. The river flows due west towards it, down a deep glen, with cliffs of great height on the south, but lower on the north. The country on both sides is a vast plain, but generally higher on the left than on the right bank of the Orontes. Just at this spot a bold spur of rock runs from south to north, abruptly terminating in a bluff. The river meets this wall of rock at right angles, and, dashing against it, suddenly flows north through a magnificent fissure till it reaches the end of the bluff, when it turns as sharply again, rounds it, and pursues its westward course. Along this ridge was perched the citadel of Larissa. We were standing on the top of the massive battlements which overhang the fosse, enjoying such a variety of bird-life as one can seldom watch in such a narrow space. The battlement on which we lay was perhaps 60 feet above the gorge, and our presence was quite ignored by the busy throng below us."

Then follows a long list of birds, such as Lesser Kestrels, Bee

Eaters, Rock Swallows, Wall Creepers, Rollers, &c., even to the Jackdaw, most amusingly described, but with which I will not take up your time, but proceed. "On a sudden, with a whiz and a sound of wings almost deafening for a moment, a dark cloud dashed from the river's channel through the opening, and immediately deployed in the plain to the west. At first, as they approached, they might have been taken for the common Starling; but when we looked down on the rosy backs flashing beneath us, it was plain enough that we had come on a migration of the Pastor. Hardly had this flight passed when, turning our eyes up the river, we saw another cloud gliding, like a balloon, just over the ravine of the Orontes towards us. About a quarter of a mile above us was a small islet in the centre of the stream, of perhaps a quarter of an acre in extent. It was covered with rich long grass. The balloon hovered over it for a moment, then rapidly expanded into the shape of an inverted parachute, then flattened out, then became a spiral column, then, like a waterspout, dropped on the islet, which, in less time than it takes to write it, was suddenly transformed from a green oasis to a black patch. Not a trace of green could be seen; the whole mass was simply a mass of birds, so closely packed that the rose-colour was invisible—the black of heads and wings had absorbed all else. After remaining here for a few minutes, as if to take breath, the mass suddenly rose and dashed in a long line through the fosse. They took about a minute to pass. We waited for some time, as flight after flight, in rapid succession, passed down the river's channel, often in strange forms—wreaths, balloons, columns,—deploying into long lines, never leaving the river's course, but generally high in the air above it. But all of them, as they approached this cutting, dropped from their aerial height, and, leaving the tortuous stream, struck right through the cleft far below us. The plain westward is uninterrupted, and here they at once spread themselves out, and, after skimming very near the ground, at length alighted, probably in quest of locusts. From Kelat Seijar we pursued for two days a north-easterly course over the Syrian plain, and through the whole journey flock after flock of Pastors passed us, all pursuing a due west route. At one place we came suddenly, after mounting a gentle ascent, on the crater of an extinct volcano, full of water, and surrounded with basalt boulders. As we came up, one of these flights, which had alighted to drink, rose in alarm and darkened the air overhead. At another place a solitary tree over a well was so covered with them that the colour of the tree changed from black to green as we approached. Once we came on a patch of some acres, which had recently been visited by locusts. The old locusts were gone, but the young, not more than a quarter of an inch long, made the ground literally alive; they rose at every step of our horses, like sand-lice on the sea-shore from a piece of sea-weed left by the tide. Just after we passed through this devastating flight, I turned my head and saw a great globe in the air. It suddenly turned, expanded, and, like a vast fan, descended to the ground. We waited a few minutes, and saw acres covered with a moving black mass dappled with pink. In a short time the mass became restless, and we rode back. The birds rose quickly, but not till we were close on them, and only those within dangerous distance. But not a young locust could we see. The Pastor had well earned its name of the 'Locust Bird,' and one batch of foes to man and his labour had been promptly and for ever exterminated. After these three days I never again saw a Pastor. The natives all declared their visits to be most uncertain and occasional. They assured me they had not seen one for three years, though they always look and hope for them in locust years, which these last had been. They always come from the east and go to the west. They never saw them return, nor did they ever hear of their breeding there. Throughout Syria the bird is everywhere familiar by name, but nowhere is it known to sojourn; nor was I able to ascertain whether its migration is always at the same season. When and where do they breed? Among the hundreds of thousands which crossed our path I did not detect one in young plumage; and therefore they could not have yet bred, although it was near the end of May—unless, indeed, they had left their broods in India, and taken their summer holiday free from family cares."

This I do not think likely, but in all probability these birds, which Canon Tristram fell in with, were on their way to their breeding-grounds, wherever that may have been, guided by an unfailing instinct as they moved westwards to some spot suitable to their nesting habits, and where a bountiful supply of food, both for themselves and their young, would be likely to be obtained. Being late breeders, they seldom arrive at their breeding-grounds before the very end of May, and, not beginning to breed until the middle of June, they had in all likelihood hit off the very time (when the Canon saw them in their rapid flight) that it would be requisite for them to get there. In furtherance of this belief I will now quote some extracts of an account to be found in the *Zoologist* for 1857, p. 5668, translated from an article in *Naumannia* by the Marquis Oratio Antinori, of their migration and nesting in the neighbourhood of Smyrna:—"On the 26th of May, about sunrise, great numbers of these birds were to be seen sitting so closely packed on the trees as to make them look as if they were all covered with red flowers. From the 29th of May to the 5th of June the flights were most numerous. After that time they ceased, and the birds became stationary. The fields and gardens were full of them, and even in the villages they sat on the roofs of the houses. These facts convinced me that the birds were nesting in the hills surrounding the Gulf; but, in spite of our efforts, owing to the dense ignorance of the inhabitants and the inconquerable idleness of the peasantry, we could obtain but very few eggs. The man who brought us some told us they had been collected upon a hill seven miles off, in the interior, and that the Turks, who caught him in the act, had beaten and driven him away.

"The possession of these eggs determined me to undertake at once a search for them, and on the morning of the 30th of June I set out for the village of Bournatut, where I was assured the gardens and surrounding hills were full of Rose-Starlings. I was well rewarded, for, not only on the road to, but even in the streets of the village, upon the moss-grown walls, and on the trees of the courts and gardens, I had ample opportunities for making close observations on these peculiar birds.

"I must here mention that the rather high and rugged hills which hem in the Gulf of Smyrna and the Valley and Gulf of Bournatut, particularly towards the north, and form the foot of the higher hills, consist of surface beds of limestone, covered with large erratic blocks of granite of different shapes and sizes. These massive stones, heaped one above another, leave no place for vegetation of any sort except the *Asphodelus ramosus*. Our way led northwards towards these pathless mountains; and, after a wearisome ascent up the empty bed of a torrent, on whose banks the beautiful *Nerium oleander* and the charming *Agnus castus* grew luxuriantly, we arrived at the foot of the higher range above mentioned. We had hardly begun to mount the hill before we noticed that there was not a stone or block which was not covered with the white excrement of these birds, they resorted there in such multitudes; but how great was our astonishment when we saw, at a distance of about 200 metres above us, the rocks covered with white as if lime had been spread for 200 square yards. On arriving there we found a real camp and a battlefield in one. The nests were in thousands, some quite open and uncovered, others so concealed amongst the blocks of stone that it was necessary to turn these over to find them. Some were more than a foot below the surface, and others could not be reached with the arm. They were often so close as to touch one another, and were made with little care, the birds contenting themselves with a slight hollow in the ground, in which were placed some dead stalks of *Agnus castus*, and, in a few instances, a lining of grass. In many cases the eggs were lying on the bare earth. This mode of nesting exposed them to many enemies—jackals, martens, wild cats, &c.—by which numbers of nestlings were destroyed and the ground strewed with their remains. Hence the appearance of a battlefield. And who can tell the number of eggs destroyed by snakes? It is wonderful how the Rose-Starling can propagate at all with so many enemies to encounter."

Mr. Seebohm, in his work on "British Birds and their Eggs," mentions another great visitation of Rose Pastors at Smyrna in 1871 just sixteen years afterwards, where, in the hills of the neighbour hood, they swarmed in thousands, as he was told, building their nests in clefts of the rocks and the stony ground on the steep hillsides, and devouring grubs and locusts to the admiration of the peasantry. As soon as breeding is accomplished, about the 15th of July, they immediately take their departure, winging their way back in all probability straight to India, to the spot they had left the preceding spring. There is evidence of their arrival there from August to November, at which latter season, Dr. Jerdon says, they associate in vast flocks, doing much damage, and committing great devastation in the cholam or jowaree fields *(Andropogon sorghum)*. They consume much of the grain, in spite of the efforts of the natives, by whom they are assailed with slings, cracking of whips, shouts, and cries, in the endeavour to drive the depredators off. But, notwithstanding the amount of fruit and grain that must be consumed by these vast hordes in the several countries they visit, they are, as a rule, protected by the natives. The good done in the wholesale slaughtering of their common enemy, the locust (which the Pastor not only devours for food, but, if he has the chance, will, even when appetite is appeased, kill for the mere pleasure of killing), far more than compensates the loss which they sustain.

In life the Rose-coloured Starling is very different from the one before you, as after death, and in mounted specimens especially, where long exposed to the light, they lose that brilliancy of colour they exhibit when alive. The male bird is particularly conspicuous, with the rose tint richly suffused over the whole of the upper and under parts, as well as the bill, while the head, adorned with its silky crest, as well as the neck, breast, wings, and tail, is deeply contrasted with intense glossy black, shaded with purple and green reflections. Though these birds are so gay, yet when a flock suddenly drops into a long chain of oleanders, when on their summer visits to Palestine, or into some thicket of the rose robinia when sojourning in India, they suddenly become invisible and lost to view as they settle among these shrubs, the rose backs and breasts amalgamating so perfectly with the pink and rose colour of the flowers.

Many more very interesting notes regarding these birds might be given, but as enough has been said in illustration of their migration, food, and nesting, I will only mention, before closing, one curious occurrence mentioned by Mr. Wilson (*vide* "Dresser's European Birds"), of a solitary pair having actually bred in this country, in June, 1867, in a burrow in a sandbank at Methlic, in Aberdeenshire. How this pair, all by themselves, got separated from their congeners (in all ways strictly gregarious, and probably, at the nearest, breeding in the Dobrudscha, some thousands of miles off), and got to this very out-of-the-way spot, is one of those curious points in migration the explanation of which we have yet to find out and determine. Most unfortunately the nest was destroyed by some mischievous boys. On being driven away, the birds, without leaving the district, removed to another sandhole a mile or so off; but Mr. Wilson does not think they succeeded in rearing a brood. This, perhaps, is the only case (at least I never heard of another) in which the Rose Pastor ever bred, or attempted to do so, in any part of Western Europe.

3. THE RUDDY SHELDRAKE.—The bird I wish next to bring before your notice is one that has never before been recorded from the Tay District; indeed, there are only two notices of its ever having been got before in Scotland—once in Sanday, in Orkney, in

1831, and once in Caithness. This rare bird, which was procured through Mr. James Henderson, of Dundee, is a male bird in full plumage, being distinguished by the black collar round the neck, which the female has not got. Hence it has been called the Collared Duck, and sometimes the Ruddy Goose, from its goose-like appearance and the ferruginous colour of its plumage. As a well authenticated Tay-shot specimen, the Society may be proud in having it in their possession. I say well authenticated, as, having had a good deal of correspondence on the subject, and made full inquiries, I am perfectly satisfied as to the truth of its appearance on the sands of Barry, at the mouth of the Tay, not only in this instance, but in that of another, if not a third. Mr. M'Andrew, jun., plumber, Carnoustie, in whose possession the bird was, writing to me in reply to a letter on the subject, informs me that he shot it, in company with a friend, near Barry Burn, at the mouth of the Tay, in the beginning of April, 1881, and that the bird had been observed in the locality for about a week. The name of the bird was entirely unknown to him, and he sent it immediately it was shot to Mr. Marshall, birdstuffer at Arbroath, who set it up for him. Mr. M'Andrew further informs me that another bird of the same species was caught by a rabbit-trapper in a burrow on Barry Links nine years previously—that is, in the year 1872. This looks as if the bird had been breeding there. On making inquiries at Arbroath, and writing to Mr. Nicol Simpson, with whom I had much previous correspondence with regard to the birds of Arbroath and its vicinity, he most kindly went and saw Mr. Marshall, and questioned him most narrowly on the subject. Mr. Marshall stated that he had received a duck of the species described from Carnoustie three or four years before, in the flesh, which he had set up. He further stated that two or three birds of the same species had at different times passed through his hands, but he could give no dates or particulars, as he had not kept any notes.

The Ruddy Sheldrake is common in some parts of Eastern Europe, and when travelling in Bulgaria, on the Lower Danube, some years ago, I frequently fell in with it. Messrs. Elwes and Buckley fonnd it very common in the adjoining district of the Dobrudscha, nesting in holes, sometimes in the middle of cornfields; and Mr. W. H. Simpson, in his "Fortnight on the Dobrudscha" (*Ibis*, 1861, p. 365), says, "The earth-cliffs about Kustendjé (the eastern terminus of the Danube and Black Sea Railway) are much resorted to by birds for breeding, from the facility with which they are perforated. The Ruddy Sheldrake breeds in these places, and also in the holes of Trajan's Wall, and in other holes up the country. Though the bird is plentiful, it is by no means easy to obtain the eggs. I and my friend spent the greater part of the day in driving a tunnel into a bank where one had been seen to come out; but our labour was in vain, for, after advancing several yards, working one at a time, prostrate, in the dark, the original hole was found to fork off into two branches. The natives sometimes obtain a sitting, and the young ones are brought up for domestic purposes."

According to Mr. Moschler, as mentioned by Dresser in his "Birds of Europe," "In Southern Russia it breeds entirely in holes of trees, the male perching on a branch of the same tree, giving warning in case of danger, and, when so warned, the female immediately leaves her eggs." In the Eastern Atlas, in North Africa, my friend, Mr. Osbert Salvin, who found the bird pretty numerous on all the salt lakes of the elevated plains, says that it invariably selects for breeding a hole or crevice in a cliff, associating with the Raven, Black Kite, and Egyptian Vulture during the period of the reproduction of its young. He also mentions having discovered, after careful investigation, a nest in a hole in the face of a rock, to reach which required all the skill of his Arab attendant, with appliances of ropes, &c. Out of this nest he obtained four hard-set eggs, and suggests the interesting question as to how and when the young, when hatched, are conveyed from their aerial home to their natural element, upon which question he regrets his inability to throw any satisfactory light.

This fact of breeding in holes in rocks is very much in unison with the habits of our Common Sheldrake, to which, though differing in some respects, it has, in many others, a great similarity. The Common Sheldrake, with us, not only breeds in considerable numbers in old rabbit-burrows at the mouth of the Tay, but also comes a long way inland, annually visiting the braes of the Carse, and nesting, like the Ruddy Sheldrake, in holes and clefts of the rocks. Nests have been found, not only on the braes of Fingask, but on the high rocks and cliffs at Glencarse, where the birds have several times been trapped in taking rabbits, leading or conveying their broods to the river—a distance, in the former case, of about four miles as the crow flies, and about half that distance in the latter. It is supposed that the Common Wild-Duck, which has been frequently known to nest in trees, and sometimes in old crows' nests, carries its young to the water in its bill. I do not know that there is any proof of their having been seen in the act of doing so, but my belief is that, in the case of the Duck, they would naturally descend with the young on their back. This they could safely do, the young being ensconced under the scapulæ, three or four at a time.

A curious circumstance, which I may here mention, occurred two or three years ago at Newton House, in the village of Rosie-Hill, Glencarse. Early one morning a pair of Sheldrakes were seen leading their young, consisting of a number of ducklings, along an adjoining field, and passing through the farm-yard by an open gateway into the garden adjoining the house, where they deposited them. On the appearance of one of the men the old birds flew away, and the young ones were safely captured. The nest was on the neighbouring hill, some quarter of a mile off, from which the old birds must have carried their young down to the foot, most probably on their backs. They must then have led them away through the fields in the direction of the river, but, having mistaken their line, got into the difficulty above described. From this, may we not suppose that in the same way the young Ruddy Sheldrakes may be carried from their aerial homes on the cliffs of Atlas down to their base, and then be led to some wild spot on the plain, where they would probably rest in greater security than our Sheldrakes did in a civilised garden in Scotland?

Though, as above mentioned, the Ruddy Sheldrake has in many respects an affinity to our Common Sheldrake, it may be said to have a greater resemblance to the Goose than to the true Duck. It walks like a Goose, it trumpets and calls like a Goose, it eats like a Goose, grazing in fields and on tender shoots, and it has the same watchfulness as a Goose—shy, not easy of approach, and keeping in open places where it can instantly detect the presence of an intruder.

In every part of Great Britain the Ruddy Sheldrake is one of the rarest of birds, instances of its occurrence being few and far between, and these, it is generally thought, having been merely escapes from domestication. But I do not see why the Ruddy Sheldrake (which, as has been shown, is not an uncommon bird on the Danube and the shores of North-Eastern Africa) should not occasionally find its way to the banks of the Tay quite as easily as the Little Bustard to

St. Andrews, the Little Bittern to Aberdeen, the Little Egret to Loch Katrine, or a score of others, equally as rare, which from time to time appear in one county or another, both in England and Scotland, and which are never included in the category of escapes. On reaching our shores, that wide stretch of sandy flat ground on either side of the Tay, on Barry and Tents Muir, with marshy spots intermixed, is a most natural place for it to occupy. I do not therefore see that there is any reason to doubt that the specimen before us was really a wild bird in a state of nature, and not a mere escape.

4. The Great-Crested Grebe.—A young male bird of this species was shot in December last by a professional puntsman opposite Errol. Though a well-known bird in this country, it is now far from common. Here with us it may only be considered a winter visitant, and is generally found in our Scottish waters at that season in immature plumage, though many years ago I recollect seeing a very fine pair which had recently been obtained in full summer plumage, and stuffed by the late Mr. Crerar at Dunkeld. These were believed to have been shot on Loch Ordie; but there is no notice of their having been seen in the district again (that I am aware of) in the breeding dress. Again, in England, where they are resident, they used to breed in considerable numbers on the Broads of Norfolk and other similar places; but from drainage, and other causes not far to seek, they have nearly disappeared.

When in full breeding dress nothing can be more handsome than these birds, with their ample crests and hoods. The hues are beautifully contrasted, with black and deep reddish-chestnut, shading into rich brown, with which both male and female are adorned. Their shining breasts, also, are, if anything, more brilliant at the breeding season than at other times. Though never entirely losing its satiny gloss, it is, when in its more sober winter dress, a very different looking bird to what it is in summer.

Among the other causes (alluded to above) of its decrease has been the incessant persecution with which it has been assailed for the value of its skin for decorative purposes, especially for the trimming of ladies' dresses and the making-up of boas and muffs—a fashion which, I am happy to say, has of late years much diminished. When we consider the number of birds' lives that must be sacrificed even for a single muff or boa, and the extent to which this deplorable fashion was carried only a few years ago, we may gather some idea of the thousands upon thousands of these beautiful birds that were, in every part of the world, ruthlessly destroyed to be sacrificed to the idols of fashion.

I can only trust that the inordinate desire of adorning ladies' dresses with the most beautiful of plumaged birds will be in a short time a thing of the past, and that we shall not hear again of such things as an order from a London plumassier for 10,000 Kittywake Gulls, to be actually destroyed off their nests, and the young left to starve, and all for the adorning of ladies' hats. This is no fiction, but an undoubted fact, which occurred not further back than 1868. Then, again, only very lately, we heard of a lady in Paris appearing in a ball dress trimmed with Robins' wings. I am rejoiced to hear, through a well-known London paper, that Her Gracious Majesty discountenances the wearing of any bird decorations in the dresses of her ladies at Court. We must trust that her lady subjects will follow her noble example, and especially that those who take up Natural History, as is now so universally done by ladies, will do everything in their power to suppress this persecution of birds for articles of dress, recollecting that where there is no demand there will be no supply.

II.—Mnium riparium, *Mitt.*, *in Scotland.* By R. H. Meldrum.

(Read 11th November, 1886).

The subject of this brief notice is a moss which I detected last February growing on a steep bank of earth by the side of the stream in the Milton Den, Aberdalgie. From the general appearance of the plant I conjectured it to be a species of *Mnium*. I took a specimen for home examination under the microscope, not supposing that it was anything rare, but only knowing that I had not met with it previously during the period I had been studying mosses.

The means at my disposal for the determination of specimens were Dr. Buchanan White's Moss Herbarium, which he recently presented to the Museum, where I had ready access to it; the first nine parts of Dr. Braithwaite's "Moss Flora," which, however, do not contain the genus Mnium; Wilson's "Bryologia Britannica," with descriptions and plates, now getting rather out of date; and Hobkirk's "Synopsis of British Mosses," with short descriptions, but no plates. This last book contains descriptions of two species of *Mnium* recorded since Wilson's "Bryologia" was published, viz., *M. riparium* and *M. spinosum*, the latter only being represented in Dr. White's Herbarium.

On arriving home with my specimen, I set to work to make out the species, and after a careful examination of it, and comparing it with the descriptions and plates in the books mentioned, and with all the species of *Mnium* in the Museum, I came to the conclusion that it must be *Mnium riparium*, for which Hobkirk gives the single locality of Sussex, gathered there and described and named by Mitten.

However, I could not be absolutely certain that it was this species, as I had no figure nor specimen of *M. riparium* with which to compare it, only the brief diagnosis given in the Synopsis, so, to make sure, I sent it to Dr. Braithwaite under the name of *M. riparium* desiring him to verify it. From him I received the following reply:—"I think your specimen of *M. riparium* is quite correct, although I have not much experience of the plant, and only a mere scrap. According to Mitten, Wilson's *Mn. orthorhynchum* is his *riparium*, and the true *Mn. orthorhynchum* is therefore the rarer, and seems confined to limestone districts. I enclose bits of each, which you can compare under the microscope, and you will find the areolation of the two is widely different."

This reply puzzled me somewhat, as I had made myself sure that, whatever it was, my specimen was not *Mn. orthorhynchum*, both from Wilson's description and from examining the specimens in the Museum labelled as that species. Besides, Hobkirk retained both species, whilst giving almost verbatim Wilson's description of *Mn. orthorhynchum*, and quoting the same localities. The only explanation I could think of was that Wilson's description was that of the true *orthorhynchum*, but that the plants from the localities cited by him were *Mn. riparium*.

To get some light on the subject, I made another examination of my specimens from the Milton, the specimens of *Mn. orthorhynchum* in the Museum, and those sent by Dr. Braithwaite.

Dr. Braithwaite in his letter directs my attention to the different areolation of the two species—that is, to the different character of the cells of the leaf. From a comparison of the descriptions in the books, the only decided difference I could fix on was in the shape of the leaves. These, in *M. orthorhynchum*, are described, "upper, ovate-lanceolate; lower, ovate-acuminate." In *Mn. riparium*, "orbicular or broadly elliptical, apex rounded and tipped with a mucro." In the latter the cells are said to be large, hexagonal, and chlorophyllose, while no mention is made of the cells in describing the former.

Now, if these descriptions are correct, my plant was certainly *Mn. riparium*, and, as certainly, not *Mn. orthorhynchum*, as described by Wilson.

Then, in Dr. White's Herbarium are specimens labelled *Mn. orthorhynchum* from Yorkshire, gathered by Hunt, and from the Swiss Alps, gathered, or at least distributed, by Professor Schimper. These agree with each other, and with the description given, being quite different from *M. riparium* in the shape of the leaves, and in having the cells smaller. They are evidently the true *Mn. orthorhynchum*, and not *Mn. riparium.*

These specimens differ distinctly from mine in other particulars, which, however, may not be constant. Thus they have a much more robust stem. Then mine, when moist, presents very much the appearance of a miniature frond of the green spleenwort, the leaves apparently springing mainly from the opposite sides of the stem, while in the others they are disposed on all sides, and are more erect.

Dr. Braithwaite sent me three specimens. One, labelled "*Mn. riparium*," from Sussex, gathered by Mitten, the type from which he described the species, agrees perfectly with my plant. Another is a specimen labelled "*M. orthorhynchum* of Wilson, *Mn. riparium* of Mitten," from one of the localities given in Wilson's "Bryologia Britannica." This has the robust stem, and the general appearance of what I take to be the true *Mn. orthorhynchum*, but has the large areolation of *Mn. riparium.* The third specimen is labelled "*M. orthorhynchum verum*," the true *orthorhynchum*, from Yorkshire, gathered by Nowell.

I do not know what to say about this, for, after repeatedly examining it, I fail to detect any difference in the areolation between it and the others, although Dr. Braithwaite speaks of it as being "widely different." I think he must have inadvertently enclosed the wrong plant, as there is no difficulty in noticing the difference in the size of the cells in the Museum specimens when compared with mine.

I am inclined to call all three specimens sent by him *Mn. riparium*. At any rate, the moss from the Milton Den is undoubtedly that species, and has not hitherto, I believe, been recorded from Scotland.

In the same Den, and near the same place, I found another *Mnium*, *Mnium stellare*, which I have not seen recorded for Perthshire. I have made enquiry as to its occurrence, but as yet have received no reply.

In conclusion, I would call attention to the necessity there is of some competent Bryologist publishing in the "Scottish Naturalist," or elsewhere, a list of our Scottish mosses, as far as known. If there are good reasons for issuing similar lists of the flowering plants and fungi, surely the same reasons hold good in the case of mosses.

III.—*Some Localities for Perthshire Plants.* By R. H. Meldrum.

(Read 3rd February, 1887).

During the past season the botanical members of this Society have been successful in making several interesting additions to the Flora of our county. Besides adding new species, additional localities for some of our rarer plants have been obtained, and in this paper I intend to enumerate these as far as I can. The list will show that a large number of these additions are from our own immediate neighbourhood, which, with perhaps the exception of Ben Lawers, I should think was the best examined part of the county. From this we may conclude that a great deal remains to be done before a fairly complete knowledge can be obtained of the distribution of plants in our very extensive district. It will be a long time indeed before anything like a complete acquaintance with our county Flora can be obtained if the work is to be left almost entirely in the hands of three or four botanists working from Perth as a centre. To properly examine any district the same ground must be gone over several times a year at different seasons, and not one year only, but year after year, as some plants may suddenly appear in, or as suddenly disappear from, the locality. For such repeated observation there must be a botanist (or a dozen of them) resident in each district, and I trust that the time approaches when such will be the case. It is a very interesting and profitable study to enquire into the reasons for the occurrence of particular plants in certain districts, and their absence from others apparently equally well suited for their growth. Many problems arise in connection with the distribution of species, and these can only be satisfactorily solved when something like complete information has been collected concerning the localities of the rarer plants.

During an excursion the occurrence of a rare plant is much more readily noticed and recorded than the absence of a species generally common; but the non-occurrence of a widely-spread species in any locality is as worthy of notice, and as important, as the presence of a rarity, or perhaps more so. The sudden appearance or disappearance of certain species, already alluded to, is a point worthy of the attention of any one specially examining a small district and residing therein. He can note such events as soon as they occur, and will be in a position to investigate their cause with some prospect of success.

The following is the list of plants to which I wish specially to refer :—

Ranunculus sceleratus, L. (the Celery-leaved Crowfoot or Buttercup).—This buttercup, when once seen, is easily recognized again by its small flowers, and by the compact bullet-shaped head of achenes when in fruit. It is one of the most acrid of the genus, and tramps have been said to use the leaves to produce sores for the purpose of exciting compassion. It is a rare plant in Perthshire, but occurs by the side of the Tay in the lower part of its course. It was pointed out in this locality on the occasion of the Society's excursion to the banks of the Tay and Earn last June, and the same evening I found a good number of plants of it round the margin of a stagnant pool in an old quarry at Woodlands, near Cherrybank. Certain considerations point to the probability of the past summer being the first occasion of its appearance there, where it seems to have been introduced by the agency of waterfowl.

Trifolium striatum, L.—This species of clover is rather local with us. It was seen on a knoll above Elcho during the excursion already mentioned, and I subsequently found it on a similar knoll on Callerfountain.

Astragalus hypoglottis, L.—This is another member of the order *Leguminosæ*, and of restricted distribution. I found it on the same hill. A patch of this in full flower is exceedingly pretty. In the leaves it is very similar to *Ornithopus perpusillus*, but has a very different flower.

Vicia tetrasperma, Mœnch.—This vetch is recorded in Sir W. J. Hooker's "Flora" from Ruthven, near Perth, but has not been found there recently, and is not included in the preliminary list of Perthshire plants published by Dr. Buchanan White in the "Scottish Naturalist" some years ago. However, I found it last July growing by the side of a road at Moncreiffe, so that it can again be claimed as a member of our Flora. It may easily be passed over for the very common *Vicia hirsuta*, if attention be not paid to the pods, which are four-seeded, while those of the latter are two-seeded. Hence the specific name *tetrasperma*, four-seeded.

Saxifraga tridactylites, L.—This saxifrage is very rare in the county, having, if I mistake not, been previously found in only one locality. A new station for it was got last season under rather curious circumstances. Members of the Society had assembled at the General Station for the excursion to the Lake of Monteith, but unfavourable weather prevented their departure. A small party, under the charge of Dr. Buchanan White, having adjourned to the Museum to have a look at the Herbarium, one of the party expressed a desire to see this particular saxifrage, and its rarity in Perthshire was commented on. The weather improving, a visit was made to the Perth Nurseries, and there was this plant in plenty on one of the walls, and on the dyke by the side of the Dundee Road—about the last place one would have thought of looking for it.

Drosera anglica, Huds.—The members of the genus *Drosera* are remarkable for their carnivorous propensities. Their leaves are studded with hairs, which exude a sticky fluid, and when a small insect alights thereon it is retained and digested. One species, *D. rotundifolia*, the round-leaved sundew, is very common in boggy places, but the long-leaved one, *D. anglica*, is less frequently met with. It was obtained on Cardross Moss during the excursion to the Lake of Monteith, and Mr. Barclay and I met with it again at the foot of Ben Laoigh, whence, however, it had been already recorded.

Callitriche autumnalis, L.—This is a member of an aquatic genus which comprises some puzzling species. *C. autumnalis*, however, is a pretty distinct one, and rare and local in its distribution. It was found during the past summer in the White Moss, near Dunning, and abundantly in the old course of the Earn at Kirkton.

Œnanthe fistulosa, L.—During the excursion already noticed to the banks of the Tay and Earn this plant was detected opposite Inchyra by Dr. White, who suspected it to be that species, though some doubts were entertained of its being other than a young state of *Œnanthe crocata*, which was abundant near the same place. A careful comparison with dried specimens, and with the descriptions in the manuals, resulted in the confirmation of Dr. White's name, though the plant did not agree with these descriptions in every particular. Mr. Barclay and I found large beds of it at a subsequent period farther down the river, near the Fifeshire boundary. This forms a very interesting addition to our Perthshire list of plants. In Hooker's "Student's Flora" its northern limit on the east coast is given at Berwick.

Eupatorium cannabinum, L.—This composite has only been found in a few places in the county, and a fine plant of it was seen last August on the banks of the Tay, between Errol and Glencarse.

Bidens tripartita, L.—Another local plant belonging to the same order. I found it in a backwater of the Earn, below Dupplin.

Andromeda polifolia, L.—This member of the heath family was recorded only from Blairdrummond Moss in Perthshire previous to our excursion to the Lake of Monteith, where, on Cardross Moss, a second station was obtained for it. Both these stations belong to the Forth district.

Lamium intermedium, Fr.—This is intermediate between *Lamium purpureum* and *L. amplexicaule*, some of its characters agreeing with the one and others with the other, while it is larger and more succulent than either, and has different calyx-teeth. It was obtained in a cultivated field near Errol during an excursion thither made by Dr. White, Mr. Barclay, and myself, and, I think, has not hitherto been recorded from Perthshire.

Lycopus europæus, L. (Gipsywort, so called from the gipsies being credited with using it to heighten their natural swarthiness of complexion).—This is a very rare plant with us, being, if I remember aright, previously known from only a single locality. It was got on the same day as the last-mentioned plant by the side of the Tay, near Errol.

Mentha sylvestris, L.—This mint is far from common in this county. It, or one of its varieties, was obtained at the old course of the Earn at Kirkton. At the same place another mint, *Mentha sativa*, L., was found at the same time. Whether this was the type of the species or one of its varieties I do not know, as I fancy it is the case with the mints as with the brambles and aquatic butter-cups, that no two authorities would give the same name to the same plant.

This same locality (the "Deadwater," as it is locally called) produced another interesting plant, one of the Duckweeds, those small green plants that float on the surface of stagnant pools, with thread-like roots dangling in the water, but fixed to no support. They rarely flower, but are propagated rapidly by budding. One species, *Lemna minor*, L., is very common everywhere. In it the young fronds are at first sessile on the old ones, and soon become detached. In the much rarer *Lemna trisulca*, L., the young fronds are placed crosswise to the old, and it is a much prettier species than the former. It used to occur on a pond at Moncreiffe, but a search made for it there last year failed to find it. However, it turned up in some quantity on this Deadwater, and so still claims a place in our Flora.

Polygonum Bistorta, L.—This plant, in most of its localities, has little claim to be considered native, but at the Lake of Monteith it was found under circumstances such that Dr. White thought it might fairly be considered indigenous.

Sparganium simplex, Huds. (the unbranched bur-reed), is much less common than *Sp. ramosum*, Huds., the branched one. It was got in company with the latter at the Deadwater.

Kobresia caricina, Willd.—This is a very rare British plant, and has only been obtained from three or four counties. It occurs on several of the hills in Breadalbane, and Dr. White detected it there in a new locality on the occasion of the memorable excursion to Killin last July, so graphically described by him in his opening address this session. This new station is on Craig Chailliach, on another part of which, however, it had previously been found.

During the past season a good deal of attention was paid to the *Carices* or sedges, with very successful results, and there is room for believing that a continuance of this attention will result in increasing our knowledge of the various forms which occur within our bounds, and possibly species as yet unrecorded for Britain may turn up upon our higher or less accessible mountains.

At Cardross Moss a very rare Perthshire sedge was found, viz., *Carex paniculata*, L. This is only known from another locality in the county, one of the lochs in the neighbourhood of Blairgowrie. It is remarkable for the curious way in which the root-stocks are matted together, forming large tussocks, often of considerable height and diameter.

Carex muricata, L., another local sedge, I found growing abundantly in a meadow beside Moncreiffe House.

Carex acuta, Lin.—This is an addition to our county Flora, and was obtained on the banks of the Tay, near Elcho, during the Society's excursion thither. Like *Œnanthe fistulosa*, its northern limit is given by Hooker at Berwick, on the east coast, so that this locality extends its distribution very considerably. The same excursion produced another very local sedge, viz.,

Carex aquatilis, Wahl., a large bed of which was found by the side of the Earn.

Carex limosa, L., a rare plant in Britain as well as in Perthshire, was obtained in two new localities—first on Cardross Moss, and again in a marsh on Craig Chailliach.

Carex rariflora, Sm., a rare alpine sedge, was obtained for the first time within the Perthshire boundary, as reported by Dr. White in the "Scottish Naturalist" of last October.

I may also mention *Carex rupestris*, All., which was got at the head of Glen Lochay, as already recorded by Dr. White at the opening of the session. It has been reported from Ben Lawers, but has not been found there of recent years.

Among the ferns the only one calling for notice is the Adders-tongue, *Ophioglossum vulgatum*, L. It was reported to Dr. White some years ago as occurring at Dupplin, and, guided by the description of the locality, I was enabled to verify its occurrence there. It is apparently very scarce there, as I could find only one plant of it. It is rare in the county, but it is very easily overlooked, and may possibly be found in other suitable localities if carefully looked for.

In conclusion, I will mention the occurrence of one or two alien species which have escaped from gardens or been introduced with seeds.

Aremonia agrimonioides, D. C., one of the *Rosaceæ*, is well established by the side of the Glasgow Road and in the Old Quarry at Woodlands. It also occurs by the side of the Dundee Road in several places, and is making itself at home in many other parts of the country. A description of it ought now to be included in the Floras, seeing that many other species are there described which have just as little or less claim to find a place in them.

Crucianella stylosa, D.C., a pretty plant, with pink flowers and very long styles, occurs also at Woodlands. It belongs to the *Rubiaceæ*, and has apparently been found elsewhere as an escape, as it is named in the list of excluded species at the end of Hooker's "Flora."

Dielytra formosa, L., one of the *Fumariaceæ*, occurs as an escape in the Milton Den, Aberdalgie, and is well established there. This is a common garden plant, but I have not seen it noticed elsewhere as an escape.

Cannabis sativa, L.—This is the plant from which hemp is obtained, and occurred last year in a market garden at Cherrybank, introduced apparently with foreign seeds. It grows to a considerable height (one plant measured about 7 feet), and has small greenish flowers. The odour of the plant is rather unpleasant.

The banks of the Tay, below Perth, a locality especially rich in escapes, produced *Lysimachia punctata*, L., and *Rudbeckia laciniata*, L., as well as *Carum Carui*, the fruit of which is the well-known Caraway seeds, and *Allium Scorodoprasum*, L., a species of garlic.

The visit to the Perth Nurseries, already mentioned, produced another interesting plant, *Draba muralis*, L., not previously noticed in the county. It is an introduced plant in Scotland, but it is indigenous on limestone rocks and walls in the West of England. Only one plant of it was seen.

IV.—*Origin of the Interbedded and Intrusive Volcanic Rocks of Kinnoull Hill.* By H. Coates, F.R.P.S.

(Read 7th April, 1887).

Apart from distinctions of mineralogical composition and other lithological characters, all volcanic rocks, considered with regard to their origin, fall into two great divisions—first, those which have come to the surface of the earth's crust in a molten state, and have consolidated either exposed to the air or under water; and, second, those which have not come to the surface of the earth in a molten condition, but have forced their way into fissures and other channels, and there consolidated beneath the earth's surface. The distinction is perhaps one of degree more than of kind, as the ultimate source whence the molten material was derived was probably the same in both cases; but yet it is a very important distinction in helping the geologist to build up the history of the earth's crust.

It is obvious that volcanic rocks formed in the first way will be found resting on beds which were formed immediately prior to their being poured out, and that lying on the top of them will be found beds which were formed immediately after. They are therefore called "contemporaneous" or "interbedded" volcanic rocks. With regard to rocks formed in the second way, it is equally evident that the rocks in which they occur must have been formed before the volcanic mass was forced into them, perhaps many ages before. They are therefore called "subsequent" or "intrusive" volcanic rocks. It has been proposed by at least one authority to call the former "volcanic," or superficial, and the latter "plutonic," or deep-seated; but it seems better, in the present state of our knowledge at least, to reserve the term "plutonic" for more obviously deep-seated rocks.

Although the mineralogical composition of the two classes of rocks may be precisely similar, thus pointing to a common source of molten material, yet the different modes in which they have consolidated give rise to important differences, both in minute structure and in their occurrence as rock masses. Thus interbedded volcanic rocks are always more or less open in texture, particularly in the upper part of the sheets, which generally present a slaggy appearance, precisely like that of the surface of a recent lava flow. This amygdaloidal structure, as it is called, is due to the expansion of the rock, while still plastic, by the contained steam. In the case of an intrusive rock the pressure of the superincumbent mass is too great to admit of such expansion. The steam holes, or amygdules, generally become filled up with various mineral deposits, such as calcite, calcedony, &c. This amygdaloidal structure is very well marked in the interbedded volcanic rocks of Kinnoull Hill, and, where the cavities have been filled with quartz, they give rise to the familiar Kinnoull Hill pebbles, or agates. The concentric lines, which add so much to the beauty of these, mark the successive layers of the deposit, and may therefore be called "lines of growth." Other structural peculiarities of interbedded lavas might be mentioned, but these may suffice for the meantime.

There are also certain structural peculiarities which mark intrusive rocks. They are always more finely grained in their outer than in their central portions, in consequence of the former having been the first to cool and crystallize. They are frequently more or less prismatic, extreme cases of which may be seen in the Giant's Causeway and the basaltic columns of Staffa. Both of these characters are well seen on examining the intrusive rocks of Kinnoull Hill.

One of the most important distinguishing features is that, while interbedded rocks always conform with the bedding of the rocks with which they are associated, intrusive rocks never do, at least in perfect degree. Then, again, while the rocks in contact with an intrusive mass are frequently baked and hardened, and otherwise altered, by the molten mass which has been forced against them, this is never the case with rocks containing interbedded sheets.

Let us now see how these two kinds of volcanic rock are represented in the structure of Kinnoull Hill. The great mass of the hill consists of beds of the interbedded or contemporaneous type, while, at the back of the hill, cutting through the other rocks, is an extensive vertical dyke of intrusive or subsequent igneous rock. We shall examine each of these separately.

The interbedded sheets consist of extensive beds of porphyrite, which dip towards the north-west. The well-known face, or cliff, of Kinnoull Hill represents the broken-off edge, or outcrop, of these beds, which at one time must have extended across the whole of what is now the lower valley of the Tay, but which, in the course of many ages, have been worn away by the denuding action of weather and water. The corresponding rocks on the opposite side of the valley, which form the main part of Moncreiffe Hill, belong to the same series, and as they also dip north-west, they must, of course, underlie the Kinnoull Hill lavas, and were therefore laid down immediately prior to them.

It will thus be apparent that Kinnoull Hill, though composed of true volcanic rocks, cannot, strictly speaking, be regarded as an extinct volcano. I will briefly sketch the history of its formation.

The hill, as it stands to-day, is the result of three successive processes, extending over a great interval of time. First, there was the laying down of the sheets of lava, poured out in a molten state from volcanic vents, whose activity gradually died out many ages ago. These sheets were poured out over a level tract of country, part of which, at least, was under water. The periods of activity varied in duration and in intensity. Sometimes sheet after sheet would be poured, one on the top of the other, without intermission; then a period of comparative quiescence would intervene, and sufficient time would elapse for tolerably thick deposits of sand and gravel to be laid quietly down on the bed of the lagoon or sea. Again the subterranean forces gathered head, and a vast shower of dust and stones was shot into the air by the bursting open again of the choked-up volcano or volcanoes. This loose material was scattered all around, and fell on the beds of sand and gravel, the dust forming the beds of tuff, and the coarser material the beds of breccias, that we now find underlying the Kinnoull Hill lavas. After the loose material had been blown out, streams of lava again poured forth, obliterating the face of the land for miles, and continuing their discharge till the beds had been piled up which now form the cliffs of Kinnoull Hill. The total duration of volcanic activity forms the first of the three stages in the history of Kinnoull Hill. The geological date of this first stage we can determine with certainty, for the sheets are interbedded with sandstones and conglomerates of undoubted Old Red Sandstone age.

The second stage in the history is represented by the gradual upheaval of the rocks from the horizontal position in which they were laid down to the gently sloping position in which, as already described, we now find them. When this change took place I do not think we have any means of determining.

The third and final stage is that of denudation, that is, the stage represented by the carving out of the valley which now separates Kinnoull Hill from Moncreiffe Hill. When this process of denudation began I am unable to say. It may have been, and I should think probably was, in progress long before the advent of the great Ice Age, or it may have had its commencement in the grinding of the glaciers, which have scored and polished the surface of the hill in many places. One thing we do know, however, and that is, that the process is going on still, and that nature's carving tools—frost, wind, rain, and stream—are as busily at work to-day as ever they were.

So much, then, for the history of Kinnoull Hill, which may be summarised in these three words—Deposition, Upheaval, and Denudation. But, it may be asked, if Kinnoull Hill is not an extinct volcano, whence did all this volcanic material come from, which was poured out over the surface of the land till it had accumulated to the enormous thickness of not less than fifteen hundred feet, and probably much more? This question we are not able to answer precisely. The supposition proposed by Dr. Geikie last year seems at least highly probable, namely, that the district was dotted over with a number of low volcanic hills, each of which contributed its quota of lava streams and ashes. This, it will be remembered, was the phase assumed by the volcanic activity which broke out in the now famous region of the Pink and White Terraces of New Zealand in June, 1886.

In considering this part of the subject we must bear in mind the immense antiquity, geologically speaking, of the Kinnoull Hill lavas, and the great changes which have taken place during the geological ages which have elapsed since their formation. In order to appreciate this, let us glance at the relative ages of the successive periods of volcanic activity in this country, of which record has been preserved in the rocks.

There appear to have been at least four great periods of activity. The first occurred in Silurian times, and attained its greatest development in Wales. The next was that of the Old Red Sandstone age, and is exemplified by the volcanic hills which extend over the greater part of central Scotland, embracing the Sidlaw and Ochil ranges, and with them, of course, Kinnoull and Moncreiffe Hills. The next great outburst occurred in Carboniferous times, when our coal fields were in course of formation. The volcanic rocks of this period, therefore, are found extending across the southern portion of Scotland, being particularly well seen in Fifeshire, in the district around Edinburgh, and in Ayrshire. After this, if we except some contemporaneous beds of Permian age, a very long interval of quiescence intervened. Of course, during this interval there may have been occasional outbursts, but, if so, the evidences of them have since been obliterated. The fourth and last period of activity brings us to comparatively recent times, namely, the Miocene period. The volcanic products of this period are represented by an immense number of trap-dykes, occurring at various points along the west coast of

Scotland, especially in the Inner Hebrides. It is probably to this final period that the dyke belongs which forms the most striking example presented by Kinnoull Hill of intrusive volcanic action.

I have referred to these different periods to show how very ancient, relatively, the Kinnoull Hill lavas are, and in order that we may be able to appreciate the changes which have taken place since their formation. We may take it for granted that the older a volcanic district is, the more of the superstructure of the volcanic products must have been removed, so that in a region of very ancient activity, such as our own, the rocks which are now exposed at the surface are not only more or less altered in character, but represent only the foundation, or substructure as it were, of former volcanic hills.

This will be rendered more apparent if we compare a more recent, but still very ancient volcano, of which the superstructure has not been so completely obliterated by the hand of time. Of such a most instructive example is afforded by the hill at Burntisland known as The Binn.

This hill was an active volcano during the third, or Carboniferous, period of volcanic activity alluded to above. It now consists, roughly speaking, of a central core of volcanic material, with sedimentary rocks sloping down from it on all sides. This central core represents the hardened mass of debris which filled up what was once the neck, or crater, of the volcano, or, at least, the deeper portion of it. The upheaved sedimentary rocks represent the strata through which the volcano burst, and interbedded with them are sheets of lava which were poured out from its crater.

This, then, is an example of an ancient seat of volcanic action which, while only the stump, as it were, of a volcano, is yet in a much more perfect state than anything that has been preserved from Old Red Sandstone times. The bearing of this on our present subject is, that we have here an easily-deciphered link in the chain of evidence which connects the most ancient with the most recent volcanic phenomena, and which enables us to prove for volcanic action what has been proved in other departments of geological history, namely, that the forces which have been at work modelling the earth's surface from earliest times are identical in kind with those which are in operation still.

V.—*The Flora of the Woody Island.* By WILLIAM BARCLAY.

(Read 5th May, 1887).

It is not necessary to describe minutely to a Perth audience the situation and surroundings of the Woody Island. There can hardly be one of you that has not frequently strolled northwards along the river bank till within a short distance of the confluence of the Almond. You must have marked with delight the magnificent landscape. To the right extend the woods of Scone, in the first bright green of spring, or perhaps adorned with the fading many-coloured leaves of autumn. In front spreads the rich, broad plain of Strathmore, bounded far off by the towering heads of the Grampians. To the left stretches the beautiful valley of the Almond, and far away in the distance rises the sharp peak of Ben Voirlich, with, close beside it, the blunter top of Stuic a Chroin, its scarcely less gigantic neighbour. The lover of nature is amply repaid for a visit to the Woody Island by the beautiful scenery which delights his eyes, and if he be also a botanist a richer reward awaits him. He will find, within the compass of a few acres, a very large number of interesting plants, few of them, perhaps, extremely rare, but many of them by no means common. Indeed, there can be few spots in Scotland containing so rich and varied a flora within anything like the same area.

The name Woody Island is, strictly speaking, scarcely correct; it should be Woody Islands, for there are two of them. Measuring from the map of the Ordnance Survey, they appear to be nearly equal in size—the western one containing about 4¾ acres, the other 4½ acres. But the latter has, since the date of the survey, been sadly curtailed by the current of the river, which has undermined its bank and carried off a considerable portion of it, so that I do not think that the total area of both islands can now exceed 7½ or 8 acres. The height above the level of the sea cannot exceed 20 feet, and the soil seems to consist of a stratum of vegetable mould resting upon a bed of gravel. Within this limited space there occur upwards of two hundred species of plants included in the Loudon Catalogue of British Phænogamia, besides a few others not found in that list, because they have not yet been recognised as being completely naturalised. These two hundred species include representatives of about forty orders, and of about one hundred and thirty genera, so that the Woody Island affords a very excellent and varied field of study for any one who wishes to become a botanist. You will observe that I have not given these figures as rigidly exact, for I am satisfied that my list is not yet complete.* I hope, however, to have it as complete as possible by the time it is necessary to print it in the *Transactions*, and as I have included no plants of whose occurrence I am not certain, any alterations will not be in the way of subtraction but of addition.

It would be a wearisome task for you to listen to some two hundred Latin names of species, and I shall certainly not ask you to do so. I shall simply notice some of the more notable plants, and make any remarks that may occur to me concerning them.

And first, as to trees, which I shall take together, although they belong to very different orders. The Island has evidently been planted with three species of cone-bearers—the Scotch fir, the Spruce, and the Larch. When this was done I do not know. I think it probable, from the size of the trees, that it was at some time within the first quarter of the present century; but my opinion is not worth much in a matter of that kind. Besides these, there occur on the Island eleven other species which are either native or naturalised, and have no appearance of having been planted. Of what may be called timber trees we have the Ash, the Elm, the Birch, the Alder, and the Sycamore. So far as I know the Beech and the Oak are not found. The others include the Elder, the Hawthorn, the species of Crab known as *Pyrus mitis*, the Gean *(Prunus Avium)*, and the Bird-Cherry *(Prunus Padus)*. The latter is pretty abundant in the Island, and in spring its long pendulous racemes of white flowers render it a beautiful object. Some few of the Willows attain the dimensions of trees, but they will be dealt with separately. Another plant, which often reaches the size of a small tree, is deserving of special mention, as it is by no means common. This is the Guelder Rose *(Viburnum Opulus)*. In early summer it adorns itself with large cymes of white flowers, which are of two kinds. Those in the centre of each cyme are small in size, but perfect, whilst those in the circumference have a large spreading five-lobed corolla, but are destitute of stamens and pistil. By cultivation the flowers in the centre can be rendered large and neuter like those of the circumference, and the plant then becomes the snowball tree,

* As I anticipated, a further search has shown that these figures are much too small. The correct numbers are given in a note at the end of this Paper.—W.B.

which may often be seen in shrubberies. The wild plant is found in various spots along the banks of the Tay, as, for example, at a short distance below Cargill. In autumn it is gay with bunches of juicy scarlet berries.

Leaving the trees, which the non-scientific mind does not usually think of as flowering plants, though of course they are so, I come to those recognised as such by all. With regard to them I shall run over a few of the principal orders, mentioning the more noticeable members of each. And first, belonging to the *Ranunculaceæ* or Crowfoot order, we find *Thalictrum minus*, the Lesser Meadow Rue, a plant very rare in Perthshire, except along the Tay and one or two of its chief tributaries. It is by no means a beauty, and in this respect it differs widely from another plant of the same order, *Trollius europæus*, the Mountain Globe-Flower. This is not particularly rare, but is very pretty, and I mention it because the Woody Island is the nearest place to Perth where it is to be found. There I first beheld and admired it some five-and-twenty years ago.

There are a good many species of Crucifers on the Island, but the only one requiring notice is *Cardamine amara*, the Bitter Cress, easily recognised from the other cresses by its large white flowers and purple anthers. Of the *Caryophylleæ*, the Pink and Chickweed order, we have *Silene maritima*, which is a common plant among sand or shingle by the sea-shore. It occurs also by the side of streamlets on the higher mountains, and is also found on the gravelly shores of the larger rivers, such as the Spey and the Tay. To this order belongs also *Stellaria nemorum*, the Wood Stitchwort, a very handsome and by no means common plant, which has a very curious way of creeping along the ground after it has done flowering. Its leaves, too, then vary greatly in size and shape, and altogether it looks as if it were a totally different plant from what it was when in bloom.

The plants belonging to the order *Leguminosæ* are common, and call for no remark. Dr. Buchanan White, however, informs me of other two which at one time grew on the Island, but which seem to be now extinct. These are the Wood Vetch (*Vicia sylvatica*)* and a very much rarer one, at least in Scotland, *Lathyrus sylvestris*, the narrow-leaved Everlasting Pea. It has been doubted whether the latter is really indigenous anywhere in Scotland.

*Not extinct, but thoroughly established, as I found after this Paper was read.—W. B.

We next come to the order *Rosaceæ*, one genus of which, *Rubus*, the Bramble tribe, appears to be a specialty of the Woody Island. It is not so very long since all the British *Rubi* were supposed to include but four or five species. It was not then very difficult to attain to a sufficient knowledge of the brambles. But now these four or five have been increased by a process of fission, or splitting, into some sixty species, said to be distinct, besides several varieties. No wonder though but few botanists care to meddle with the brambles, and, like myself, put off the evil day of touching such a thorny subject to the dim and distant future. Dr. Buchanan White, however, to whom I am greatly indebted for assistance in obtaining materials for this Paper, has kindly furnished me with a list of the *Rubi*. From this list I find that there grow on the Island seventeen species of brambles. Several of these are extremely rare. One species, *Rubus villicaulis*, var. *gratus*, has not been found elsewhere in Britain except in the county of Surrey, and another *(R. ammobius)* has not as yet been detected elsewhere in Britain.

To the order *Saxifrageæ* belongs *Chrysoplenium alternifolium*, the rarer Golden Saxifrage, which was but the other day discovered on the Woody Island, though it has doubtless been there for a long time. This is the only recorded locality for this plant in the Gowrie district of Perthshire, as it is also the only locality in the same district for *Adoxa Moschatellina*, which was found plentifully by Dr. Buchanan White on a visit which he and I paid to the Island three weeks ago. The *Adoxa* is not very striking in its appearance, and does not continue long in flower, and this is probably the reason why it has hitherto escaped notice. Although so scarce in Gowrie, it is plentiful in Strathearn, and is indeed not uncommon in Scotland, occurring both at low and high elevations, and, more rarely, in the intermediate zone.

The order *Compositæ* is well represented, but I shall only mention *Eupatorium cannabinum*, the Hemp Agrimony, a very scarce plant in Perthshire, and *Doronicum Pardalianches*, the Leopard's Bane. The latter is not considered a native British plant, but it is thoroughly naturalised in many places, as, for example, about Dupplin, where it has been long established. It occurs in the Island in large patches, and is very showy when in flower.

Of *Campanulaceæ*, or Bell-flowers, I may notice *Campanula latifolia*, the Giant Bell-flower, a well-known ornament of our woods.

Campanula glomerata, the Clustered Bell-flower, was also found by myself in the Island about two years ago, but as there was only one plant we can hardly set it down as yet as more than a casual visitor.

Other plants belonging to different orders, of which I shall simply note the occurrence, are—*Solanum Dulcamara*, the Woody Nightshade; *Veronica montana; Mimulus luteus*, an American plant, now naturalised in boggy places all over the country; and *Litorella lacustris*, the Shore Weed, which is plentiful in the channel between the Island and the Muirton bank.

I now come to another specialty of the Woody Island, and another horror of botanists, the *Salicineæ*, or Willow tribe. When I undertook to write this paper it was expressly stipulated that Dr. Buchanan White should undertake to describe the Willows, and he has studied them so thoroughly that every bush on the Island belonging to the genus *Salix* is, I am sure, his familiar friend. He has kindly communicated to me the following remarks upon the *Salices* of the Woody Island:—

"THE SALICES OF THE WOODY ISLAND.—There is no spot of ground in lowland Perthshire, known to me, richer in species of the genus *Salix* than the Woody Island. From the nature of the ground—alluvial soil and sand resting upon gravel that is permeated by water—most of the species find all that is necessary for their luxuriant growth. Thus the species that have been brought hither by the river have not only thriven and multiplied, but, after the manner of willows, have intercrossed, and thus originated forms which are at present unknown to me from any other part of Perthshire.

"The portions of the Islands that are richest in this class of plants include all the west side, the top, and the lower part of the east side of the West Island; in the East Island willows are almost confined to the south-western shore, and there are no great variety of forms. In the places indicated the plants grow in belts or thickets of varying widths, and in some spots of almost impenetrable denseness. In some cases such thickets are composed chiefly of a single species; in others almost all the species that inhabit the Island occur.

"Except in the case of a few large trees of *Salix fragilis* and *S. alba*—which may, but not necessarily, have been planted,—all the species seem to be undoubtedly wild.

"Of the forms which are considered to be good and distinct species, the following occur:—

Salix fragilis, L.	Salix viminalis, L.
alba, L.	cinerea, L.
triandra, L.	phylicifolia, L.
purpurea, L.	nigricans, Sm.

"Of *S. fragilis*, both the form which is called by British authors *S. fragilis* and the var. *decipiens*, Hoffm., occur. While not rare, it is not one of the common species of the Island, though it is much the largest. Two or three of the largest specimens, situated towards the N.W. of the West Island, have hermaphrodite catkins, a few female flowers being mixed with the male. No entirely female specimens of this species have been seen on this Island.

"*Salix triandra* is not very common. Like most of the Perthshire examples, the form found here is the var. *Hoffmanniana.*

"*S. purpurea* is one of the most abundant species. The varieties called *ramulosa*, *Lambertiana*, and *Woolgariana* seem all to occur.

"*S. viminalis* and *S. cinerea* (with varieties *oleifolia* and *aquatica*) are also common.

"*S. phylicifolia* and *S. nigricans* are not rare, and are, as usual, very variable.

"As may readily be imagined, in a place where so many species and individuals occur, a genus which is so susceptible to hybridism has every facility for exhibiting this phenomenon. All the hybrid forms which occur in the Woody Island have not yet been worked out, but the following may be mentioned:—

"*S. rubra*, a cross between *S. purpurea* and *S. viminalis.* The common form of this hybrid more resembles *S. viminalis* than *S. purpurea*, but it is not yet certain that forms nearer the latter do not also occur.

"With *S. cinerea*, *S. purpurea* forms another hybrid, *S. Pontederana*, which seems to have been very rarely noticed in Britain. In the Woody Island it appears to be common and very variable. One of its forms that is found there is suggestive of a third cross, viz., between *S. Pontederana* and *S. cinerea*, one of its parents.

"The latter—*S. cinerea*—also forms a hybrid, or perhaps a series of hybrids, with *S. viminalis*, the characteristic form which occurs in the Island being probably *S. ferruginea.*

"*S. viminalis* also crosses with *S. Caprea* (which apparently is absent from the Island), but, as the only representative of this hybrid which has been found in the Woody Island has not yet flowered, it is somewhat uncertain what name it ought to bear. It may be *S. acuminata.*

"With *S. nigricans S. cinerea* forms yet another hybrid, notably the form which has been called *S. puberula.*

"Finally, *S. Caprea* or *S. cinerea* crosses with *S. phylicifolia* to form *S. laurina.*"

Of the remaining orders there are not many that require notice. A thriving specimen of *Paris quadrifolia* is at present to be seen on the Island. This plant, which, though classed with the *Liliaceæ*, has net-veined leaves, is found on the banks of the Almond at various places. It will be interesting to note if it should succeed in permanently establishing itself on the Island. Of *Cyperaceæ*, the Sedge family, *Scirpus sylvaticus* is abundant along the western shore of the Island. This species is to be found on the banks of the Tay at intervals from Killin downwards, but it is not common elsewhere in Perthshire. The large genus *Carex* is represented, so far as I have yet been able to ascertain, by but one species, the common *Carex rostrata (ampullacea).* Most of the *Carices* are bog plants, and therefore could not be expected to occur on the Island; but it is rather curious that some of what may be called the dry-land species should not be found. Possibly a few of them may yet be discovered.*

Of *Filices*, or Ferns, the Island can show but a meagre record. Four species only seem to occur, and in very small quantity. These are the common Male Fern, *Lastrea Filix-mas;* the Lady Fern, *Athyrium Filix-fœmina;* the brittle Bladder Fern, *Cystopteris fragilis;* and the common Spleenwort, *Asplenium Trichomanes.* Of the latter I have seen but one plant.

The situation of the Woody Island is eminently favourable to the introduction of species from the higher parts of the Tay and the Almond. There can be little doubt that numbers of species now thoroughly naturalized have come to the Island in this way, and those I have mentioned as occurring in but small quantity are most likely visitors of the same kind which may or may not succeed in making good their footing. In the case of some plants, however, there

* Other five species have since been found.—W. B.

is no doubt whatever, they bear the stamp of their foreign origin plainly enough—they may be said to carry the mark of the beast on their forehead. Such is *Mimulus luteus*, such is a shrubby species of *Spiræa*, and such are two forms of an American Aster which has thoroughly established itself and made itself at home. A plant of *Iberis amara*, the common Candytuft of our gardens, in some such fashion found its way thither last year, and was gathered by a member of the Society. Nor must I fail to tell of the exclamation of surprise with which, last autumn, a friend of mine beheld growing at the side of the Island a fine plant of *Helianthus tuberosus*, the Jerusalem Artichoke.

I have now mentioned most of the more remarkable plants to be got on the Island. The others will, of course, be found in the list. They will be found to embrace many of our best known and most admired wild flowers—the favourites of the poets,—those that do not require a botanist's eye and a pocket lens in order to see and appreciate their beauty. Among them will be found the glowing violet, "the rathe primrose," "cowslips wan, that hang the pensive head," the little celandine, the blushing wild rose, the nodding hyacinth, the stately fox-glove, even the Highland heather and tasselled broom of Scotland, with many a humbler weed unknown by an English name. And it must not be supposed that it is a matter of no importance to note the presence or absence of these in any particular locality. Nothing has struck me more forcibly in drawing up the list of the Woody Island Flora than the importance of the plan which was inaugurated last year by Mr. James Coates in his paper on the botany of Kinnoull Hill—the plan of thoroughly examining and recording the flora of a comparatively limited locality. In this way not rarities only are noted, but, what is more liable to be overlooked or neglected, the presence or absence of the commoner plants is forced upon the attention of the enquirer. Such records will not only serve as guides to local students, and as authentic testimonies to which reference can be made in the future, but, as it is only in this way that the larger districts can be thoroughly and systematically worked out, they will provide a body of facts which will help to throw light upon many dark questions concerning the distribution of species, questions which are at present but little understood, and to the solution of which naturalists are as yet but slowly groping their way.

NOTE.—The foregoing paper was read on the 5th May of the present year. During the succeeding summer months I paid numerous visits to the Island, generally accompanied by Dr. B. White and sometimes by other members of the Society. On these occasions a thorough search was made, which resulted in the discovery of a great many species not previously known to grow on the Island. The most notable of these were *Ranunculus auricomus*, *Potentilla Comarum, Alchemilla alpina*, *Saxifraga aizoides*, *Lythrum Salicaria, Campanula rapunculoides*, *Symphytum officinale*, *Oxyria digyna*, *Polygonum maculatum*, *Sparganium simplex* (in the channel between the Island and the Muirton bank), five additional *Carices*, all, however, common species, and *Melica nutans*. *Potentilla Comarum*, which is a bog plant, was found thoroughly established upon the stone pier which projects into the river upon the east side of the Island. The part where the plant is rooted can only be reached by the water of the river in very high floods, so that practically it is growing from the side of a dry wall. On the same pier *Sedum acre* has fixed itself in small quantity, and it will doubtless keep its ground and spread. *Vicia sylvatica*, which, at the time the paper was read, was supposed to be extinct, was rediscovered and found to be thoroughly established. *Lythum Salicaria* was found flowering in the dry bed of the river. Of course the next flood would sweep it away. *Helianthus tuberosus*, referred to in the paper, was seen again in the present autumn, and seems to have made good its footing in the Island.

The list, as here subjoined, contains 320 species, embracing representatives of 173 genera and of 50 orders. All of these were seen and verified during the present year, with the exception of *Campanula glomerata* and *Lathyrus sylvestris*. The last is, I am afraid, now extinct. *Campanula glomerata* is probably still in the Island, though it was not seen this season. The undergrowth in some parts of the Island is so dense during the summer months that it is often difficult to find a plant even when you know the spot where it grows. I was surprised that we did not see some of the commoner Orchids during any of our visits this year. None of them appear in the list, but I still think that I have in previous years seen *Orchis mascula* and *Orchis maculata* in the Island. On the whole, however, the list is a wonderful one, when it is considered within how small a space such a variety of species are to be found. Our search was so often repeated, and so thorough, that I am convinced not many plants escaped our notice, so that the list may be relied on as being as nearly complete as it could possibly be made. I must again acknowledge my obligation to Dr. Buchanan White for the assistance which he so freely gave me. Without that assistance the catalogue which is here subjoined must have been much less complete and much less reliable.

1st November, 1887.

CATALOGUE OF THE FLOWERING PLANTS AND FERNS OF THE WOODY ISLAND.

Ranunculaceæ.

Thalictrum minus, L., *b.* montanum, Wallr.
,, *c.* flexuosum, Reichb.
Anemone nemorosa, L.
Ranunculus Flammula, L.
auricomus, L.
5 acris, L.
repens, L.
Ficaria, L.
Caltha palustris, L.
Trollius europæus, L.

Fumariaceæ.

10 Fumaria officinalis, L.

Cruciferæ.

Nasturtium officinale, Br.
palustre, D.C.
Barbarea vulgaris, Br.
Cardamine amara, L.
15 pratensis, L.
hirsuta, L.
Erophila vulgaris, D.C.
Sisymbrium Thalianum, Gay.
officinale, Scop.
20 Alliaria, Scop.
Brassica Sinapis, Vis.
alba, Boiss.
Capella Bursa-pastoris, [Mœnch.
Iberis amara, L. (a rare casual).
25 Raphanus Raphanistrum, L.

Violarieæ.

Viola palustris, L.
sylvatica, Fr.
canina, L.

Caryophylleæ.

Silene maritima, With.
30 Lychnis diurna, Sibth.
Flos-cuculi, L.
Cerastium triviale, Link.
Stellaria nemorum, L.
media, Cyr.
35 Holostea, L.

Stellaria graminea, L.
uliginosa, Murr.
Arenaria trinervia, L.
serpyllifolia, L.
40 Sagina procumbens, L.
Spergula arvensis, L.

Portulaceæ.

Montia fontana, L.

Hypericineæ.

Hypericum perforatum, L.
quadratum, Stokes.
45 pulchrum, L.
hirsutum, L.

Lineæ.

Linum catharticum, L.

Geraniaceæ.

Geranium sanguineum, L.
sylvaticum, L.
50 pratense, L.
Robertianum, L.
Oxalis Acetosella, L.

Sapindaceæ.

Acer Pseudo-platanus, L. (self-sown).

Leguminosæ.

Ulex europæus, L.
55 Cytisus scoparius, L.
Laburnum, L. (self-sown).
Ononis repens, L.
Trifolium pratense, L.
hybridum, L.
60 repens, L.
Lotus corniculatus, L.
pilosus, Beeke.
Vicia hirsuta, Koch.
Vicia cracca, L.
65 sylvatica, L.
sepium, L.
Lathyrus pratensis, L.
macrorrhizus, Wimm.
sylvestris, L. (now extinct).

Rosaceæ.

70 Prunus Padus, L.
Avium, L.
Spiræa Ulmaria, L.
,, var. denudata, Presl.
sp. related to S. salicifolia, L.
Rubus* Idæus, L.
75 plicatus, W. & N.
ammobius, Fcke. (the only station in Britain).
affinis, W. & N.
imbricatus, Hort.
ramosus, Blox.
80 latifolius, Bab.
pyramidalis, Kalt.
carpinifolius, W. & N.
villicaulis, W. & N.
,, var. gratus, Focke (found hitherto only in Surrey as a British plant).
Maasii, Focke.
85 rosaceus, W. & N.
,, var. hystrix, Weihe.
Radula, Weihe.
corylifolius, Sm., var. sublustris, Lees.
deltoideus, P. J. Müll.
scabrosus, Müll, var. trigonodontus, Boul.

* This list of *Rubi* is founded upon specimens collected by Dr. Buchanan White, and determined for him by Professor Babington.

90 Rubus cæsius, L., var. ligerinus, Genev.
Geum urbanum, L.
intermedium, Ehrh.
rivale, L.
Fragaria vesca, L. [Ehrh.
95 Potentilla Fragariastrum,
Tormentilla, Neck.
Anserina, L.
Comarum, Nestl.
Alchemilla vulgaris, L.
100 alpina, L.
Rosa spinosissima, L.
mollis, Sm.
tomentosa, Sm.
canina, L. [Wallr.
105 Pyrus malus, L., *b.* mitis,
Cratægus oxyacantha, L., *d.* monogyna, Jacq.

Saxifrageæ.

Saxifraga aizoides, L.
granulata, L. [um, L.
Chrysosplenium oppositifoli-
110 alternifolium, L.
Ribes Grossularia, L.
rubrum, L.
nigrum, L.

Crassulaceæ.

Sedum Telephium, L.
115 acre, L.

Halorageæ.

Myriophyllum alterniflorum, [D.C.

Lythraceæ.

Lythrum Salicaria, L.

Onagrarieæ.

Epilobium montanum, L.
obscurum, Schreb.
120 palustre, L.
Circæa lutetiana, L.
„ var. inter-
alpina, L. [media.

Umbelliferæ.

Sanicula europæa, L.
Ægopodium Podagraria, L.
125 Pimpinella Saxifraga, L.
Conopodium denudatum, [Koch.
Myrrhis odorata, Scop.
Anthriscus sylvestris, Hoffm.
Angelica sylvestris, L.
130 Heracleum Sphondylium, L.
Caucalis Anthriscus, Huds.

Caprifoliaceæ.

Adoxa Moschatellina, L.
Sambucus nigra, L.
Viburnum Opulus, L.
135 Lonicera Periclymenum, L.

Rubiaceæ.

Galium boreale, L.
Cruciata, Scop.
verum, L.
palustre, L. [Sm.
„ var. Witheringii,
140 Aparine, L.
Asperula odorata, L.

Valerianeæ.

Valeriana officinalis, L., *b.* sambucifolia, Mik.

Dipsaceæ.

Scabiosa succisa, L.
arvensis.

Compositæ.

145 Eupatorium cannabinum, L.
Solidago Virgaurea, L.
Bellis perennis, L.
Aster Novi-Belgii, L.

Helianthus tuberosus (naturalised).
150 Gnaphalium uliginosum, L.
Achillea Millefolium, L.
Ptarmica, L.
Chrysanthemum segetum, L.
Leucanthemum, L.
155 Parthenium, Pers.
Matricaria inodora, L.
Tanacetum vulgare, L.
Tussilago Farfara, L.
Doronicum Pardalianches, L.
160 Senecio vulgaris, L.
Jacobæa, L.
aquatica, L.
Cnicus lanceolatus, Hoffm.
palustris, Hoffm.
165 heterophyllus, Willd.
arvensis, Hoffm.
Centaurea nigra, L.
Lapsana communis, L.
Crepis paludosa, Mnch.
170 Hieracium vulgatum, Fr.
murorum, L.
crocatum, Fr.
Hypochæris radicata, L.
Leontodon autumnalis, L.
175 Taraxacum officinale, Web.
Sonchus oleraceus, L.

Campanulaceæ.

Campanula glomerata, L.
latifolia, L.
rapunculoides, L.
180 rotundifolia, L.

Ericaceæ.

Calluna Erica, D.C.

Primulaceæ.

Primula vulgaris, Huds.
veris, L.
Lysimachia nemorum, L.
185 Anagallis arvensis, L.

Oleaceæ.

Fraxinus excelsior, L.

Boragineæ.

Symphytum officinale, L.
Myosotis cæspitosa, Schultz.
palustris, With.
190 arvensis, Hoffm.
versicolor, Reich.

Convolvulaceæ.

Calystegia Sepium, Br.

Solanaceæ.

Solanum Dulcamara, L.

Scrophularineæ.

Scrophularia nodosa, L.
195 Mimulus luteus, L.
Digitalis purpurea, L.
Veronica arvensis, L.
serpyllifolia, L.
officinalis, L.
200 Chamædrys, L.
montana, L.
Anagallis, L.
Beccabunga, L.
Euphrasia officinalis, L.
205 Rhinanthus Crista-galli, L.

Labiatæ.

Mentha rubra, Sm.
sativa, L.
arvensis, L.
Origanum vulgare, L.
210 Thymus Serpyllum, Tr.
Calamintha Clinopodium, Benth.
Nepeta Glechoma, Benth.
Prunella vulgaris, L.
Stachys palustris, L.
215 sylvatica, L.
Galeopsis speciosa, Mill.
Tetrahit, L.
„ var. bifida, Bœnn.
Lamium album, L.

Teucrium Scorodonia, L.
220 Ajuga reptans, L.

Plantagineæ.

Plantago major, L.
lanceolata, L.
Littorella lacustris, L.

Illecebraceæ.

Sceleranthus annuus, L.

Chenopodiaceæ.

225 Chenopodium album, L.
Atriplex patula, L.

Polygonaceæ.

Polygonum Convolvulus, L.
aviculare, L.
Hydropiper, L.
230 Persicaria, L.
lapathifolium, L.
maculatum, Dyer & [Trim.
amphibium, L., *b.* terrestre, Leers.
Oxyria digyna, Hill.
235 Rumex sanguineus, L. *b.* viridis, Sibth.
obtusifolius, L.
acutus, L.
conspersus, Hartm.
crispus, L.
240 aquaticus, L., (Bab.)
Acetosa, L.
Acetosella, L.

Euphorbiaceæ.

Mercurialis perennis, L.

Urticaceæ.

Ulmus montana, Sm.
245 Urtica dioica, L.

Cupuliferæ.

Betula alba, L.
Alnus glutinosa, L.

*Salicineæ.**

Salix fragilis, L.
,, var. decipiens, [Hoffm.
alba, L.
250 triandra, L.
,, var. Hoffmani- [ana, Sm.
purpurea, L.
,, var. Woolgariana, [Borr.
,, var. ramulosa, [Borr.
,, var. Lambertiana, [Sm.
rubra, Huds.
Pontederana, Schleich.
viminalis, L.
255 Smithiana, Willd.
ferruginea, G. Anders.
acuminata, Sm.
cinerea, L.
,, var. aquatica, [Sm.
laurina, Sm.
260 phylicifolia, L.
nigricans, Sm.

Coniferæ.

Pinus sylvestris, L. (planted).
Larix europæa, D.C. ,,
Abies excelsa, Poir. ,,

Hydrocharideæ.

265 Elodea canadensis, Mich.

Liliaceæ.

Allium ursinum, L.
Scilla nutans, Sm.
Paris quadrifolia, L.

Juncaceæ.

Juncus bufonius, L.
270 effusus, L.
supinus, Mnch.
lamprocarpos, Ehrh.
acutiflorus, Ehrh.

* From a list furnished by Dr. Buchanan White.

Luzula maxima, D.C.
275 campestris, D.C.
multiflora, Lej.

Typhaceæ.

Sparganium simplex, Huds.

Alismaceæ.

Alisma Plantago, L.

Naiadaceæ.

Triglochin palustre, L.

Cyperaceæ.

280 Eleocharis palustris, Br.
Scirpus setaceus, L.
sylvaticus, L.
Carex echinata, Murr.
ovalis, Good.
285 Goodenowii, J. Gay.
panicea, L. [Tausch.
flava, L., *c.* lepidocarpa,
rostrata, Stokes.

Gramineæ.

Phalaris arundinacea, L.
290 Anthoxanthum odoratum, L.
Alopecurus geniculatus, L.
pratensis, L.
Phleum pratense, L.
Agrostis alba, L.
295 vulgaris, With.
Aira caryophyllea, L.
Deschampsia cæspitosa, Beauv.
„ *b.* brevifolia, Parn.
Holcus mollis, L.
lanatus, L. [Beauv.
300 Arrhenatherum avenaceum,
Cynosurus cristatus, L.
Koeleria cristata, Pers.
Melica nutans, L.
Dactylis glomerata, L.
305 Poa annua, L.
nemoralis, L.
pratensis, L.
trivialis, L.
Glyceria fluitans, Br.
310 Festuca ovina, L.
elatior.
Bromus giganteus, L.
Brachypodium sylvaticum,
[R. & S.
Agropyron caninum, Beauv.
315 repens, Beauv.

Filices.

Asplenium Trichomanes, L.
Athyrium Filix-fœmina, Roth.
Cystopteris fragilis, Bernh.
Lastrea Filix-mas, Presl.

Equisetaceæ.

320 Equisetum arvense, L.

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VI.—*An August Ramble on the Forfarshire Coast of the Tay.*

By William Barclay.

(Read 8th December, 1887).

Last year, about the middle of August, a few of us, headed by our indefatigable President, made an excursion to that part of the coast which lies north of the Firth of Tay, and forms the south-eastern angle of Forfarshire. Beginning at Monifieth we proceeded eastward along the sands of Barry to Buddon Ness, and then northwards to Carnoustie, finishing up at the West Haven. We were favoured with fine weather; enjoyed the long tramp and the fresh sea-breeze, but were not particularly successful from a botanical point of view. We spent, I remember, no small part of the day in looking eagerly for salt marshes, wherein we might hope to discover new or rare plants. These marshes we somehow or other had imagined to be numerous, but we found them uncommonly scarce or else uncommonly dry. Sometimes we mounted to the top of a lofty sand-hill, and saw in the distance what appeared to be the wished-for bog; but 'twas distance that lent enchantment to the view, for when we reached the spot it turned out to be but dry sand, with perhaps a rather thicker coating of grass than usual. This journey, however, inspired me with the desire to see what the coast farther to the north was like. I had been at Arbroath once or twice, and had heard of the famous cliffs and caves that begin a little to the north-east of that town. I resolved that I would have a look at these during the summer of the present year; but somehow I could not manage to carry out this resolution till the last week of August, when it was just late enough in the season for botanising. But better late than not at all, and, besides, it was not my intention on this first visit to do more than botanise in a cursory sort of way; my object was rather to see what the ground was like, and to get over a good stretch of it in the two days I was able to devote to it. On a beautiful morning, then, on the last Friday of August, I jumped from the train at a little roadside station about a mile and a half to the west of Arbroath, and took my way along the sandy beach towards that town. Nothing worth mentioning attracted my notice on this part of the way. The sand was mostly coated with long straggling specimens of that not very enticing but very variable weed, the common Knot-grass, *Polygonum Aviculare*, intermixed with greasy-looking individuals of another equally common and even more repulsive plant, *Atriplex patula.* On reaching Arbroath I kept along by the harbour, and marched straight through the town. My steps were quickened by the peculiar conglomeration of smells which assailed me—the odour of fish entrails, rotting garbage, decaying dogs, and mouldering cats; all that variety of scents—simple, complex, and compound—which add so greatly to the charm of a herring port. Escaping from these and from the town I bent my steps towards the cliffs, keeping on the high ground to the left at some little distance from the sea. After going about half-a-mile, my eye was caught by a pretty little plant growing on the bank a few feet below the path. This turned out to be rather a good find—*Dianthus Armeria*, the Deptford Pink,—but I mistook it at the time for another plant, to which it bears a slight resemblance. This *Dianthus* was recorded by Don, the famous Forfar botanist, as being found in Angusshire, but not at this station or near it. It is scarce even in England, and many botanists do not admit that it is truly indigenous anywhere in Scotland. It was formerly found at one place in Perthshire, but it is now extinct. How it came to be where I found it I am unable to conjecture; but there was nothing, according to my recollection of the spot, to suggest that it had been planted. Still pursuing my way towards the cliffs, I came to a ditch running along the foot of a steep bank. This ditch was in some parts nearly choked with strong plants of the narrow-leaved Water Parsnep, *Sium angustifolium.* This species is an umbellifer of rather rare occurrence in Scotland, and was specially interesting because I had seen it but once before, and then not in flower. On the steep bank above the ditch was growing plentifully another plant which I saw for the first time, but had no difficulty in recognizing as *Scabiosa Columbaria.* This is hardly found in Scotland except near Arbroath and Montrose. Its flowers have somewhat the appearance and colour of our common Field Scabious, but their structure is different. Its leaves also are different, and, when in fruit, the heads are very distinct, and cannot be mistaken. It does not occur in Perthshire.

Quite pleased that I had been so lucky at the very outset of my walk, I reached the cliffs, and proceeded along their brow. For a long distance I wandered on with ever-growing wonder and admiration at what I beheld. As far as could be seen the coast was shut in by great walls of rock, torn and bored and gashed by the waves of countless ages. Here you could behold in perfection what geologists have described as the wearing away of a sea-cliff. Frost and heat, each in turn, rend and crumble its brows, whilst the sea batters its base with mighty force. The waves hammer it with its own fragments, scooping out in one place vast caves, in another undermining it and bringing down ponderous masses in crashing ruin. A great part in front of the cliff has been worn down almost to sea level, forming a sort of uneven pavement, strewn with huge blocks and hollowed out in yawning chasms, whilst here and there stands a solitary mass which has not yet succumbed to the power of the raging waters, but stands in lonely grandeur, scarred and worn, but steadfast still amidst the surrounding wreck. Nowhere can be seen a more striking example of the changes that are ever going on around us, so slowly, indeed, that the unobservant man takes no notice of them, and talks idly of the steadfast rocks and everlasting hills, unconscious of the fact that rocks and hills are crumbling into dust before his very eyes. Thus musing and admiring I proceeded on my way, now and again descending to the foot of the cliffs to peep into some dark cavern or examine more closely some gaping rent in the rocky floor. Ascending a steep but grassy slope after one of these downward expeditions, I came upon some dwarfish plants, with crowded prickly leaves and strange-looking heads. This was my first acquaintance, in a growing state, with the Carline Thistle, *Carlina vulgaris*. Its time of flowering was past, and already the leaves were becoming dry and withered. On the same bank *Campanula glomerata* (the clustered bell-flower) was abundant, but its glory too was gone, and its large blue bells were replaced by clusters of erect and swollen capsules. Another plant, the common Agrimony, *Agrimonia Eupatoria*, was so plentiful here, and for some distance along the top of the cliffs, that it became somewhat troublesome. Its fruit, which is covered by a calyx studded with hooked spines, stuck to my clothes and gave them rather a speckled appearance. About an hour after mid-day I arrived at the little fishing village of Auchmithie. Here the cliffs retreat for a short distance, forming a sort of curve, with a high and steep slope, between the base of which and the sea is a narrow strip of beach. At the top of the slope is the village, and a winding road leads down from it to the beach.

It must be a hard task to carry the produce of the fishing up this "strait path," and it is one that falls, I believe, to the lot of the women. Passing this village, through a row of men and women busily baiting their long lines and coiling them into creels, I again took the footway along the top of the cliffs, which seemed to be getting higher the further I proceeded. Now, also, the fences came pretty close to the top of the rocks, leaving but scant room for the narrow footway. Walking was therefore not quite so pleasant as in the previous part of the day, for though with ordinary care there was no real danger, still, if you were to fall a-day-dreaming, you might easily walk over the brow of the cliff. It was somewhere here, I think, that I descended to the base of the rocks for a short distance, and was rewarded by finding in their crevices a few good plants of the Sea Spleenwort, *Asplenium marinum*. About this part of the coast it occurs sparingly here and there upon the rocks for some miles. In taking the way along the base of the cliffs it was necessary to look carefully ahead, for, as the tide was flowing, it was quite possible in several places that one might be hemmed in between the sea and the rocks, advance and retreat alike impossible—in the same predicament as were Sir Arthur Wardour and his daughter when they attempted to go round by the Halket Head, and had to be drawn up with rope and pulley from Bessy's Apron. It was, therefore, only occasionally that I sought to descend, and then for but a short distance. The cliffs were now getting higher and higher, and from this I judged that I could not be very far from the Red-head, a huge rock which is the culminating point, and which reaches a height of some 277 feet above sea level. About this place I came upon a clump of the Narrow-leaved Everlasting Pea, *Lathyrus sylvestris*, with well-formed pods, but with some blossoms still lingering upon it. Several patches of the Wood Vetch, *Vicia sylvatica*, were also scattered here and there, and a few of its beautiful blooms were still to be seen. Here, also, I gathered *Dianthus deltoides*, the Maiden Pink. This is not so rare in Scotland as the Deptford Pink, but is a lovely little flower, and one which is not to be got in every locality. And now descending, I made rather a longer journey along the base of the cliffs than I had hitherto done. First came a strip of sandy beach, and then the rock-strewn floor began again, but for a considerable distance it was of some width. A steep earthen slope led up from this to the cliff above. This slope was covered so closely with brambles that it was not without pain I forced a way through them to the foot of the rock. Here and there among the brambles the *Lathyrus* was again to be seen in abundance. This plant is not considered as indigenous in Scotland, but, from the appearance of the place where it grew in this locality, and from the fact that it is recorded by Don as growing in the same spot about 70 years ago, its claim to be regarded as truly native in this station is a strong one. The rocks here were overgrown with honeysuckle, and their beautiful garment became them well. Nothing else, however, rewarded my journey through the brambles, and I soon came down again to the bottom of the slope. Here, behind a huge boulder, I was delighted to find a thriving plant of the Sea Wormwood, *Artemisia maritima.* This bears considerable resemblance to the southern-wood of our gardens, whilst at the same time it possesses a good deal of the bitter flavour of the true Wormwood, and, indeed, it has been employed in medicine for the same purpose as that plant.

Ascending once more to the top of the cliffs, I hied on my way and soon reached the Redhead. From this point the rocks begin to get lower very rapidly, till they at length terminate a short distance within the southern extremity of Lunan Bay. On the level top of the Redhead the maiden pink was growing in profusion, but the plants were dwarfed and impoverished, owing probably to the extreme dryness of the summer. The outlook from this point was splendid, but I had no time to enjoy it. My journey for the day was here brought to an end much sooner than I had intended. The clouds had been massing themselves together for some time past, and now heavy and persistent rain began to fall. Evidently there was nothing for it but to leave the coast and set off in search of Inverkeillor station. The way was devious, intersected by numerous cross roads, and at such places it was marvellous how the wrong turning always seemed to me to be the right one. But, by dint of frequent inquiry, I at length reached my goal, and there spent a somewhat gloomy two hours in looking out on the pouring rain. The train, however, came at last, and I was soon in comfortable quarters at Montrose, where I spent the night.

The next morning was bright and pleasant, giving promise of a fine day. After breakfast I set out to walk from Montrose to Lunan Bay. On crossing the suspension bridge, at what is called the Basin of Montrose, I turned to the left towards the sea; but I had turned too soon, for this was but an island that I had reached, and my steps had to be retraced and the intervening water crossed by another bridge. On the way back I picked from some rubbish by the roadside a plant which was a stranger to me, and which on examination at home turned out to be *Mercurialis annua*, the annual dog's mercury. It is rather rare, occurring mostly, I believe, as a casual, and generally in such places as where I gathered it. Before crossing this second bridge I looked along the muddy shore, and found growing thickly that curious seaside plant, the jointed Glasswort, *Salicornia herbacea*, and another not much less curious in its structure, *Suæda maritima*, the sea-blite. Both of these are more abundant on the west coast, and it is from the ashes of them and some other seaside plants that kelp is obtained. The shore of Montrose basin has been long known as a station for *Salicornia*, but it has surprised me greatly that I cannot find in the county lists any mention of *Suæda* as a Forfarshire plant. Crossing the bridge, I set off along the waterside to the sea-coast proper, a distance of rather more than a mile. In a boggy spot I found abundance of a sedge, *Blysmus rufus*, recorded by Don as growing in this locality. Passing through the quaint fishing village of Ferryden, where again in the narrow streets the baiting of lines was going on briskly, I reached the seashore and followed the coast to the south-east. For a considerable distance it was low and sandy, except that patches of broken rocks cropped up within tide mark. Some of the sandy fields which had been cleared of their grain crop were now gay with the bright scarlet blossoms of the Poor Man's Weather Glass, *Anagallis arvensis.* Never hitherto had I seen this lovely little plant so abundant, and as the sun was shining and the flowers were fully expanded the effect was very fine. A little farther on the ground was carpeted with the matted stems and golden petals of the Creeping Cinquefoil, *Potentilla reptans.* This is by no means a common plant in many districts. It is very variable and sometimes approaches so closely to a kindred species, *Potentilla procumbens*, that it is difficult to say where the one ends and the other begins. Here also appeared in some plenty several of the commoner grasses and sedges of sandy seashores. Of these I had seen but little on the previous day on account of the rocky nature of the ground. Soon the cliffs began again, but for some time they were neither so lofty nor did they form so close a wall as those of the day before. Few plants of any consequence were seen on this part of the road. The Hemp Agrimony, *Eupatorium cannabinum*, hung out from the rocks in large tufts, and in one place I came upon a single specimen of the Scottish Lovage, the only one which I saw during the whole journey. And now the rocks again towered to a great height, but still I continued to proceed for the most part along their bases. It was impossible not to be struck by the sight of one huge cliff, rising to an immense height, its brow projecting in massive greatness, while below it was bored and torn by the power of the waves. Some relics of building which rest on its summit are known by the name of St. Skay's Chapel. At length I came to a low peninsula which juts out into the sea and forms the northern horn of Lunan Bay. Near its extremity are situated a heap of what seemed to be buildings of some kind, and which I found marked on the map as the Boddin Lime Works. On the high ground from which this peninsula stretches out I sat down beside a large patch of the smaller Bindweed, *Convolvulus arvensis*, gay with beautiful rose-coloured bells. The prospect from this point was magnificent. In front was spread the wide expanse of the German Ocean, its waters gleaming in the bright sunshine, and with here and there a sail seen dimly on the far horizon. To the right stretched the long curve of Lunan Bay. From where I sat a range of lofty cliffs ran along for some distance, and then sank suddenly into a low and sandy beach which, backed by swelling uplands, reached almost to the Redhead. One isolated rock rose from the level sand almost in the centre. It was crowned with the ruins of the Red Castle, and stood solitary and commanding, like a sentinel keeping watch over the bay. After dwelling long upon the fair landscape I again took the narrow way along the top of the cliffs. A fence of barbed wire ran along by my side and did not at all add to my pleasure. Numerous gullies in the rocks were filled with the great hairy willow herb, *Epilobium hirsutum*, and the Hemp Agrimony was still plentiful. Near the termination of the cliffs the side of the path was thickly fringed with the Crow Garlic, *Allium vineale*. On two specimens only did I find flowers. All the rest had their flowers, as is usually the case with this species, charged into bulbils; in some such way, I suppose, as we sometimes find grasses in what is called a viviparous condition—that is, with buds taking the place of flowers. When the rocks came to an end I proceeded along the beach towards the Red Castle, passing on the way a sandy knoll which was thickly covered with the lesser Meadow Rue, *Thalictrum minus*. On reaching the base of the promontory on which the Red Castle stands I found that the Lunan burn required to be crossed, and that only one or two broken stumps were left to tell that a bridge had been there. To wade it, however, was no great feat, and on reaching the farther bank I found myself in the midst of a numerous pic-nic party, for whose benefit a large tent had been pitched, and a plentiful luncheon laid out beneath the canvas. Though by this time hungry enough, I did no more than look at the luncheon (I was not invited to do even that), and then set off to climb the steep slope which led to the ruins. These were of no great extent, and exhibited few points of interest; but the trouble of reaching them was more than repaid by the glorious prospect which met the delighted eye. No great distance now separated me from the Redhead, the point at which I had left off on the previous day. The time, however, that remained was too short to permit of my going over this intervening space, so that I was reluctantly compelled to bring my ramble to a close and seek the nearest railway station.

Thus ended a very pleasant and by no means unprofitable excursion. The plants which I culled and brought back have indeed lost their freshness, and no one but a botanist will find in them either beauty or attractiveness; but dry and sapless as they are, they will always have for me a peculiar charm. When I look upon them I seem once more to inhale the fresh sea-breeze, to tread again the wave-beat cliff, to peer into the dark cavern, and, from the summit of the Red Castle, to gaze forth upon the yellow sands and placid waters of Lunan Bay.

VII.—*The Geology of the Breadalbane District of Perthshire.*

By P. Macnair.

(Read 8th December, 1887).

The scope of the following paper is to present briefly the more salient features of the geological structure of Breadalbane, Perthshire, dealing only with the solid rocks, and will be considered in the following order:—

I.—The Physical Appearance of the District.

II.—Its Rocks and Minerals.

III.—The History of the Formation of the Rocks and their subsequent Denudation.

The various ore-bearing rocks will also be noticed, and a brief account given of their workings.

I.—The Physical Appearance of the District.

The area which we are about to describe geologically embraces the district more immediately situated around Killin as a centre; the valleys of the Dochart and the Lochay, with their bounding ridges of mountains; and the long, wide valley of Loch Tay.

The river Dochart, with Loch Tay and the river Tay proper, lie in a line across the country, whose compass bearings might be roughly described as being north-east and south-west. Their valleys belong to that type which has been named longitudinal, so characteristically developed in the Scottish Highlands, and whose principal features are that they generally coincide with the strike of the rocks, or with the folds and flexures into which they have been thrown.

In the plication of the rocks forming the Scottish Highlands these folds and flexures, or anticlines and synclines, have had a general north-east and south-west trend; and this has been one of the most important factors in determining the lie of the longitudinal valleys, as they have acted as lines for directing the operations of the denuding forces. But this will be more fully considered when we come to inquire into the relationship between the geology and scenery of the district.

At Killin the river Dochart is met by the river Lochay, immediately before the entrance of the former into Loch Tay. In its lower parts the river Lochy runs in a north-westerly direction, while in its higher parts it runs parallel with the valley of the Dochart. It thus belongs to the same type of valley as the Dochart—namely, longitudinal,—and has a rough coincidence with the strike of the rocks. Numerous minor valleys, or passes, run off in a lateral direction from the longitudinal valleys just described, such as Glen Ogle, Glen Lednock, &c. These have been named transverse, because they lie in such a position relative to the longitudinal valleys.

From an æsthetic point of view the scenery is of romantic beauty and wild grandeur. To the north of Loch Tay the mountains rise precipitously to an average height of about 3000 feet, while Ben Lawers towers its hoary head to an altitude of nearly 4000 feet above sea level. To the north of the Loch the mountains are less wild and rugged, while the whole of the bottoms of the valleys have been covered with the moraines of the glaciers that wended their way down their sides during the great Ice Age. Glen Ogle might be cited as one of the most rugged and wild of mountain passes in the country. The mountains rise precipitously on each side, and the glen is everywhere strewn with boulders dislodged from the parent rock by the successive frosts and thaws of countless winters.

> "Crags, knolls, and mounds, confusedly hurled,—
> The fragments of an earlier world."

From the top of Ben Lawers a magnificent view may be obtained of the surrounding scenery on a clear day; to the south may be seen the valley of Strathmore, and in the distance the long line of the Sidlaw and Ochil Hills; while in the immediate foreground Ben Voirlich towers its mighty peak far above its fellows; to the west lie the valleys of the Lochay and the Dochart, with the lovely little village of Killin nestling at the foot of Sron Clachan, the terminating point in the ridge that separates these two glens; to the east lies Strath Tay, with the river Tay flowing gently through it, which, from such a high altitude, looks little else than a streamlet; towards the north may be seen Glenlyon, and away in the distance Loch Rannoch; while all around us rise the tops of countless mountain summits, some of them enveloped in mist and some standing out clear and sharp against the lighter background of the sky.

II.—The Rocks and Minerals.

We now proceed to describe the rocks and minerals of the area under notice, looking first at the metamorphic, or most universally distributed rock in this district, out of which the valleys have been carved and the mountains raised by circumdenudation, and then at the intrusive bosses and dykes found in the neighbourhood.

Mica-schist may be said to be the representative metamorphic rock in this district. It is composed of an aggregation of the minerals, quartz and mica, arranged in thin laminæ, the quartz being interposed between the scales of mica. In external appearance it varies greatly, according to the predominance of either of these minerals. The presence of the mica gives to the rock a bright, glistening appearance, by which it can be easily recognized; with the increase of quartz the mica-schist passes into quartz-rock and quartz-schist. As before stated, the mica-schist is the most plentifully developed rock in this area, Ben Lawers and the whole range of hills lying to the north and south of Loch Tay being formed of beds of this rock. Subordinate beds of hornblende rock are often associated with the mica-schist, and are to be met with all along the hill sides. By the addition of lime the mica-schists pass at times into calcareous schists. This may be well seen in Meal-na-Creig, a hill situated to the east of Ardeonaig, in Glen Lednock.

Iron and copper pyrites accompany the schists as associated minerals. A bed of the latter, with well-developed crystals, is exposed in a cutting of the schists on the Glen Lochay road near Corry-charmaig. Splendid crystals of iron pyrites are to be found on Ben Cruben, a point of Meal-nan-Tarmachan. Garnets are also very frequent in the mica-schist, sometimes being so numerous as to make up a large bulk of the rock, from which it has been termed garnet-schist.

The garnets vary from about the size of a pea to about half an inch in diameter; their colours are dark crimson and blackish brown; and, when set in the mica-schist, they glisten and sparkle under the sun like gems set in gold. Handfuls of these iron garnets may be picked up on the hillside above Tirarthur, where they have been wethered out of the surrounding rock. Veins of pure white quartz, running parallel with the beds of mica-schist, or crossing them in every direction, are to be met with all along the hill sides. These veins of quartz, in contrast to the darker schists, present a very pretty effect, especially when the beds are crossed by a mountain torrent. The fissures in the rock are often beautifully coated with quartz crystals, and splendid specimens of the latter are thus often to be met with. When the quartz is transparent, and some colouring matter is present, it produces the cairngorms of Craig-na-Challeich. The next most important rock in the district is the crystalline limestone. It is intercalated between the bedding planes of the mica-schist, and runs in two broad bands along both sides of the Loch, one on each side. Farther on we will see that these bands represent the broken outcrop of the beds, and that they are one and the same, having formerly been united over what is now Loch Tay, but have now been separated by denudation. The limestone is crystalline in its structure, and, as usual, effervesces on the application of acids. Its colours are various—white, grey, and bluish black being the predominating ones; sometimes it is charged with a large percentage of mica, when it puts on the appearance of a micaceous schist. This may be well seen in a quarry at the back of Killin Pier.

The limestone is burned in kilns along both sides of the Loch for manure and other purposes. Beautiful crystals of calcite are often to be met with as an associated mineral of the limestone.

Towards the top of the Craig-na-Challeich range of hills the mica-schists pass into a quartzite or quartzose schist. This rock is often charged with iron pyrites, and curious circular markings are to be found in the débris in front of the Craig-na-Challeich escarpment.

The rocks we have just described belong to the class termed by geologists metamorphic, meaning that their original form has been changed. The quartzites and mica-schists were no doubt at an early period in the world's history laid down as a deposit of one of its primeval oceans. The presence of the limestone points also to the fact that this ocean must have been tenanted by inhabitants who had the power of building up such a structure. The original texture of these rocks has, however, been entirely changed, and a crystalline structure superinduced. Undoubtedly the principal factor in producing this transformation has been heat, however it has been generated. In the crystallization of the mica-schist the crystals have assumed the form of plates, the different minerals being arranged in layers which split into laminæ, hence the name foliated or schistose rocks. In the quartzites the sedimentary origin of these rocks is still more apparent. Even to the unaided vision it can be seen to be made up of distinctly rounded granules of quartz, which have been transfused into one another by the action of heat, giving to the rock a much harder and more flinty texture than ordinary sandstone. This phenomena of the metamorphism of sandstone into a hard quartzite may be seen on a small scale in the valley of Strathmore, where the dykes of intrusive basalt have been injected into the sandstone. The latter, for a few feet from the walls of the dyke, has been altered into a quartzite similar in every respect to the great beds of that rock to be met with in the Highlands of Perthshire.

At an early period in the history of Geological Science it was supposed by a certain class of theorists that these rocks owed their origin to chemical precipitation. They were called primary under the belief that they had been formed at a period in the world's history anterior to the advent of life upon the globe, when as yet the crust of the earth had not sufficiently cooled down as to admit of the existence of animal or vegetable life. The waters resting upon this fundamental crust of granite where heated to a high degree of temperature, and any mineral matter they may have contained, in solution, was deposited on this fundamental crust by chemical precipitation. Afterwards these chemical precipitates were disrupted and further metamorphosed by the intrusion of molten granite; in fact, one old writer upholding this theory says that, gathering together all the evidence, "there are few dogmas of science that can rest upon a stronger induction of facts, than that the mountains of the Earth owe their elevation to the expansive forces of internal fire, and that its massive foundations have been mainly consolidated through the instrumentality of the same agent." But that which was considered a dogma yesterday fades away under the clearer light of to-day, as it is now universally admitted that these rocks have been accumulated at the bottoms of ancient Paleozoic seas in the same manner as ordinary sediments, such as sandstones, shales, etc., and that they have been afterwards metamorphosed into their present equivalents—quartzites, schists, etc.

Before passing to describe the other rocks of the district, which are mainly intrusive, we would claim your attention to the geological structure, ores, and workings of the Tyndrum lead mines. As all the other mines in the district are worked in the rocks we are about to describe, they will be considered as each rock falls to be mentioned; but as the Tyndrum mines are in a true fault fissure it will be more systematic to consider them in connection with the metamorphic rocks just described. At Tyndrum the mica-schists have been faulted down against a series of quartzose rocks, the fault trending in a north-easterly and south-westerly direction, and running across the Strathfillan and Coninish valleys; the part to the west of the fault being occupied by the quartzites, and that to the east by the mica-schists. The schists seem to be the same as those just described as occupying the greater part of Breadalbane, Perthshire, whereas the quartzites belong to a horizon lower than the schists, and, as Messrs. Wilson and Cadell suggest, may belong to the same horizon as the grits and quartzites of the Glenlyon district. A belt of high ground, with an easterly trend, and terminating in its eastern extremity in a mountain called the Sron-nan-Colan, is the ridge in which the workings are situated, and chiefly in the latter hill.

The levels of the workings have been driven into the Sron-nan-Colan to catch the vein as it passes through the hill. The clay vein which generally occupies the fault fissure, and the hard vein which, in the Strathfillan valley, occupies the quartzites, trend at an angle to one another, and meet above the valley in the Sron-nan-Colan. Where they are separated, the hard vein hades towards the clay vein, so that they must both unite at a certain point beneath the hill. The richest working seems to have been in the hard vein above this line of intersection.

The veinstone is pure white quartz in the case of the hard vein, and breccia, made up of quartzite and mica-schist in a matrix of quartz, in the clay or soft vein. The principal ore is argentiferous galena (sulphide of lead with silver). Copper and iron pyrites are also to be found, cobalt being found in the hard vein.

In Glen Lochay, about three miles from the foot of the glen, a bed of serpentine crops out on its southern side between the mica-schists, and was mined for chrome iron ore by the late Marquis of Breadalbane. The serpentine is of a dark green colour, mottled with lighter shades. The chrome iron ore is disseminated through the serpentine in grains; with it are associated steatite (soapstone), crysotile, etc.

At Tomnadashan, a hamlet situated on the south side of Loch Tay, about nine miles from Killin, the mica-schists have been penetrated by a boss of igneous rock, which has in its turn been pierced by another igneous rock, the injection of the latter into the former having in some way influenced the production of the ores. The older rock, or that which was first injected into the schists, is of a dark sombre colour, not unlike an ordinary basalt or dolerite in external appearance, and named by some of the earlier writers on the Breadalbane mines as greenstone; but Messrs. Wilson and Cadell have shown it to be altogether different from the basalt of the district, and have named it kersantite, a mica diorite, owing to the large percentage of biotite in the rock. The rock that has in turn pierced the kersantite is of a bright reddish aspect, seeming to be a variety of granite, and called granitite by the above-mentioned authority. By the increase in size of the feldspar crystals the granitite passes into granitic porphyry.

The kersantite extends from the shores of the Loch well up the side of the hill, and presents a decidedly hummocky appearance from a distance, due probably to the weathering of the rock. The granitite may be seen here and there in the kersantite, being best exposed in the cuts made by the streamlets flowing down to the Loch. Large cave-like openings have been made in the face of the hill by the removal of the rock containing the ore. At the bottom of these openings a level may be seen driven into the side of the hill. This level had been driven into the rock under the supposition that the ores were concentrated in a vein, but, as such was not the case, they, as a consequence, never reached it. The chief ores are copper pyrites (chalcopyrite) and grey copper (fahlerz). Quartz and calcspar are also to be found as associated minerals. The ore is disseminated through the igneous rock in irregular masses, so that its working must always be more or less precarious.

Numerous bosses of diorite are to be found intruded here and there amongst the schists, one of which may be seen near the summit of Craig-na-Challeich. At Ardeonaig a great boss of quartz-felsite may be seen. The rock is of a pale pink colour, and may be traced for a short distance down Glen Lednock.

The district is ramified in every direction with dykes of different kinds of igneous rocks, basalt, porphyrite, felsite, etc. They run across the mica-schists in every direction, penetrating to the tops of the hills or running down into the valleys; two or three run across the bed of the Dochart at Killin, one immediately below the bridge over which the Killin railway passes. They are also very well shown in the bed of a burn at the back of Auchmore House. The burn cuts through the schists at right angles to their strike, and three of these dykes may be met with going up the burn from the Ardeonaig road. As before-mentioned, the burn cuts through the schists at right angles to their strike, so that where the dykes cross the burn the waters of the latter have in some cases been deflected from their former course across the schists, and run parallel with the joints of the dyke.

These dykes of intrusive rock in point of age belong to two widely different epochs in geological time. While the porphyrite, felsite, etc., are probably very old, it has been proved that the dykes of basalt belong to comparatively a late epoch in geological time.

During early Tertiary times the Inner Hebrides was a scene of active volcanic action, great sheets of lava being poured out all over that region, and forming what are now great horizontal sheets of basalt. The fissures in which the lava rose to the surface opened all over Scotland, and are now to be seen in the numerous dykes of basalt that cross the country in a prevalent north-west and south-east direction. These basalt dykes are often quarried for road metal, and even at times for building purposes.

III.—The History of the Formation of the Rocks and their subsequent Denudation.

Having thus briefly described the mineralogical characteristics of the rocks in the district, we now proceed to deal with the history of their formation, the manner in which they have been elevated into their present positions, and the connection between the geology and the scenery of the district. In doing so we will have occasion to revert to the history of the Grampian range as a whole, paying, however, more particular attention to the Killin district in part.

As before stated, the mica-schists and quartzites must have been laid down at an early period in the world's history as a deposit of one of its primeval oceans, which at that time probably covered the greater part of what is now the Highlands of Scotland. This sea, eating away the then existent land, laid down the sediment that was afterwards to become the solid rock out of which the main portion of the Grampians was to be carved by sub-aerial denudation. In this manner the whole pile of the Grampian strata was laid down, probably requiring a vast amount of time, as they must have reached a great thickness. This may be termed the first stage in the long process of mountain building.

All these sediments must have been originally laid down in approximately horizontal beds, but the most superficial inspection will show us that they no longer occupy such a position, but are to be found inclined at all angles to the horizon, and dipping in various directions—the movement of these beds from their original position into that which they now occupy representing the second stage in the evolution of the Grampian mountains. This stage introduces us to those forces caused by the contraction of the earth's crust and the consequent production of tangential strains, by which the whole series of aqueous rocks were crumpled and folded into the position they now occupy, as indicated by their lines of stratification. In this great crumpling and folding the rocks were in some cases faulted and folded in such a manner as to produce the phenomena called inversion, by which a lower series of rocks were made to overlie a higher, causing them to occupy unusual and abnormal positions; another effect of these side thrusts was to produce the prevalent north-easterly strike of the rocks common to all the Grampian series, and which, as before-mentioned, played such an important part in afterwards determining the trend of the principal valley systems and mountain ridges, by acting as lines for directing the operations of the denuding forces. This contorting and crumpling of the strata must also be intimately connected with the phenomena of the metamorphism of the argillaceous shales, sandstones, and limestones, into their present equivalents—mica-schists, quartzites, and crystalline limestone, the whole having occurred after the deposition of the rocks as sediments, and prior to the deposition of the rocks forming the Old Red Sandstone system, as the great beds of conglomerate lying at the base of the latter system contains fragments of the metamorphic rocks of the Highlands.

In this great puckering and folding of the strata now forming the Grampians of Scotland, the Breadalbane rocks were, of course, included, and were thrown into a series of long folds or flexures, an upward fold or anticline coinciding with what is now the valley of Loch Tay, and a downward fold or syncline running off on both sides of the anticline, the one to the south towards the basement beds of the Old Red Sandstone, and the other to the north in the Glenlyon direction.

This structure of the mountains and valleys, or manner in which the beds forming them are arranged into anticlines and synclines, may be best studied by an inspection of the rocks forming the beds of the streamlets that flow down their sides. By observing the rocks forming the beds of the streamlets that flow down the northern side of the valley of Loch Tay, it may be seen that they dip in a north-westerly direction, whereas an inspection of those streamlets flowing down the south side of the valley reveals the beds to dip in an opposite direction, namely, to the south-east, showing that these beds of schist and limestone were once continuous over what is now Loch Tay, so that what is now a hollow or trough, occupied by Loch Tay, is, geologically speaking, an upward folding of the rocks, while Ben Lawers, a mountain rising to an elevation of about 4000 feet above sea level, has actually been carved out of a hollow or downward fold of the schists and limestones. Minor curvings and foldings of the rocks are well shown in a gorge made by the river Lochay, a few yards above the falls, as well as in cuttings made in the rock on the Glenlochay road near the same place. The manner in which the rocks dip, changing, in a few yards, from a very low to a high angle, also indicates that the beds must have undergone a great amount of twisting and contortion. This is well exhibited in the beds of some of the streamlets traversing the high ground near the Craig-na-Challeich escarpment.

The last stage in the evolution of the mountain scenery of the Highlands introduces us to the slow but all-powerful action of the denuding forces. The prevalent north-easterly strike of the rocks and the constant parallelism existing between the synclines and anticlines into which they had been thrown had no doubt been one of the principal factors in directing the operations of the denuding forces, and so the valley of the Dochart, Loch Tay, and the river Tay proper, all coincide roughly with the strike of the rocks. The Highlands, from the close of the Silurian period up to quite recent times, had undoubtedly remained, to a large extent, as a land surface, and during that immense period of time the denuding forces had been slowly at work removing from the surface large quantities of rock.

That a great amount of rock has been removed from the surface of the country within comparatively recent times may be seen from the fact that the trap dykes, to which we have already alluded, often run from the valleys up the sides of the highest hills, the valleys having been scooped out since the dykes of molten lava had been injected into the schists, and, as these dykes date back to early Tertiary times, thousands of feet of rock have thus been removed from the surface of the land since that comparatively late epoch in the world's history.

Little or nothing is thus left to us of the original configuration of these mountains, all traces of which must have vanished under the ceaseless action of rain, river, and tempest. At one time they must have formed a part of a great mountain chain like the Alps or Himalayas, but now they are little more than the wrecks of such a chain, or, as Professor Judd puts it, "they have been razed to their very foundations."

Thus we learn that, like the rest of the Highland area, our mountains and valleys are the consequences of a long-continued process of erosion; differences in the rocks themselves, or in the inclination of their beds, have given rise to individual peculiarities of mountain or of mountain range. They no longer present any of the characteristics of true mountains of elevation as far as the mountains should coincide with an upward fold or anticline, and the valleys with a downward fold or syncline; in fact, as already stated, it has been the reverse of this in the case of Ben Lawers and Loch Tay, which proves that, in whatever manner they have been moved from the original horizontal position in which they must have been deposited, this has in no way influenced the scenery as far as that an upward curving of the rocks should coincide with a height and a downward curving with a hollow. These hills are amongst the oldest in the world. They have been, comparatively speaking, subjected to a much longer period of erosion than many of our higher continental mountains, and so it is no wonder that all trace of their original contour is gone.

In conclusion, I might say a few words on the position of these rocks in the geological scale. At an early period, in geological science, it was thought that these rocks dated back to a period prior to the advent of life upon the globe, and that they could not therefore be co-ordinated with any fossiliferous strata or system of rocks. But the discovery of fossils in the metamorphic rocks of Western Sutherlandshire proved that a great metamorphism of ordinary sediments had occurred at a period later than Silurian times. It was upon the discovery of these fossils in the limestones and quartzites of Sutherlandshire that Sir Roderick Murchison based his theory of the succession of the Highland rocks, which for such a long period was recognized by many of our leading geologists as being the true solution of the Highland problem. Briefly stated, his theory was as follows:—In the Northern Highlands a great series of beds of quartz-rock and limestone were supposed to pass conformably upwards into a series of crystalline schists and gneisses, the limestones of the lower series containing fossils of decidedly Lower Silurian age; hence it was inferred that the crystalline schists and gneisses were but the metamorphosed sediments of some part of the Silurian system. Applying this theory of the succession of these rocks to all the Highland area, he believed that the whole of the Highlands of Scotland were covered by these rocks, having a succession similiar to that revealed by the Sutherlandshire sections.

At Killin the quartzites and limestones of Sutherlandshire were represented by the quartzites and limestones of Glenlyon and Loch Tay, and the upper series of schists in that district had their equivalents in those of Ben Lawers. But this theory had to be abandoned when the supposed conformable upward succession of the rocks in Sutherlandshire was proved to be erroneous. There seems, however, to be an inclination towards the belief that the tops of our hills are probably of Lower Silurian date, while the lower rocks are the representatives of still older members of the Paleozoic series.

Like every other department of human thought, the development of our knowledge concerning the origin, growth, and structure of the great ranges of mountain chains that are everywhere distributed across the surface of our globe has been a gradual one. Before geological science had pushed its way into this region, humanity had been content to ascribe to the mountains an eternal existence, and to leave their origin under a shadow, which they considered impossible to dispel. Measured by the short span of their own lifetime, the mountains seemed to be incapable of change. They had seen many a storm dash upon their hoary sides; each winter brought down its addition to the mass of boulders strewn along its face, but still the same old outline remained. Old associations, stories, or traditions connected with some particular spot, or scene amongst the wild crags and crevices of the mountains, had been handed down from father to son. The connection of these ancient events with the scenery around influenced their minds towards the belief that within historic times the configuration of the hills had always been the same, and as they had no idea then of the infinite cycles of years that had rolled by ere man came to this world, it is but natural that they should have ascribed to them the grand attributes of immutability and eternal existence.

But with a rude hand the science of geology pulled aside this veil of mystery that for so long a time had remained a fit theme for the imagination of the poet, or as an analogy for the theologian when illustrating the attributes of God. Not only did this new science show that the mountains were not coeval with time, but it also proved that they had appeared at different epochs in the great cycle of geological ages—that one range of mountains was much younger than another, that years upon years must have elapsed between the birth of each.

> "The hills are shadows, and they flow
> From form to form, and nothing stands;
> They melt like mists, the solid lands,
> Like clouds they shape themselves and go."

The following is a list of papers published in connection with the geology of Breadalbane (mostly relating to the mines), to all of which I am greatly indebted in the construction of this paper :—

(1) "The Mines and Minerals of the Breadalbane Highlands." By F. Odernheimer. Highland Society's Transactions (1841).
(2) A paper in the Proceedings of the Geological Society of London. By Gustavus Thost (1860).
(3) "The Breadalbane Mines." By James S. G. Wilson and H. Moubray Cadell. Proceedings of the Royal Physical Society of Edinburgh (1884).

VIII.—*Notes on the Aculeate Hymenoptera, with a list of the Wild Bees and Wasps collected in Perthshire in 1887.*

By T. M. M'Gregor.

(Read 12th January, 1888).

The Bees and Wasps which are noticed in this paper do not comprise the whole of the species occurring in Perthshire, but only those which have been captured during the past summer of 1887. Many years ago a member of this Society formed a small collection of bees, but no list of the Perthshire *Hymenoptera Aculeata* has been previously published, and we now notice the occurrence of these insects as for the first time.

We cannot in such limited time describe the individual species taken; we will therefore only take a general survey of the group, and point out the more prominent members of the different families.

As there are over 300 British species of bees and wasps, and as our humble record shows only some 60 different kinds, much work yet remains to be done before any idea can be formed of the number native to Perthshire.

The wonderful typical permanence prevalent in this sub-order makes the determination of species most difficult, and it is solely through the kindness of Mr. Edward Saunders, F.L.S., that the different kinds have been named.

Bees and wasps belong to that sub-order of the *Hymenoptera* termed by Latreille "aculeates," under which head are grouped those insects only which are possessed of true stings—ants, bees, and wasps. As they have characteristics non-existent in any other order, we find them occupying the supreme position amongst the articulates. Their remarkable industry and superior intelligence are proverbial. The typical permanence displayed by them naturally causes a great deal of simulation; indeed, to such an extent is it prevalent that partial dissection and subsequent microscopical examination are frequently necessary to distinguish the different members of a family, although only amongst the smaller species. The larger species, too, are sometimes remarkably alike in appearance. This is especially the case in the *Vespidæ*, or social wasps.

It is interesting to note that the aculeates do not imitate any other class of insects. They are decided and distinct in themselves. In the lower forms of insects, however, simulation of this order is common, notably amongst the *Lepidoptera*, wherein we find good illustration of this. The "clearwings" as a family, of which the bee and hornet clearwing moths are examples, carry out this simulation to a wonderful degree, and are even diurnal in their habits, like the bees and wasps.

However much we may admire the gorgeous colours of the *Lepidoptera*, and the beautiful metallic lustre of the *Coleoptera*, it is generally admitted that they lead lives comparatively idle to those ever-busy insects, the *Hymenoptera*. We can imagine a butterfly sunning itself in luxurious idleness on a flower top, or associate the drowsy beetles with inactivity, but we can only characterise the bees and wasps in the restlessness of proverbial industry.

Although generally sober in their colouring, remarkable symmetry of form and grace of movement, which we do not find in any other class of insects, are peculiar to the whole of the members of this group. The popular idea of a wild bee is that of an insect clothed in velvety-black and crimson, or with gaudy yellow bars across its body, these being the more familiar forms of the humble bee. The typical wasp, too, is an insect with a gaudy uniform of black and yellow—an insect dreaded and avoided, and ruthlessly destroyed on every occasion. But we have native bees and wasps with which the casual observer must be unacquainted.

The *Bombi*, or humble bees, are the most widely known of all social bees, their geographical distribution being very extensive. The genus is represented in almost every part of the known world. We are all familiar with the appearance of these insects, which are so conspicuous in our country rambles. Their colonies are composed of males, queens, and large and small workers, the latter seldom, if ever, leaving the nest. Although they can never claim a kindred interest with the honey bees, the humble bees occupy a prominent place in the economy of nature. It has been proved that certain flowers would cease to grow were it not for the direct agency of these insects, which are such active agents in the fertilization of our flora.

Some of our humble bees are burrowers, and others are moss builders. In outward appearance the nests are very similar, and are not unlike a reversed bird's nest, being composed of moss, grass, roots, &c. This outer covering is lined on the inside with a thin layer of wax, which serves a double purpose—to retain heat and prevent the damp or wet soaking through. It is very interesting to watch these insects build this outer covering. From the side of a nest of *Bombus lapponicus* a large piece was taken away, exposing the comb. A piece of cotton wool was placed near the opening, and the bees at once set to work to repair the injury. In a short time the wool was interlaced through the moss, and the covering was even more perfect than the original.

Bombi, or True Humble Bees.

The commonest of our native humble bees is *Bombus terrestris*, Linnæus, a large black and yellow banded insect, which is very plentiful throughout the immediate neighbourhood, as is also a variety of the same insect, *B. lucorum*, Smith. They are both terrestrial in their habits, their nests being well underground.

Another common member of this family is *B. lapidarius*, Linnæus, so named from its preference for building amongst stones or in rocky places, and not from any special talent for cutting or boring stones, as some suppose. We would point out the striking contrast between the male and female of this bee, as sexual variation to this extent is most exceptional. The variation in this instance is so marked that the male has been mistaken for a different bee, and named *B. arbustorum*. Being one of our most pugnacious bees, the nest must be approached with as much caution as the nest of a wasp, for the slightest disturbance is sufficient to give the alarm.

We can only mention the occurrence of *B. Derhamellus*, Kirby, as we have succeeded in capturing only three female specimens.

It is to be hoped, however, that a future season will make us more familiar with this insect. It is but slightly different from *B. lapidarius*, but the male is devoid of the yellow pubescence so conspicuous in that bee.

The beautiful mountain bee, *B. lapponicus*, may be found on any of our neighbouring hills throughout the summer, being one of the most familiar forms we meet with on the hills of Moncreiffe and Kinnoull. Its showy vestments of crimson and gold make it very conspicuous, and it is by far the handsomest species native to Perthshire. It is by no means a generally distributed insect, and is confined to high altitudes, although rare instances are recorded of its occurrence in the lowlands. It is considered by some a mountain form of *B. pratorum*, a bee very similar in habits, but less showy; and while in the uplands we meet with both forms, in the lowlands *B. lapponicus* entirely disappears—a fact which tends to bear out the supposition. We have been fortunate in securing two nests of these bees, which are to be found in burrows and also among moss.

B. pratorum, Linnæus, is mentioned in conjunction with the foregoing bee. Although this insect occurs very plentifully in this district, we have been unable to find a nest. The colouring is much more variable than that of *B. lapponicus*, the rufous pubescence on the apical segments giving place in some specimens to black.

The pretty *B. hortorum* we have only occasionally met with in the district, and are therefore quite unable to speak of its habits.

At once conspicuous by its large size and distinctive colouring, *B. distinguendus* must be classed amongst the more beautiful of our humble bees. It is almost entirely clothed in a rich coat of yellow, while a heavy black band passes between the wings. It is quite plentiful in the district in the neighbourhood of clover fields. Like the other yellow or brown bees, it is a moss builder. The colonies of this bee are usually small.

The moss bees, *B. muscorum* and *B. cognatus*, are remarkable for their simulation of each other. Their habits are similar, and they are usually found in the same localities. Their colouring is most variable, and, although a distinctive feature is usually preserved, they are often very similar in appearance, and at times the one species seems to be hopelessly lost in the other. Both insects are very common in Perthshire.

Psithyri, or False Humble Bees.

The false humble bees, or humble bee parasites, are distinguished from the true bees by the posterior legs being destitute of *corbicula*, or pollen brushes, and having no pollen basket, the femur being convex.

The sexes are only two, for, as they have no industrial habits—being entirely parasitic,—they require no workers.

Their parasitism is of a very mild order, being similar to that of the *Nomadinæ*, or cuckoo bees, which simply lay their eggs in the nests of the true bees. When the larvæ are hatched they expel the original tenants, and devour the food themselves.

On a favourable day we may count these insects in hundreds, searching every nook and cranny for the nests of the *Bombi* in which to lay their eggs; and, while we observe the true bees skipping from flower to flower in brisk activity, the *Psithyri* are usually found on flower-tops in a state of lazy intoxication.

Four out of five British species of these false humble bees have been taken in Perthshire.

The Solitary Bees.

In this group we have an army of carpenters, leaf-cutters, masons, miners, &c. In size, shape, and colour they are very varied. We find their nests, constructed of mud, in stone walls and in old wood, in stems of plants, in sand, and a variety of other places. Their life-history is a most interesting study. In a favourable locality, on a sunny day, we may observe numbers of these small insects flying out and into their holes. Most of them are very soberly dressed, although a few of them—the *Nomadinæ*—are beautifully coloured.

Solitary bees consist of males and females only, which we may frequently find in numbers in these holes. Each hole has usually more than one chamber, in each of which we find a small piece of orange-coloured matter. In the centre of this we find the future bee, which feeds upon the matter, which is composed of pollen and honey. It is known as bee-bread.

Some twenty kinds of solitary bees have been collected, the commonest species occurring being the *Halicti* and *Andrenæ*, the latter genus more closely resembling honey bees. Only two species of the *Nomadinæ* have been met with. These insects are parasitical on the solitary bees. They are commonly known as "wasp-bees," from their resemblance to the solitary wasps.

Wasps.

The *Vespidæ* are the true social wasps, or paper-makers, which construct their nests of papyraceous substances. In structure they approach the bees, but are usually much less hairy, and are dressed in gaudy colours of black and yellow. In all families of wasps, as in the bees, the females are all provided with powerful stings and strong biting jaws. They are also physically stronger and more robust than the males. The social wasps live in communities, which are composed of males, females, and workers, the latter being really sterile females. Of the seven British species we have found five native to Perthshire, three of which are terrestrial and two arboreal, the ground builders being *Vespa vulgaris*, *V. germanica*, and *V. rufa*, and the tree builders *V. sylvestris* and *V. norvegica.*

Solitary Wasps.

The second family of the *Diploptera* are the *Odyneri*, or false wasps, grouped together under the *Eumenidæ*, of which there are sixteen British species. In this district have been collected some four or five species, the commoner of these being *Odynerus parietum* and *O. parietinus.* In this family only males and true females occur. They are generally smaller than the social wasps, but are decidedly wasp-like in colour and structure, whence they are termed "false wasps," and not from any parasitic inclination. They are pretty little creatures, with the body more or less marked, and the abdomen ringed with yellow. They differ from the true wasps chiefly in the structure of mouth and feet. They usually build their nests in such situations as hard sand-banks, decayed tree-roots, old posts, &c., while some of them construct small globular nests of mud on the sides of old walls, in niches or crevices of the stone.

We now pass on to some of the more obscure families of solitary wasps, which are termed fossorial, or digging, *Hymenoptera.* These comprise a great many different families, and include more than 100 species. They are represented in our collection by some ten or a dozen species, the best represented forms being the *Crabronidæ* and the *Pompilidæ.* They are all more or less wasp-like in appearance, and although considerably diverse in structure, in habit are similar to the preceding family, forming their nests in sand-banks and decaying roots, and storing them with living food. The family *Pompilidæ*, however, differs from the other families in having a partiality for storing their nests with *spiders*, which they hunt down and attack with great intrepidity. This group is also interesting on account of the elongated body, which forms a mean between the short globular thorax of the bee and the slender body of the *Ichneumonidæ.* One of the most familiar forms is the blue wasp *Pompilus plumbeus*, which is plentiful in this locality. When we first came across this insect, on the banks of the Almond, it was skipping about with great agility among the stones in the dry bed of the river, poking its head into holes and crannies in a very business-like manner, in pursuit of prey.

Our foundation of a collection of *Aculeata* has been placed in the Museum, and it is to be hoped that it will annually show an increase until the district has been thoroughly worked up.

In conclusion, I beg to acknowledge my indebtedness to my friend and co-worker, Mr. David Cuthbert, for his very valuable assistance.

LIST OF HYMENOPTERA ACULEATA COLLECTED IN PERTHSHIRE IN 1887.

FOSSORES.

Pompilidæ.

POMPILUS, Fab.
- plumbeus, Fab.
- pectinipes, V. d. Lind.

PRIOCNEMIS, Schiödte.
- pusillus, Schiödte.

Nyssonidæ.

NYSSON, Latr.
- spinosus, Fab.

GORYTES, Latr.
- mystaceus, Linn.

MELLINUS, Fab.
- arvensis, Linn.

Crabronidæ.

CRABRO, Fab.
- palmipes, Fab.
- elongatulus, V. d. Lind.
- dimidiatus, Fab.
- cribrarius, Linn.

DIPLOPTERA.

Vespidæ.

VESPA, Linn.
- vulgaris, Linn.
- germanica, Fab.
- rufa, Linn.
- sylvestris, Scop.
- norvegica, Fab.

Eumenidæ.

ODYNERUS, Latr.
parietum, Linn.
parietinus, Linn.
sinuatus, Fab.

ANTHOPHILA.

Andrenidæ.

SUBD. I.—OBTUSILINGUES.

COLLETES, Latr.
Daviesana, Sm.

SUBD. II.—ACUTILINGUES.

SPHECODES, Latr.
dimidiatus, Hagens.
subquadratus, Sm.
affinis, Hagens.
HALICTUS, Latr.
rubicundus, Chr.
cylindricus, Fabr.
albipes, Kirb.
subfasciatus, Nyl.
tumulorum, Linn.
Smeathmanellus, Kirb.
ANDRENA, Fabr.
albicans, Kirb.
Trimmerana, Kirb.
Gwynana, Kirb.
varians, Rossi.
fucata, Sm.
denticulata, Kirb.
albicrus, Kirb.
Coitana, Kirb.
nana, Kirb.
Afzeliella, Kirb.
CILISSA, Leach.
hæmorrhoidalis, Fab.
NOMADA, Fab.
alternata, Kirb.
bifida, Thoms.
MEGACHILE, Latr.
centuncularis, Linn.
PSITHYRUS, Lep.
(*APATHUS*, Newm.)
vestalis, Fourc.
Barbutellus, Kirb., *nec.* Sm.
campestris, Panz.
quadricolor, Lep.
BOMBUS, Latr.
cognatus, Steph.
muscorum, Linn.
distinguendus, Mor.
hortorum, Linn.
pratorum, Linn.
lapponicus, Fab.
Derhamellus, Kirb.
lapidarius, Linn.
terrestris, Linn.
v. lucorum, Sm.

IX.—*The Gall-making Hymenoptera of Scotland (exclusive of those that live on Oaks).*

By Prof. JAMES W. H. TRAIL, A.M., M.D., F.L.S., Aberdeen.

(Read 10th May, 1888).

In 1884 I had the honour to lay before the Perthshire Society of Natural Science an account of the Gall-Flies (*Cynipidæ*) of the Oak in Scotland, with especial reference to the peculiar life-history of many of the species, in which *dimorphism* has been proved by Dr. Adler to exist. I have now selected as the subject of a second paper the remaining *Hymenoptera* known to be makers of galls on wild plants in Britain.

The latter insects form a far less homogeneous group than the oak gall-flies, as they belong to several orders of *Hymenoptera*, often differing from their nearest allies in their habits and power of making galls. Dimorphism is not known to occur amongst them, though several belong to the true gall-flies. The chief sources of information with regard to these gall-makers, as well as to the *Hymenoptera* of Scotland in general, are included in the writings of Mr. P. Cameron (formerly of Glasgow, but now residing at Sale, in Cheshire), with whose works every one desiring to make himself acquainted with this department of Scottish Entomology ought to be thoroughly familiar. The most important, in this connection, of his numerous writings are—

(1) "Monograph of the British Phytophagous Hymenoptera." Published for the Ray Society,—of which Vol. I. appeared in 1882 and Vol. II. in 1885 (both dealing with Saw-Flies), and two more vols. have yet to be published.

(2) "The Fauna of Scotland: Hymenoptera." Published by the Glasgow Nat. Hist. Society,—Part I. in 1878 and Part II. in 1886. In this are enumerated the Saw-Flies and the Gall-Flies known to be Scotch at the above dates.

(3) "New or Little-known British Hymenoptera." Trans. Nat. Hist. Soc., Glasgow. II., pp. 304-324.

(4) "On the Hymenoptera of Kingussie." *l. c.*, 1876; pp. 86-96.

(5) "Observations on the Study of the Phytophagous Hymenoptera." *l. c.* 1877; pp. 141-152.

(6) "On the Origin of the Forms of Galls." *l. c.*, 1883; pp. 1-10.

(7) "On the Habits of Enura." *l. c.*; pp. 38-41.

It is necessary also to consult the works of continental writers to gain a complete knowledge of these gall-makers. Chief among these writers, as regards the *Cynipidæ*, is Dr. Mayr of Vienna, whose memoir, "*Die Europaischen Cynipiden, mit Ausschluss der auf Eichen vorkommenden Arten*," gives descriptions and figures of all the galls; while his memoirs on the genera and on the species of gall-inhabiting *Cynipidæ* (1881-82) describes the gall-makers found in Europe.

The gall-making saw-flies have been fully treated of by other writers; but the list of works is too extensive to permit of more than an enumeration of some of the leading memoirs upon the group. Among these may be noted as of special importance the writings of

Zaddach, Brischke, Thomson, Andre, Vollenhoven, Dufour, Hartig, and Beyerinck. The saw-fly galls are also figured and described in the books of Reaumur, Degeer, and other old writers, with wonderful accuracy.

The galls of the *Cynipidæ* and of the *Tenthredinidæ*, or saw-flies, differ from one another so greatly in important respects that they are easily distinguished from one another after a very little experience. The galls of both groups occur on stems and leaves, or in the buds, either imbedded in the tissues of the part attacked, or attached to its surface. But though they agree in situation, and to some extent in form, as well as in being "closed" or "true" galls, they differ in their development and internal structure. Among the *Cynipidæ* the female punctures the appropriate part of the food-plant, and a drop of fluid from a much-branched organ (resembling that which excretes poison in bees and wasps) is inserted in the wound along with the egg; but the gall does not begin to grow until the larva has escaped from the egg and has begun to feed on the tissues. Among the oak gall-makers the usual rule is to have only one larva in each gall; but among the remaining *Cynipidæ* the galls are more often fused into a mass. Each is protected by a layer of hard tissue, composed of closely-knit thick-walled cells, which surrounds the chamber occupied by the larva.

The *Cynipidæ* form galls on several orders of plants, but, next to oaks, their favourite hosts are the roses. The other plants known to be galled by them in Scotland are *Papaver* (capsules), *Potentilla tormentilla* (stems), *Rubus* (stems), *Hieracium* (stems and peduncles), *Nepeta Glechoma* (leaves), (?) *Agropyrum repens* or (?) *Avena elatior* (corms).

The *saw-flies* are confined in Britain, so far as is known, to species of *Salix*, with one exception, which galls the leaves of *Vaccinium vitis-idæa*. On *Salix* they produce galls on the leaves, or cause the twigs or the petioles to become swollen, sometimes very greatly, or they live in the buds, gnawing the inner parts, but seldom showing external signs of their presence, except in the slight enlargement of the buds.

Of the galls on species of *Salix* some are so much alike that it is impossible to be assured of the makers except by rearing them. Some of those on the leaves are peculiarly hard to distinguish from one another, as these leaf-galls fall under a very few types, which we may denote as "pea-galls," "bean-galls," and "twin bean-galls." The same saw-fly may produce galls on more than one species of *Salix*, and the appearance of the galls depends much on the degree of hairiness of the surface, which in its turn depends upon the degree in which the healthy leaves are covered with hairs.

In their formation the saw-fly galls differ from those of the *Cynipidæ*, inasmuch as they reach their full size in a few days, while the egg is still in each gall, so that the larva takes no part in its production.

Still another group of *Hymenoptera* has been found to include gall-makers in Scotland. I refer to the genus *Eurytoma*, among *Chalcididæ*—a family so uniformly parasitic in habits that it has been supposed that any species reared from galls must be parasitic on the larvæ of the gall-makers. Thus, despite the constancy with which certain galls on *Agropyrum repens* and on *A. junceum* have yielded *Eurytoma hyalipennis*, it has been denied that this insect made the galls, which have been attributed to a supposed dipterous fly. The fact that no one has ever reared such diptera from the galls, while the *Eurytoma* is easily and abundantly obtained from them, affords strong support to the view that the latter insect is their true maker, and no parasite.

Various opinions have been advocated with respect to the mode in which galls are formed. Some, among whom is Mr. Cameron, believe that, among the *Cynipidæ* at least, the galls are the product, not of the introduction of a specific poison into the wound when the egg is placed in it by the female, but of the irritation caused by the larva during its development within the tissues, the different forms of galls produced being attributed to the influence exerted by the larvæ of the different species, each working in its own peculiar manner. The eggs are inserted into the zone (cambium) of most active growth, where they or the larvæ are able to produce the greatest effect on the new cell-growths. Another view is that galls are the result of the injection into the tissues around the egg of a fluid secreted in the glands of the female connected with the base of the ovipositor or saw, and which correspond to the "poison-glands" of bees and wasps. This view is ably supported in a paper by M. Beyerinck upon the gall of *Nematus capreæ* on *Salix viminalis*, published in January of this year in the "*Botanische Zeitung*." It is certainly very difficult to explain the constancy of the forms of galls on the theory of irritation of the tissues alone, without the action of a specific poison or ferment; but there are various important questions as to the formation and development of these structures that can be solved only by well-devised and persevering experiments and observations.

I shall now endeavour to give brief descriptions of the galls of *Hymenoptera* (excluding oak galls) that have been found in Scotland, such as will enable any one interested in these curious productions to ascertain the makers should he find the galls. I shall also state the food-plants and the known localities for each gall in Scotland. A full description of the insects would occupy too much space, and can be found by any one desirous to gain a more thorough knowledge of the subject in the works of Mr. Cameron and Dr. Mayr.

It is more convenient for my object to group the galls by their makers than by their "host-plants;" but a list of host-plants, with their galls, is subjoined also.

The groups will be taken in the following order :—

I.—Cynipidæ (Gall-Flies).

Xestophanes Potentillæ (Vill.), Mayr., on *Potentilla Tormentilla.*
Diastrophus Rubi, Hartig, on stems of *Rubus.*
Aulax Hieracii, Bouché, on species of *Hieracium.*
Graminis, Cam., on corms of grass *(Agropyrum* or *Avena).*
Papaveris, Perris, in capsules of *Papaver (Rhœas).*
Glechomæ, Hartig, on leaves of *Nepeta Glechoma.*
Rhodites Eglanteriæ, Hartig, on leaves of species of *Rosa.*
Rosæ, L., on twigs of species of *Rosa.*
spinosissimæ, Gir., on *Rosa spinosissima.*

II.—Chalcididæ.

Eurytoma hyalipennis, Wlkr., in bud-galls of *Agropyrum.*
(?) *collaris*, Wlkr., in stem-galls of *Festuca ovina.*

III.—Tenthredinidæ (Saw-Flies).

Nematus vesicator, Bremi, in "bean-galls" of *Salix.*
leucostictus, Hartig,
leucostigma, Cam.
purpureæ, Cam.
nigrolineatus, Cam.
} on leaves of *Salix*, under folded margin.
Vacciniellus, Cam., in bud-galls of *Vacc. vitis-idæa.*

Nematus ischnocerus, Thoms., in "twin bean-galls" on leaves of *Salix*.

baccarum, Cam.,
Salicis-cinereæ, Retz.,
bellus, Zadd.,
curticornis, Cam.,
herbaceæ, Cam.,
} in "pea-galls" on leaves of *Salix*.

gallicola, Steph. & Westw., in "bean-galls" of *Salix*.

Euura pentandræ, Retz., in twig-galls on *Salix*.

nigritarsis, Cam.,
saliceti, Fall.,
} in swollen buds of *Salix*.

angusta, Hart., in twig (or petiole) galls of *Salix*.

? *venusta*, Zadd., in swollen petioles of *Salix*.

I.—Cynipidæ.

The true gall-flies of Scotland are mostly confined to the oak; but a few others are gall-makers on plants of other orders. Of these known to us one-half are confined to *Rosaceæ*, viz.:—*Xestophanes Tormentillæ* on *Potentilla Tormentilla*, *Diastrophus Rubi* on *Rubus* species, and three species of *Rhodites* on wild roses. Four species, all belonging to the genus *Aulax*, attack herbaceous plants of four natural orders. Other plants also are galled by *Cynipidæ* on the European continent, but do not occur wild in Scotland.

Xestophanes.—Of this genus three species have been recorded as European, viz.:—*X. Potentillæ*, Vill., from galls on *Potentilla reptans; X. brevitarsis*, Thoms., from galls on *P. Tormentilla;* and *X. foveicollis*, Thoms., from galls on *P. reptans*. The three are very similar to each other, and can be determined with certainty only by a specialist. I follow Mr. Cameron in accepting *X. Potentillæ* as our Scottish insect, though the galls are on *P. Tormentilla*. Possibly we may have one or both the others also in Scotland.

I have found the gall near Inverary, and specimens found near Aberdeen have been given me. They are irregular rounded swellings, several often being united on a stem, just above the nodes. The surface is pale green or purple-brown, and slightly hairy. Each mass incloses several oval cells, each occupied by a larva. They are common near Glasgow, and also are found at Dumfries (*fide* Cameron). Dr. Mayr describes the species of this genus (*Arten d. gallenbewohnenden Cynipiden*, p. 10). The distinctive characters are—

X. foveicollis has pronotum and metathorax tomentose.

X. Potentillæ has third antennal joint in female scarcely longer than fourth; fourth joint of hind tarsi almost twice as long as broad; antennæ brown, but more or less yellow-red at base.

X. brevitarsis, Thoms., has third antennal joint evidently longer than broad; fourth joint of hind tarsi scarcely longer than broad; antennæ dark brown, often without paler tint at base.

DIASTROPHUS, Hartig.—Of this genus two European species have been reared from galls, viz.:—*D. Rubi*, Hart., on *Rubus fruticosus*, *R. cæsius*, and *R. Idæus*, and *D. Mayri*, Reinh., on *Potentilla argentea*.

D. Rubi, Hartig., has been reported by Mr. Cameron from several places around Glasgow, but I have not seen or heard of its discovery in the centre or east of Scotland. It makes galls on the stems, which become thickened into spindle-shaped masses ⅔ to 2 inches long and ⅓ to ½ inch thick, at first green, afterwards brown. The pith is the part most affected. It is swollen and full of oval cavities, each in a firm cell wall, tenanted by a larva.

D. Mayri, Reinh., may possibly be found in Scotland where its food-plant occurs. It causes swellings on the stems of *Potentilla argentea*.

AULAX, Hartig.—This genus is one of the largest amongst gall-forming *Cynipidæ*, and its species are most varied in their selection of food-plants.

A. Hieracii, Bouché (*A. Sabaudi*, Hart.) forms galls on the stems of various species of *Hieracium*, preferring especially *H. sylvaticum* and *H. corymbosum*, so far as my experience goes. The galls are most frequently situated at the lower end of the inflorescences, so that the peduncles arise from them; but often the bases of the flower-heads are galled. At times the lower parts of the stems and the roots also bear galls. They are usually almost globular, or broadly spindle-shaped, and reach nearly an inch, or even more, in length, and contain numerous white oval cells, each protecting a white larva. These galls are common in Scotland. They are firm in texture, and often remain unaltered in form throughout the winter, becoming more conspicuous by their paler colour in spring when withered.

A. Hypochœridis, Kieffer, produces spindle-shaped or oval swellings on the peduncles of *Hypochœris radicata*. The largest galls may reach 1½ inches in length by nearly ⅓ inch in thickness. Their surface is like that of the healthy stem; but the pith is much swollen, and encloses a row of oval larval cells. These galls have not yet been found in Scotland, though they probably occur with us. I have recorded (*Scot. Nat.*, IV., p. 16) a specimen found in North Wales by Dr. Vice. They have been found also at Naples, and at Bitsch in Lorraine.

A. graminis, Cam., was reared by Mr. Cameron from corms of "knot-grass," but whether the corms were those of *Agropyrum repens* or of *Avena elatior* he could not determine (Proc. N. H. Soc. Glasgow, 1875, p. 321). The corms were little, if at all, modified, even in appearance, externally; each contained several oval cavities, in each of which lived a larva of what proved to be a new *Aulax* (described by him, *l. c.*, p. 322). They have as yet been found only near Partick; but they are so very inconspicuous that they may be quite common in many places, as their discovery is more likely to be accidental than the result of a search. I have often looked for them without success.

A. Papaveris, Perris (*A. Rhœadis*, Hart.), infests the capsules of *Papaver dubium* and *P. Rhœas*, causing them to become swollen and distorted to twice or thrice their usual size. On section they are found to be filled with oval cells, each inclosed in a hard wall. The larval chambers are formed in the septa of the ovary, as many as from five to thirty gall-flies sometimes being reared from a single capsule. The galls have been found in Berwickshire, by Mr. Hardy (Trans. Berw. Nat. Club, 1871, p. 263), but nowhere else in Scotland. The insects have the antennæ dark brown, scutellum of male with often a shallow longitudinal furrow, abdomen black or dark brown; length of male $\frac{1}{10}$ inch; of female $\frac{1}{12}$ to $\frac{1}{10}$ inch.

A. minor, Hartig., also galls the capsules of *Papaver Rhœas;* but it has not been found in Britain. Its galls distort the capsules even less than the galls of *A. Papaveris.* The insects differ a little in their characteristics, as the male of *A. minor* has the antennæ brown, with the second joint yellow-red or rusty red, scutellum unfurrowed, abdomen more or less yellow-red or chestnut-brown, darker above. Length of male $\frac{1}{14}$ to $\frac{1}{12}$ inch; of female $\frac{1}{16}$ to $\frac{1}{13}$ inch.

A. Glechomæ, Hartig.—I have found the galls of this insect on leaves of *Nepeta Glechoma* from Perthshire, sent by Dr. Buchanan White in June, 1873. They are situated on the midribs of the leaves, or on the side veins, or on the leaf-stalks. The separate galls are spherical and pea-shaped; but sometimes they are united two or three together, and form masses about an inch across. The walls are fleshy, and are covered with short whitish hairs.

RHODITES, Hartig.—The species of this genus all form galls on wild roses.

R. Rosæ, L., is the maker of the well-known "bedeguar-galls," so common on *Rosa canina*, *R. villosa*, &c. They form masses ½ to 2 inches across, covered with long, stiff, mossy-looking filaments, which are much branched, and green, yellow, or red. Each is made up of a number of small galls, enclosed in a thin hard wall. They are formed on the twigs, leaf-stalks, or midribs of the leaflets. They are very plentiful in many parts of the country in late summer and autumn.

R. Eglanteriæ, Hartig., produces pea-shaped spherical galls on the lower (rarely upper) surface of the leaflets of *Rosa canina*, *R. villosa*, *R. rubiginosa*, and *R. spinosissima.* Sometimes from four to six occur on a leaflet, but I have never seen two united together. They do not usually exceed ⅙ inch in diameter, are thin walled, easily indented, and smooth, or may bear a few bristles irregularly scattered over their surface. They are very common in all parts of Scotland. Frequently one finds them distorted, slightly swollen, and tenanted by several larvæ of an inquiline, *Periclistus caninæ.*

R. spinosissimæ, Gir., has been found in Scotland as a gall-maker only upon *Rosa spinosissima*, but on the continent of Europe its galls have been found upon *R. canina* also. They are very variable in situation and in form, being fixed to the young twigs, or sunk in the leaflets, or on the base of the flower, or on the petals or sepals. Usually two or more are united into a mass nearly an inch across; but frequently one finds single galls about ⅛ inch diameter. On leaflets or perianth they are sunk in the tissues so as to project both above and below, and often there is only a broken fringe of leaf substance round their sides. They are usually dull purplish red where exposed to the light. They are plentiful along the Scottish coasts where the food-plant grows.

R. rosarum, Gir., has been recorded from England, the galls being formed on the leaflets of *Rosa canina* and its allies. They are spherical, about $\frac{1}{5}$ or $\frac{1}{4}$ inch diameter, and usually bear four or five prickles, each $\frac{1}{15}$ to $\frac{1}{6}$ inch long, standing erect on the surface, and rendering the galls easy of recognition. Though not yet known as Scottish, they should be looked for here.

II.—Chalcididæ.

Of this family the large majority live as guests in the galls of other insects. But it has been observed that from certain galls on grasses only species of the genus *Eurytoma* have been reared, and this so often as to preclude error as to their being gall-makers. The insects are of small size, and are very difficult to distinguish from one another. The species yet recorded as Scottish are few, but in North America several others are known to injure grasses by feeding in the stems.

E. hyalipennis, Wlkr., makes galls on *Agropyrum repens* and *A. junceum*. The buds at the tips of the stems become swollen and covered with the imbricated bases of the leaf-sheaths. They may reach a length of over an inch, by a breadth of $\frac{1}{6}$ or $\frac{1}{4}$ inch. The galls on *A. junceum* are rather shorter and broader than those on *A. repens*, and are supported on a shorter stem, which is often hidden under the sand on the sea-coast. They are very plentiful in the neighbourhood of Aberdeen. They are formed in autumn, and become more conspicuous in spring when the healthy leaves fall off.

[*E. longipennis* is said to be the maker of similar galls on *Ammophila arundinacea*, found in North Holland. I fell into the error a good many years ago of supposing the galls on *A. junceum* to be on *Ammophila arundinacea*, and sent them to Mr. A. Müller as such, and he published this as the host-plant. I have not, however, found galls on *A. arundinacea*].

[*E. collaris*, Wlkr., was reared by Mr. H. Moncreaff (Entomol. V., p. 451) from galls on *Festuca ovina* found in Essex. They were elongated swellings on the stems, either one-celled or several-celled. I have found one-celled elongated swellings on the stems of *F. ovina* in two or three localities near Aberdeen, which seem to be the same as those found by Mr. Moncreaff].

III.—Tenthredinidæ (Saw-Flies).

The saw-flies form a group that is best characterised by the possession of the "saw"—*i.e.*, the ovipositor, toothed usually like a saw, and well fitted to pierce the tissues of the host-plants, to permit of the introduction of the eggs below the epiderm, or even to the cambium layers, where cell-formation is most active.

The saw-flies are a very natural assemblage of insects, almost all being rather heavy in form. Once known they are easily recognized as saw-flies; but the species are frequently very like one another, so that only a specialist can determine their names with accuracy. This is peculiarly the case in the very large genus *Nematus*, to which by far the most of the gall-makers belong.

The larvæ remind one a good deal of the caterpillars of *Lepidoptera* in habits and in appearance, though with something about them that is always distinctive after a little experience. They have generally more false feet (claspers) than exist in the larvæ of *Lepidoptera*. Many of them feed on the leaves, gnawing the edges or eating holes in the leaf-surfaces. These larvæ may live exposed, or may be protected by a covering composed of dry exudations from their skins, forming a dirty-looking coat; or they may be slimy. Others burrow in the tissues of leaves or in stems or fruits; others fold down leaf-margins, affording a transition to the true gall-makers. Of the latter a few species of *Euura* feed inside slightly swollen buds; other species of *Euura* gall the twigs, but the gall-making species of *Nematus* (except *N. vacciniellus)* produce "pea-galls," or "bean-galls," on leaves of various species of *Salix*.

All the Scottish gall-making saw-flies belong to the genera *Nematus* and *Euura*, but in England a species of *Hoplocampa (H. gallicola*, Cam.) has been reared from pea-galls on *Salix* by Mr. Parfitt. Another *Hoplocampa (H. testudinea)* has been found in Austria making galls on *Lonicera Xylosteum*.

Mr. Cameron, in the second volume of his work on the "British Phytophagous Hymenoptera," describes 107 species of *Nematus*, and divides the genus into 20 groups. The last 16 species fall into the group of "gall-makers," characterized as "species of 1½ to 3 lines in length, with black bodies, white legs (entirely white, or the femora may be more or less black), hyaline wings, with white or fuscous, or white and fuscous stigmata; clypeus incised." Under this division fall all the leaf-gall-making saw-flies, except one—*N. vesicator*, Bremi, which resembles very closely certain species that do not form galls,—and that fall under a group in which the abdomen, legs, and stigmata are more or less *yellow*.

I shall place first the only Scottish saw-fly that galls any genus of plants but *Salix*. I refer to

Nematus Vacciniellus, Cam., bred by Mr. Healy from galls found by Mr. Eedle in Rannoch on *Vaccinium Vitis-Idæa*. The galls are broadly oval, dull green when young, becoming brown when old, attached to the leaves by a narrow part of the surface, as with the galls of *N. Salicis-cinereæ*. The perfect insect is described by Mr. Cameron as like *N. baccarum*, Cam., but larger (2 lines long), with the stigma purer white, legs more yellowish, anal segment blacker, and antennæ longer. I am not aware of this insect or its gall being found elsewhere than in Rannoch.

N. vesicator, Bremi, is another Rannoch insect, not as yet found elsewhere in Britain. It forms "bean-galls" (*i.e.*, galls the shape of French beans, imbedded in the leaf substance so as to project almost equally above and below the leaf) on leaves of *Salix Helix*, *S. laurina*, and *S. purpurea (fide* Cameron). The galls are usually placed close to the midrib, with a border of unaltered leaf around each. The wall is thin, surrounding a cavity large in proportion to the size of the gall. The surface and colour are usually like those of the leaf, but the upper surface, where exposed to the sunlight, may be red. They are not unlike the galls of *N. gallicola*, W. & S., where the latter are few or solitary on a leaf, but the size of the chamber internally distinguishes the two forms. The features in which *N. vesicator* differ from other gall-makers have been mentioned above.

The "gall-maker" species of *Nematus* are very similar to one another in general features, but they present considerable differences in the nature of the galls to which they give rise. I have to thank Dr. Buchanan White for sending me numerous examples of the galls of this section, found by him in his investigation of the Willows of Perthshire, whereby my notes with regard to the host-plants of the various species have been much enriched, as will be seen below.

Certain species grouped in this section, on account of the insects possessing its distinctive peculiarities, are not strictly gall-makers, but form a transition to them, inasmuch as the larvæ of these species live below folded leaf-borders. The folding is done while the larvæ are still in the eggs. The fold may extend along the whole length of the leaf on one or both sides. According to the species, it may be directed upwards or downwards, and the width of the fold varies considerably. The species that possess this habit in Scotland are three :—

N. leucostictus, Hart. *(N. Sharpi)*, on *Salix viminalis*, *S. vitellina*, and *S. pentandra*, folding the border downwards. It is found throughout Scotland.

N. leucostigma, Cam., recorded by Mr. Cameron as folding down leaf-borders of *Salix Helix* (but feeding on the *upper* epiderm), in Braemar, Rannoch, and Dumfriesshire, but as not common. This insect is very like *N. leucostictus.*

[*N. purpureæ*, Cam., rolls down the edges of the leaves of *Salix purpurea*, as is done by certain gall-midges. It was discovered at Worcester, but has not yet been found in Scotland].

N. nigrolineatus, Cam., rolls down the leaves of *S. vitellina* in a narrow fold, seldom along both sides of the leaf. Mr. Cameron has found it in Clydesdale. He states that its saw-fly greatly resembles *N. leucostictus*, and also approaches *N. ischnocerus* closely.

We now come to the "gall-makers" strictly so-called, the larvæ of which live in true galls in or on the leaves, while the adult insects agree in the possession of the characters noted above.

N. ischnocerus, Thoms., makes galls on the leaves of various willows, especially on some of the alpine species. Mr. Cameron records them on *Salix laurina* and *S. purpurea*, on neither of which have I seen them; but I have found them in Braemar on *Salix nigricans*, *S. phylicifolia*, *S. Arbuscula*, and *S. Lapponum*, var. *Stuartiana.*

The galls are easily recognized, as they are very generally in pairs (often with the midrib or a large vein between the two), side by side. They project a good deal above the leaf, very little below. They are longer in proportion to their breadth than are the galls of most other species. In colour they vary considerably, the upper surface usually being dark purple, or pink, or dark green. The saw-flies emerge in April; the galls are found in June and July. Mr. Cameron gives Rannoch and New Galloway as localities for this species. I have found its galls on *S. nigricans* in Norway.

N. baccarum, Cam., was bred from greyish-green pea-galls sent to Mr. Cameron by Dr. White, from Dunkeld, where he had found the gall on the leaves of a sallow *(S. aurita ?).* The galls were closely covered with fine white hairs. The insect is smaller than the allied species ($1\frac{1}{2}$ lines long), and has *white* legs.

N. Salicis-cinereæ (Retz.), Thoms., is one of our commonest gall-making saw-flies, more especially if it be held to include, as Mr. Cameron is inclined to believe it should, the very closely allied, if not identical, *N. bellus*, Zaddach. Both are liable to vary in colour, so that the distinctive characters between the saw-flies are not constant. Nor are the galls more different than may be expected from the fact that those of *N. S.-cinereæ* are formed on smooth-leaved willows, and are glabrous, while those of *N. bellus* are on hairy-leaved willows, and are in consequence hairy, being very like those of *N. baccarum.* The synonymy of *N. S.-cinereæ*, Retz., is rather extensive, and references to the galls of *N. S.-cinereæ* will be found in English books or articles under one or other of the names:—*N. gallarum*, Hartig, *N. saliceti*, Zett., *N. viminalis*, Vollen., *N. cinereæ*, Thoms., *N. Degeeri*, Duf., and *N. Vollenhoveni*, Cam. The galls are about the size and form of peas, though sometimes oval, and are fixed by a narrow base to the lower surface of the midrib. They are glabrous, but may bear a few small warts (lenticels) scattered over their surface, which is usually some shade of green, with occasionally pink or red sides. Two or three galls may occur on a single leaf. They may be found throughout the summer. The larvæ eat away the walls till they are extremely thin, and contain little but a mass of granular frass. These galls occur everywhere in Britain, and all over the European continent. Cameron records them from "*Salix purpurea* and other smooth-leaved willows;" and I have them from *Salix purpurea*, *S. nigricans*, *S. purpurea* var. *Lambertiana*, *S. puberula*, Döll (*nigricans* × *cinerea*), and *S. rubra* var. *viminaloides*—sent me by Dr. White from Perthshire. I have found them in Aberdeenshire on *S. repens*, *S. phylicifolia*, and *S. purpurea.*

N. bellus, Zadd. (*N. pedunculi*, Cam.), is, as above said, scarcely separable from *N. S.-cinereæ.* It forms similar, but hairy, galls on *S. Caprea*, *S. aurita*, and *S. cinerea.* I have these galls from Aberdeenshire, Perthshire, &c. For the characters of the saw-flies reference must be made to Mr. Cameron's work, already so often quoted.

[*N. curticornis*, Cam., was taken on willows, in June, at Rannoch. It is very like *N. S.-cinereæ*, but is regarded by Mr. Cameron as sufficiently distinct. It may be a gall-maker, but its life-history is unknown].

N. gallicola, Westw. & Steph., is probably the most plentiful of all our gall-making saw-flies, as it produces "bean-galls" in countless numbers on several kinds of willows, preferring, however, *S. fragilis* and *S. alba.* On the leaves of the latter willows it is not uncommon to find from six to twelve galls, irregularly scattered, or arranged in ill-defined rows. They are oval, about ⅓ inch long, ¼ inch broad, and ¼ inch deep, projecting about equally from both surfaces of the leaf. Usually the surface is irregular. On most willows they are glabrous, but on *S. alba* they are hairy. Their colour varies on different host-plants—from deep red above on *S. fragilis* to pale green on *S. alba*, or dark green on *S. Caprea* or *S. cinerea.* At first they are almost solid; but the larva eats away the wall and makes a hole at one end, through which it ejects the frass. This species is exceedingly common everywhere. Dr. White has sent me the galls from Perthshire on *S. decipiens*, *S. fragilis*, *S. alba* var. *cœrulea*, *S. triandra* var. *concolor*, *S. ferruginea* (G. And.), and *S. cinerea* x *S. phylicifolia.*

N. herbaceæ, Cam., so far as is yet known, is confined to *Salix herbacea*, and is therefore of very local distribution, though frequently plentiful. It has been taken in Rannoch, on Ben Ledi, in Braemar, and in Sutherlandshire. The galls are attached to the leaves, usually one on each leaf, and are large in comparison with the size of the leaf. They are "pea-galls" (but are attached by a pretty large surface), occasionally oblong, glabrous, green, or red where exposed to sunlight. The saw-flies are rather small (1½ to 1¾ lines long). They emerge in spring; the galls may be found in July and August.

[*N. Bridgmanni*, Cam., was reared by Mr. Cameron from galls on sallow leaves sent him from England. It may also occur in Scotland. The galls did not differ appreciably from the galls of *N. gallicola* in the form that the latter assume on *S. Caprea.* The differences between the two saw-flies are given in full detail in Cameron's Monograph, Vol. II., pp. 202-3 and 208].

The genus *Euura*, to which we must now pass, differs from *Nematus* in no essential respect, but has been separated from it for convenience, the only constant character being the comparatively great length of the second cubital cellule in the front wings. The larvæ live usually in galls, but the galls are different from those of *Nematus.* They are swollen buds, or swollen petioles, or woody swellings of the twigs. The genus was for a time called *Cryptocampus*, but this name has had to yield priority to the older name *Euura* given by E. Newman.

E. pentandræ, Retz., produces twig-galls on *S. pentandra* in the form of swellings—oval, rounded, or irregular,—¼ to 1½ inches across, and hard and woody in texture. Several larvæ live in each gall usually, but not in the well-defined chambers so characteristic of the galls of *Cynipidæ.* This insect is local, but sometimes is only too abundant, loading the twigs with galls. *S. pentandra* is peculiarly liable to its attacks, but other willows also are infested by it. I have from Braemar what appear to be the galls of this saw-fly on *S. repens*, but of small size. I have no record of its occurrence in Perthshire.

E. flavipes, Cam., is recorded by Mr. Cameron from Rannoch and Clydesdale, but nothing is known as to its habits.

E. nigritarsis, Cam., is stated (L. C., pp. 212, 213) to live in the swollen buds of *Salix Caprea*, destroying so many of them as to kill the bushes in bad attacks. It is "common in Clydesdale—the imago in May; the larvæ in August, September, and October." It has not been observed elsewhere.

E. angusta, Hartig, is very similar to the last species, differing from it only in a few minor characters. It is "not common, but widely distributed" in Britain. It has often been bred from willow twigs, but there is some uncertainty whether it galls the buds or the petioles.

E. saliceti, Fallen, is a common species, which also galls the buds, and burrows from them into the twigs to pupate. It is little more than half or two-thirds as large as the others, being only 1½ to 2 lines long. It is said also to burrow in the petioles, and I have recorded from Glen Gairn what I supposed to be *E. saliceti*, but what may have been *E. venusta*.

[*E. venusta*, Zadd. Mr. Cameron mentions his finding near Glasgow galled petioles on *Salix Caprea* which he is disposed to attribute to *E. venusta*, Zadd. The petioles were considerably thickened throughout their length, from the base to the lamina; at first, like the healthy leaf-stalk, they become brown, as they dry up owing to their being hollowed out by the larvæ. I have found similar galls in Aberdeenshire, Forfarshire, and Perthshire].

LIST OF PLANTS (EXCLUDING OAKS) KNOWN TO BE GALLED BY HYMENOPTERA IN SCOTLAND.

Host-Plants.	*Insects.*
PAPAVERACEÆ.	
Papaver Rhœas, L. (vel P. dubium).	Aulax Papaveris, Perris.

Host-Plants.	*Insects.*
ROSACEÆ.	
Rosa spinosissima, L.	Rhodites spinosissimæ, Gir.
,, ,,	,, Eglanteriæ, Hartig.
,, canina, L. ,, villosa, L. ,, rubiginosa, L.	,, ,, ,, ,, rosæ, L. (Bedeguars). [Rh. rosarum, Gir., has not yet been observed in Scotland, but should occur here.]
Potentilla Tormentilla, L.	Xestophanes Potentillæ, Vill. [X. brevitarsis, Thoms., and X. foveicollis, Thoms., may occur in Scotland also.]
[P. argentea, L.	is galled by Diastrophus Mayri, in Austria.]
Rubus fruticosus, L. ,, cæsius, L. ,, Idæus, L.	Diastrophus Rubi, Hartig.
COMPOSITÆ.	
Hieracium sylvaticum, Sm. ,, corymbosum, Fr. ,, boreale, Fr. and probably other species	Aulax Hieracii, Bouché.
[Hypochœris radicata, L.,	Aulax Hypochœridis, Kieffer, probably occurs in Scotland, though not yet observed here.]
ERICACEÆ.	
Vaccinium Vitis-Idæa, L.	Nematus vacciniellus, Cam.
LABIATÆ.	
Nepeta Glechoma, Benth.	Aulax Glechomæ, Hart.
SALICACEÆ.	
Salix triandra concolor	Nematus gallicola, W. & S.
,, pentandra, L.	,, leucostictus, Hart. (leaf-roller). Euura pentandræ, Retz.
,, fragilis, L., and S. decipiens, Hoffm.	Nematus gallicola, W. & S.
,, alba, L., and var. cœrulea,	,, ,,
var. vitellina, L.	,, leucostictus, Hart. (leaf-roller). ,, nigrolineatus, Cam. (leaf-roller).

Host-Plants.	*Insects.*
Salix Caprea, L.	Nematus bellus, Zadd. ,, gallicola, W. & S. Euura nigritarsis, Cam. (bud-gall). ,, angusta, Hart. ,, ? ,, venusta, Zadd. (petiole-gall).
,, cinerea, L.	Nematus bellus, Zadd. ,, gallicola, W. & S. ? Euura.
,, aurita, L.	? Nematus baccarum, Cam. ,, bellus, Zadd. ,, gallicola, W. & S.
,, repens, L.	,, Salicis-cinereæ, Retz. Euura ? pentandræ, Retz.
,, nigricans, Sm.	Nematus ischnocerus, Thoms. ,, Salicis-cinereæ, Retz.
,, nigricans x cinerea (S. puberula, Döll)	,, ,,
,, phylicifolia, L.	,, ischnocerus, Thoms. ,, Salicis-cinereæ, Retz.
,, cinerea x phylicifolia	,, gallicola, W. & S.
,, "laurina" (*fide* Cameron)	,, vesicator, Bremi. ,, ischnocerus, Thoms.
,, viminalis, L.	,, leucostictus, Hart. (leaf-roller).
,, ferruginea, G. And.	,, gallicola, W. & S.
,, Lapponum, L.	,, ischnocerus, Thoms.
,, Arbuscula, L.	,, ,,
,, herbacea, L.	,, herbaceæ, Cam.
,, purpurea, L.	,, vesicator, Bremi. ,, purpureæ, Cam. (leaf-roller) ,, ischnocerus, Thoms. (*fide* Cameron). ,, Salicis-cinereæ, Retz.
,, purpurea Lambertiana	,, ,,
,, rubra viminaloides	,, ,,
,, "Helix" (*fide* Cameron)	,, vesicator, Bremi. ,, leucostigma, Cam. (leaf-roller).

Host-Plants.	*Insects.*
GRAMINACEÆ.	
? Avena elatior, L., vel ? Agropyrum repens, Beauv.	Aulax graminis, Cam.
Agropyrum repens, Beauv., and A. junceum, Beauv.	Eurytoma hyalipennis, Wlkr.
Festuca ovina, L.	? ,, collaris, Wlkr.

X.—*Note on the occurrence of the Desert Wheatear in the Tay District.*

By Col. H. M. DRUMMOND HAY, C.M.Z.S.

I have to record the occurrence, for the first time in the Tay district, of the Desert Wheatear *(Saxicola deserti).* This is the second appearance only of this rare bird in the British Islands, the other having also been got in Scotland in the year previous—in the Forth district, near Alloa. The specimen now exhibited was shot about half-a-mile east of Arbroath by Mr. Alexander Marshall, birdstuffer, on the 28th December, 1887, at about two P.M., as it was flying inland across the road leading along the top of the cliffs, having evidently just reached the shore. It was blowing fresh from the south at the time, after a very severe frost, which had continued for some days previous to this, and by mere chance it came into my hands. Hearing that the common Wheatear (which it was supposed to have been) had been got on our coast, and thinking this curious in midwinter, I asked for a sight of the bird, believing that it might possibly turn out to be a Stonechat, which not unfrequently passes the winter with us, but, to my great surprise, it proved to be the present rare species. Unfortunately, from part of the head having been shot away, it had been thrown out as unfit for preservation, but was afterwards successfully carbolized under the careful management of Mr. Robert Small, birdstuffer, Edinburgh. The sex, however, could not be ascertained, but it is believed to be a young male of the season.

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XI.—*Notes on some additions to the Birds and Nests recently placed in the Museum.* By Colonel H. M. DRUMMOND HAY, C.M.Z.S., B.O.U., Hon. Curator of the Museum.

(Read 8th November, 1888).

1. THE WHITE GREENLAND GYR-FALCON.—A fine female specimen of the White Greenland Gyr-Falcon *(Falco candicans)*, shot in Rannoch by Mr. M'Donald, I have much pleasure in stating, has now a place in the Society's Museum, presented by Sir Robert Menzies, Bart., to whose kindness and liberality, in contributing from time to time so many rare and valuable specimens, the Society is mainly indebted for the beautiful collections, representative of the natural history of Perthshire and the basin of the Tay, which it now possesses; and I am sure I have the authority of the Society in according Sir Robert its warmest thanks for placing in the Museum a bird which, as a British-shot specimen, only a very few Museums in this country can boast of.

Of the Gyr-Falcons (of which there are three, if not four, distinct races—the Greenland, Iceland, Lapland, and American,—the three first of which are admirably figured in Gould's magnificent work on the Birds of Great Britain) there has been much writing and discussion and much confusion; and it is greatly due to the labours of Mr. John Hancock, of Newcastle-on-Tyne, who, in 1838, first brought the subject before the British Association, and to his subsequent researches, that the distinction of races among the Gyr-Falcons is now so well understood. Of the Greenland, or White form (which is represented in the Rannoch bird), a native of the extreme north and arctic regions according to Mr. Seebohm, there have been only some half-dozen specimens recorded as taken in England, and about eight in Scotland, including its Islands; and, according to Gray, one of these (an immature specimen) was got in Perthshire in 1838, but the locality is not mentioned. I may here take the opportunity of stating that, somewhere about the years 1829 or 1830, when staying at Castle Menzies, I distinctly saw several times a Falcon, which I have always fully believed to have been one of this species. It was noticed by others as well as myself for several days together—sometimes to be seen on the wing, at others perched on some lofty tree,—but so wary was it, that it never allowed itself to be approached within shot, nor did it ever to my knowledge permit itself to be trapped; and, in default of any record of a Gyr being got anywhere at that time, it is to be hoped that it got safe back again to its own country.

Of the Iceland form (a darker bird), though in England the examples are not numerous, still in Scotland, as Mr. Gray informs us, there are many instances of its capture—in the counties of Ross, Sutherland, Inverness, and Argyle, and also in Shetland and in the Hebrides. It would thus appear that, at least in Scotland, the Iceland bird *(Falco islandicus)* is much the commoner of the two. It may have been from this cause, as well as from the markings of the plumage, that some eminent ornithologists who had the opportunity of seeing and examining our bird when sent for preservation expressed some doubts as to its being the true *Falco candicans.* To solve the question the bird was forwarded to Newcastle for Mr. Hancock's decision, and it may be gratifying to the Society to know that, in a letter I received from Mr. Hancock on the subject, he fully confirmed its being the Greenland form (a young female of the previous year), which I had from the first believed it to be, as the younger birds may always be known by the bluish lead-colour of the cere and feet, which as the bird matures becomes tinged with yellow. In fresh specimens, a good distinguishing mark between the Greenland and Iceland forms is, that the bill and claws at all stages are white in the former and more or less of a dusky horn-colour in the latter.

In former days the Gyrs were held in great repute by falconers, from their boldness, rapidity of flight, and keen eye, and commanded high prices when they could be got. In the language of falconry, however, the true Gyr-Falcon *(Falco Gyr-falco)* always applied to the Scandinavian bird; but of the three the Icelander bore the palm, from its greater range, higher courage, and more impetuous swoop to game, and, according to Latham, the King of Denmark was said to send annually to Iceland to buy up all that could be procured. These were caught in nets, the established place of sale being Bessested, to which the Icelanders brought them. The Gyrs were usually flown at larger game, such as the Swan, Crane, Heron, and Wild Duck, and so clever are they on the wing, that they will seize a Duck from the water when immersed and only showing the tip of the bill.

2. The Sand Grouse.—The next bird on the list, for which we are also indebted to Sir Robert Menzies, through his gamekeeper at Rannoch Lodge, Mr. John M'Donald, is a fine male specimen of the Sand Grouse *(Syrrhaptes paradoxus)* in full adult plumage, shot by the latter out of a small troop of three birds near the head of Loch Rannoch on the 29th of May of the present year (1888).

While on a visit to North Wales (residing, curious to say, close to the spot where, in a field near Tremadock, on the 9th of July, 1859, one of if not the very first Sand Grouse ever known to visit Great Britain, was shot by a labouring man, also out of a small party of three birds), I received a notice from Mr. M'Donald of a strange bird, unknown to him, which he had just shot in Rannoch, with so faithful a description that I had no hesitation in at once pronouncing it to be Pallas' Sand Grouse, though at that time this was the first intelligence I had of a second visitation of these birds to Scotland. A full description of the Tremadock bird, with an excellent coloured figure of the same, appears in Vol. II., 1860, of the *Ibis*; and in Vol. I., 1859, of the same work, is a notice of one got in Norfolk, also shot in the month of July of the same year; but, there being no dates, it is uncertain which has the prior claim; also, in this same year, several more were got both in England and the Continent. But it was not until the year 1863 that the first wonderful irruption from the plains of Eastern Tartary took place, spreading throughout all Asia and Europe, as so ably traced and described by Professor Newton, with a map illustrative of their wanderings (see *Ibis*, Vol. VI., 1864). At that period many of these birds visited Scotland, extending themselves through Perthshire and various other counties.

After an interval of twenty-five years, another extensive invasion from the same far-distant territories has this year taken place—not to say that they have never visited this country during this quarter of a century, for fresh arrivals were noticed in 1872 both in Northumberland and in Ayrshire,—but they were few in number, and none were recorded from other places. A few years later a pair were killed in Ireland, but there was no further visit in force until the present year (1888). This fresh invasion is, I understand, being worked out by Professor Newton on the same lines as the last, showing their progress from their starting-place, across the continent of Europe, to these islands. No cause has as yet, that I am aware of, been assigned for the restlessness of this species. These extensive passages westward can hardly be put down to migration, but a sort of abnormal movement that occasionally takes place, whether from want of food or over-population is only at present a mere conjecture. That there is a regular southerly migration there can be no doubt, especially from the more northern parts. During the joint occupation of the British and French troops in Northern China, flocks of many hundreds passed over that country during the winter of 1863, so that the markets were literally glutted with them; and, as mentioned by Professor Newton (*Ibis*, Vol. VI., 1864), many of these were brought home alive by gentlemen engaged in the expedition, and out of seventy-three brought home by Mr. Stuart Wortley thirty-four were handed over by him to the Zoological Society. Mr. Robert Swinhoe, in his notes on Chinese Ornithology, also alluded to their passage in Northern China as a winter migrant, abounding at that season in the plains between Pekin and Tientsin, where they are known as "Sha-chee," or Sand Fowl

(*Ibis*, Vol. III., 1861). Whether this has been as extensive a visitation as that of 1863 remains to be seen, but, as far as regards Scotland, the numbers are, by all accounts, fully up to what they were formerly, if they do not greatly exceed them, from "Berwick to Shetland." In Perthshire, besides those noticed in Rannoch, many were seen in Strathtay and Strathearn; and, owing to the kindness of Mr. P. D. Malloch, a fine female specimen has been presented to the Museum which was picked up dead, killed by the telegraph wires, in the latter district, near Abercairny, a fate which it is to be lamented has happened in numbers of instances throughout the whole country.

There has been much comment of late as to whether these birds have bred and reared their young in any part of the country. With regard to this, I have made some inquiries in the Tay district, and find that on Tents Muir, which is particularly adapted to their wants, there is no doubt but that they have bred and reared their young, though perhaps not to the extent they would have done had the season been a more favourable one, and not so unexceptionably bad, even for the rearing of our own native game birds, of which this has been one of the worst seasons known for some years. If it had been otherwise, we might have had better accounts; yet, from those received from Tents Muir, I have reason to believe that the breeding has been fairly successful, comparing the number of birds now on the ground with those that were seen in spring. In September last Mr. Alex. Speedie, jun., of Kinshaldy, on Tents Muir, informed me that there were then a good number of birds, and that he believed that many of these were young ones. On the 18th of August, when cutting a field of rye on the light sandy ground there, five young birds were captured. These were strong, well-grown, and full-plumaged birds, with the exception of the pointed tail feathers, which were not yet matured. A pair were sent alive to the Zoological Gardens in London, which were duly acknowledged as having safely arrived. The remainder were kept for some time in captivity, but were found to be so impatient of confinement that they were again restored to liberty.

On the adjoining property at the mouth of the Tay belonging to Admiral Maitland Dougal of Scotscraig they seem also to have done well, from the number of birds now on that part of the Muir. In May only a very few birds were seen, but in June these had increased to about 20 old birds, which were noticed to frequent the coarse grass growing on sandy spots. The locality was kept quiet all summer, and the birds were not disturbed till the beginning of September, when the Admiral, as he informs me, visited the ground, finding the birds in the same sort of places as described, as also in sandy turnip fields. He saw in all—one flock of 30, another of 17, a covey of 8, and 3 single birds. Four were shot, and of these a brace were young birds. The Admiral further assures me that there are still a good many birds on the ground, he having seen, only last week (beginning of November), a flock of at least 50. These rose high, and seemed to take a long flight; but, being very misty at the time, it was not seen where they alighted.

Admiral Dougal mentions a fact which I think worthy of notice as bearing on the habits of the bird in its native country. On visiting their favourite ground—which, as before stated, is on the more sandy spots, and never among the heather, which grows in the immediate vicinity,—he observed them to scrape down into the sand with their "rat-like" feet for about three inches or so, which he believed was for the purpose of feeding on the creeping roots of the coarse grass which grows there, as he noticed them using their bills as well.

With regard to this habit of making holes in the sand, Professor Newton quotes* from Herr Rudde, the naturalist attached to the Eastern Siberian Expedition of the Russian Geographical Society in 1856. Herr Rudde gives a full account of Pallas' Sand Grouse, which he saw when visiting the basin of Tarci-nor, a lake situated in Dauria, about 50° N. and 116° E., and describes them as arriving there about the 10th of March, and living in small societies (but always paired) on the salt plains, from which they resort early in the morning to the fresh-water springs to drink. There the flocks remained till about nine o'clock in the day, and then repaired to the white salt pans, among which are some slight elevations covered with grass. On these they scrape shallow pits, and sit there passing the rest of the day in quiet, some sleeping, and others walking about and plucking the young shoots of *Salicornia*, unless disturbed by a Falcon, when they immediately take wing. Might not the scrapings which Admiral Maitland Dougal observed be for the same purpose as described by Herr Rudde, and not, as supposed, for eating grass roots, seeing that their food consists chiefly of small seeds?

From the western division of the Tay District the information that I have been able to glean has been, I regret to say, most meagre. I have been unable to obtain any intelligence as to what has become of all the numerous birds that were seen last spring moving up Strathearn and Strathtay, whether they passed or remained, so little interest seems to have been taken in the matter; and it is only on the Strath Tummel side — namely, in Rannoch — that I hear that a very few birds were noticed during the summer. The last seen by Mr. M'Donald were three birds flying past Rannoch Lodge from a north-easterly direction about the end of July, and

* *Ibis*, Vol. VI., 1864.

a small lot which frequented a farm on the east of the river Ericht, during the summer, in fields—partly corn, partly meadow—near the loch side. I can only surmise that they may have nested, and, owing to the bad season, especially in so exposed a place, the eggs or broods were destroyed without being noticed. I may here mention that these birds, though called "Sand Grouse," are now removed from the genus *Tetrao*, as formerly placed by Linnæus, and associated with the *Columbæ*, to which they are more nearly allied.

3. THE GRASSHOPPER WARBLER.—Another valuable acquisition to the Museum, though not so imposing to look at as those I have already mentioned, is that of the Grasshopper Warbler, a bird which, from its habit of skulking through the thickest grassy underwood and bushes, seldom allows itself to be noticed, and may not, therefore, be quite so rare in the county as supposed. The example now in the Museum is the only one that has been got in Perthshire as yet, having been shot near Methven in the spring of 1870 by Mr. P. D. Malloch, in whose possession it has been ever since, and who has now kindly agreed to part with it in favour of the Society.

This brings the birds to a close, and I will now mention a few of the nests lately added to the collection, as deserving of notice either from the rarity of the bird itself or from the fact of its having been only known of late years to breed in Perthshire.

1. THE OSPREY.—The first I will bring under your notice is the Osprey, a pair of these birds having bred last summer (1887) at Loch Ordie, Dunkeld. The nest was a very bulky affair, having a thick foundation of lichen-covered larch sticks, many of them an inch in diameter, and the whole measuring nearly four feet across. This was placed on the summit of a lofty spruce (close to the loch) which having formerly lost its top 60 feet from the ground, the side branches had grown up so as to form a sort of canopy to the nest, out of which were taken, when first discovered, two eggs. Through the kindness of the Dowager Duchess of Athole, the nest was allowed to be taken down for the Society's Museum, and, after some labour, under the superintendence of Mr. Athole Macgregor, and of the forester, Mr. John M'Gregor, this was safely accomplished, and much is due to Mr. Athole Macgregor for the great trouble and care he took in having the nest properly secured with cordage before taking it down, and for conveying it himself to the Museum.

From the great size of the nest, as I had anticipated, it was found impossible to place it in any of the cases; we must therefore wait till the long-talked-of addition to the building has taken place. In the meantime the nest remains in a place of security, and I sincerely trust that the time for its final removal may not be very far off. I must not omit to mention that Her Grace has most kindly presented to the Society one of the two eggs originally taken; and also that, on the nest being brought to the ground, the remains of another egg were found, which had every appearance of having been sucked by a Hooded Crow. Both of these are now added to the Museum. The Osprey formerly bred regularly in Rannoch, its eyrie having a place on the tower at the head of the Loch. It is also understood to have had nesting-places on Loch Lydon; but it is now many years, till the present occasion, since it was known to have bred in Perthshire.

2. THE GOOSANDER.—The nest of this bird, as a Perthshire specimen, is a very rare acquisition, as it was only a year or two ago that it was ever known to breed in this county, the first nest having been got by Mr. Harvie Brown by the side of Loch Ericht, in Rannoch. Shortly after that I saw a young brood, lately hatched, along with the mother, on Loch Rannoch, and also a female bird on Loch Lydon, which was evidently breeding and in the possession of a nest, from the way she conducted herself, and last year, in the month of May, Mr. John M'Donald was enabled, through the kindness of Sir Robert Menzies, to secure a nest, with eleven eggs, from near the same spot, which is now in the Museum. This nest, which is composed of sedges and water-grasses, thickly lined with its grey-coloured down, was placed at the root or stump of a tree, the position of the nest being frequently on the tree itself. Since then I have been informed of another Goosander's nest, also taken in Perthshire, but in the Forth district. This was also at the root of a tree. Seebohm has it that they rarely build on the ground; the Ericht specimen was on a tree.

3. THE TUFTED DUCK.—The nest of the Tufted Duck, with full complement of eggs, was presented by David Smythe, Esq., yr. of Methven, it having been taken there, along with the next, by him and Dr. Buchanan White in June last. Though I had long suspected that these birds bred both at Methven and Dupplin, this is the first authentic instance that I have of the nest having been got in Perthshire. It is composed chiefly of sedges and water-grasses, lined inside with down plucked from the bird's breast.

4. THE POCHARD.—Another nest, which was only very lately known as to be found in Perthshire, has also been sent to the Museum, through the kindness of Captain Smythe—namely, that of the Pochard. This, like that of the Tufted Duck, was placed in a thick tussock of sedge, was composed of the same material, mixed with moss and dried grass, edged with down, and had its full complement of eggs.

5. THE WIDGEON.—The nest of another rare Perthshire-breeding Duck—that of the Widgeon (with eggs)—was presented by Sir Robert Menzies, having been got in the vicinity of Loch Eoch by

Mr. M'Donald in June, 1866, a full account of which appeared in my report in the Proceedings of the East of Scotland Union of Naturalists' Societies. Its nesting-places previous to that had, in Scotland, only been noticed in the Western Islands, Orkney, parts of Aberdeenshire, and the extreme Northern Counties.

Many other nests have been received, but those mentioned are the more notable.

XII.—*Geological Notes on Loch Carron and West Ross-shire.*

By R. Dow.

(Read 13th December, 1888).

I feel that I cannot use a more appropriate introduction to any remarks I may make to-night than that employed by Dr. Milroy, of Moneydie, in a paper he delivered to this Society a few years ago. He said, "Any remarks I may make are not given as possessing a scientific value. To communicate papers valuable in a scientific point of view is the function of specialists, and must be confined to a comparatively small number; but the great majority of members, though not scientists, can yet make use of their eyes, and can tell something of the plants and localities with which they may be familiar. The observers may not be able to draw from the facts all the conclusions which they warrant; but still, as far as the facts go, they have a value, and if members of the Society would be induced to observe and report their observations the papers would have a still more varied character, and would awaken a still greater interest." This is exactly my position. I simply desire to bring before you the results of my own observations of the district, and of my private reading since my visit to a most interesting corner of our country.

Strome Ferry, where I spent a pleasant holiday during the month of August of last summer, is 216 miles distant by rail from Perth, but only very little over 100 miles as the crow flies. It lies on the southern shore of Loch Carron, near its outer end, and is the starting-point for the mail steamers to Portree and Stornoway, a service which is kept up daily throughout the year, Sundays excepted.

In looking at a map of Scotland one soon finds that the river valleys of the north-west Highlands are arranged in two main groups or systems,—from north-east to south-west and from north-west to south-east,—and between these two systems there are intermediate ones, and some even inclining to both. The first are termed longitudinal valleys, as they run parallel to the axis of the mountain chain.

The second are termed transverse valleys, as they take up a position at right angles to the main axis. Loch Carron is the only true example of a longitudinal valley on the western seaboard of Scotland, north of the Great Canal.

While fresh-water lakes are plentifully present in the eastern slopes of the great water-shed that runs from Sutherland to the hills above Loch Linnhe, there are comparatively few on the western side, but there we have sea lochs instead. But if the land were sufficiently raised we should have the counterpart of this, viz., deep land-locked lochs, while all the outlying islands would be united to the mainland.

The deepest part of these western arms of the sea, singularly enough, is close to the shore, at their upper ends, the explanation being that these sea lochs were excavated by glaciers which once filled up all these submerged valleys. It can be shown that the whole country, with the exception of the highest hill-tops, was at one time smothered deeply in ice which flowed out from all the sea lochs, overflowing the islands off the coast, and only stopping at last in the deep waters of the Atlantic.

One of the finest examples of a raised beach—or, to speak more correctly, raised beaches, for there is a pair of them—is to be found at the entrance to the loch. The finest view-point is from the deck of the steamer as it is approaching the entrance. These beaches are there observed to be exactly at the same level, and the rich green of their slopes and upper surfaces, backed by the rocks behind, is a sight not soon to be forgotten.

These terraces are old sea-beaches, formed when the land stood at a lower level than it does now. The sea must have laid down the materials of the terrace when it was scooping out the caves at the foot of the cliff.

The oldest rock of the district is the massive gneiss, and, as Prof. Geikie remarks in his "Scenery of Scotland," there could be no fitter material for the foundation-stone on which the geological structure of Britain could be built. This old gneiss forms the long chain of the Outer Hebrides, Western Sutherland, Loch Maree, Tiree, Coll, Sleat, Rona, and Raasa. There is also a patch of it at the narrows of Loch Torridon. This gneissic platform is intensely ice-worn, the whole landscape being a wide expanse of smooth rounded bosses, with no definite lines—an inextricable labyrinth of domes, with no rugged crags or picturesque peaks. It is to be noticed that very little glaciation occurs in Skye, the youngest of our Scottish islands.

On this foundation lies the chocolate-coloured sandstone so splendidly exhibited around Loch Torridon, and hence called the

"Torridon Red." It is conspicuously shown in the mountains of Applecross, as seen from Loch Carron and from Loch Kishorn. The scenery it presents is striking and grand in the extreme, its mural character, which arises from its horizontal strata, being a most striking feature. It was co-related by Murchison with the Cambrian system in Wales, and hence called Cambrian. It is well, however, to give it a definite geographical position, and to call it Torridon Sandstone, the title given to it by Professor Nicol, of Aberdeen.

This red sandstone rests unconformably on the much older gneiss, as is well seen on the Gairloch, near the Free Church, and also around the shores of Loch Torridon, where the rounded and gnarled gneiss is seen to underlie the newer formation. The gneiss was, in truth, just as gnarled and venerable-looking a rock when these sandstones were laid down as it is now. The line of demarcation between the two formations is often remarkably abrupt and impressive.

As the ground mounts in these eminences the covering of herbage grows more and more scant, until they form naked precipices without a vestige of vegetation. Many of these colossal pyramids rear their heads to a height of 3000 feet, yet, when the formation is traced out as a whole, it is seen to thin out to a remarkable degree, and, as it must have been of a uniform thickness at its formation, we must infer that a prodigious denudation has been the reason for this thinning out.

Hugh Miller's description of these old masses of red and chocolate-coloured conglomerates and hard sandstones, which can be seen reposing upon the oldest gneiss of Scotland, is so eloquent that I make no apology for quoting it.

"Rising over a basement of rugged gneiss hills, that present the appearance of a dark tumbling sea, we descry a line of stupendous pyramids from two to three thousand feet in height, which, though several miles distant in the background, dwarf by their great size the nearer eminences into the mere protuberances of an uneven plain.

"Their mural character has the effect of adding to their apparent magnitude. Almost devoid of vegetation, we see them barred by the lines of nearly horizontal strata, as the edifices of man's erection are barred by their courses of dressed stones; and, whilst some of their number rise at an angle as steep and nearly as regular as an Egyptian pyramid, in height and bulk they surpass the Egyptian pyramid many times. Their colour, too, lends to the illusion of a deep red hue, which, in the light of the setting sun, brightens into a glowing purple. They contrast as strongly with the cold grey stone of the gneiss tract beneath as a warm coloured building contrasts with the earth-tinted sheet or roadway over which it rises."

These cones are striking memorials of denudation. The valleys have all been eroded, and these strange pyramids are left as monuments of prodigious ages of waste. They are merely detached patches of a formation not less than seven or eight thousand feet thick, which once spread over the north-west of Scotland, the horizontal stratification of one hill being plainly continuous with that of the others.

Above the Torridon Red lies a thick band of quartzite, a highly metamorphosed fine sandstone. The quartzite may be seen in patches stealing up the slopes of the red sandstone mountains, and even capping their summits. As these overlying patches are grey or white in colour, the contrasting hues of the two rocks give rise to some of the most unexpected features of the scenery. At a distance the lines of white debris which seam the mountain sides might be taken for glaciers.

The quartzite is interesting as containing the earliest indications of organic life yet discovered in Scotland, viz., *Annelid borings.* These are very clearly seen, as the borings are often filled with sand of a different colour from that in which they had been bored. They form what are locally known as "pipe rock." Examples are abundant round Kinloch Ewe.

Associated with this quartzite are bands of limestone, which extend from Loch Carron to Loch Eribol. In this limestone shells were discovered in 1854 by Mr. Peach, the eminent geologist and friend of Dick of Thurso. These were determined to be Silurian by Mr. Salter, a great specialist in such matters. The discovery of these fossils gave a great impetus to the study of these rocks, and formed the basis of the theory propounded by Murchison. It is a well-known fact that limestone yields a kindly soil to grass and flowering plants, and the out-crops of this limestone can be seen even at a distance by the contrast of the bright verdure with the dun-coloured rocks around. The limestone band may be traced from a summit for miles, like a green belt, as it winds from brown hillside to browner valley.

Just where the road from Poolewe and Aultbea touches the shores of Loch Gruinard are found two patches of the Lower Trias, consisting of a very red sandstone, somewhat similar in appearance to the Permian of Dumfries. They are reckoned to be 1000 feet thick. No fossils have been found, but their age has been satisfactorily determined.

This small patch is of extraordinary interest, being the most northerly example of mesozoic rocks on the west coast. They form an isolated fragment of the deposits of this period which extended from Gruinard to Mull, but which have been entirely swept away by denudation, except at these scattered points. At Gruinard they have been preserved from destruction by enormous faulting, being let down at least 1000 feet into the Torridon Red. These rocks are represented on the east coast by the famous reptiliferous sandstones of Elgin.

As Dr. Geikie remarks, the consideration impressed upon the observer of Highland geology is that he meets with rock masses of very different geological ages thrown into puzzling juxtaposition by the gigantic movements to which this part of the earth's surface has been subjected. He encounters at every step complicated foldings, vast dislocations, and stupendous inversion of strata.

It is somewhat striking that a country like Scotland, in which the rock formations are found hopelessly crumpled and crushed together, and broken into fragments that seem to defy all attempts to reduce them to order, should be united to one like England, where, by comparison, all is orderly and simple, the strata lying in regular sequence, like well arranged volumes in a library, and only awaiting the touch of the geological hammer to display the wealth of their fossils.

In conclusion, let it be remembered that all these formations and movements took place ages before the deposition of the Old Red Sandstone rocks, with which we are so familiar in this part of the country, for the latter lie on the upturned edges of the schists; but, in the Highlands, this formation has been almost entirely denuded.

XIII.—*Additions to the Flora of the Woody Island in 1888.*

By Wm. Barclay.

(Read 13th December, 1888).

My visits to the Woody Island during the past season were not numerous. Generally it happened that when the weather was dry and suitable, which was seldom, I was prevented from going by work or some engagement that could not be put off. If at any time I had leisure and was desirous of visiting the Island, then it commonly happened that heavy and persistent rain pouring down from a leaden sky put botanising out of the question. Two, at least, of the visits which I did make were cut short by drenching showers, and resulted in little else than draggled garments and soaking feet. Nevertheless, a few additions to the list were made, and a still greater number have been communicated to me by Dr. Buchanan White, who observed them whilst visiting the Island for the purpose of studying the Willows.

In all, the new plants seen during the season number eleven species, none of them, however, with one exception, remarkable for rarity. Eight of these are, in all likelihood, old residenters which were somehow missed during our previous visits; the remaining three probably took up their abode in the Island for the first time during the present year. The former lot—the old inhabitants—comprise *Viola tricolor*, *Cardamine flexuosa*, *Cerastium semidecandrum*, *Trifolium medium*, and one of the Batrachian *Ranunculi*. Of these it is not necessary to say anything. But special mention deserves to be made of *Salix puberula*, a hybrid species of Willow. This has not hitherto been recorded as British, although Dr. Buchanan White, who noted its presence in the Island, informs me that it occurs in several other parts of Perthshire. Another plant worthy of mention is *Ornithogalum umbellatum*. This, the Star of Bethlehem of our gardens, is not considered to be a native British plant, but belongs to Southern Europe and Western Asia. In Palestine it spreads forth its lovely star-like blossoms as early as the month of December. It must, of course, have been brought to the Island by the river, an outcast from some garden higher up the valley. Then I must not forget to mention *Fagus sylvatica*, the Common Beech, of which one specimen—a fair-sized tree—was noted in the Island for the first time during the present season. It is not exactly a microscopic object, and, of course, was not *over*looked, but *under*looked during our previous visits.

Of the three species which are almost certainly new-comers during the present year, the first is *Lepidium Smithii*, a plant not uncommon in Perthshire. It was growing in small quantity on the gravel at two different places, and it remains to be seen whether or not it will make a permanent lodgment. The second is *Valerianella olitoria*. I was much surprised on my first visit to the Island in spring to find a good many patches of this plant growing on the eastern bank next the river. It could scarcely have escaped notice had it been there the previous year, for the bank on which it was growing was rather a favourite spot of mine, and was closely searched at almost every visit paid to the Island during that season. *Valerianella olitoria* is not at all rare in Perthshire, and, as it grows plentifully near the Linn of Campsie, it is easy to understand how it came to the Woody Island. On the same bank, when on a visit to the Island in autumn, along with Mr. Meldrum, I found a small patch of the Trailing St. John's Wort, *Hypericum humifusum*.

The eleven species which I have enumerated, when added to the former list, bring up the total to 331 species, all of which, with two exceptions, have been seen actually growing during the years 1887-88. Of course all of these will not manage to maintain their footing. Floods will uproot and carry off some, while many others wlll undoubtedly succumb and perish in the keen struggle for existence which must go on where so many species are crowded into such a comparatively small space. It will be interesting and instructive to take a fresh census in the course of a few years, and to note what plants come off victorious in the strife, and of what others it will have to be said, "They were, but are not."

XIV.—*A List of Additional Aculeate Hymenoptera collected in Perthshire during 1888.* By T. M. M'Gregor.

(Read 10th January, 1889).

To the entomologist the past year has been most unfavourable; and this is in great part our excuse for presenting such a humble list of additions to our previous list. The time at our disposal, however, is very limited — chiefly Saturday afternoons, with an occasional holiday,—and as these insects are almost entirely diurnal, only appearing for a few hours in the earlier part of the day, and then only in the sunshine, it will better be understood how comparatively humble any efforts to study under such circumstances must be. At the commencement of the season, we had hoped for better results, but the eventual predominance of wet weather greatly limited our excursions, although advantage was taken of bright weather on every possible occasion.

While in some cases numbers of certain insects were obtained, some of the species are represented by only single individuals, notably *Nomada ruficornis* and *Osmia rufiventris*, both common British insects. Many of the insects which were found singly the previous year (1887) were this year found in abundance; while one species found in some numbers in 1887 has this season entirely disappeared, another member of the same family appearing in its stead at the same time and place.

The rarest of our captures we believe to be *Nomada obtusifrons*, of which we fortunately secured four specimens in one day. These we found on the Yarrow (*Achillea Millefolium*).

The insects added this year are as follows:—

FOSSORES.

Pompilidæ.

POMPILUS.
niger, Fab.
gibbus, Fab.

Pemphredonidæ.

PEMPHREDON, Latr.
lugubris, Fab.
unicolor, Latr.
lethifer, Shuck.

Crabronidæ.

CRABRO.
clavipes, Linn.
varius, Lep.
peltavius, Schreb.
v. patellatus, Panz.

DIPLOPTERA.

Eumenidæ.

ODYNERUS, Latr.
SUBG. I.—HOPLOPUS.
spinipes, Linn.
pictus, Curt.
trimarginatus, Zett.

ANTHOPHILA.

Andrenidæ.

SUBD. II.—ACUTILINGUES.

HALICTUS, Latr.
nitidiusculus, Kirb.
leucopus, Kirb.

ANDRENA, Fabr.
Clarkella, Kirb.
nigroænea, Kirb.
helvola, Linn.
fucata, Sm.
fasciata, Nyl.
minutula, Kirb.
v. parvula, Kirb.

Apidæ.

NOMADA, Fab.
ruficornis, Linn.
obtusifrons, Nyl.

XV.—*On the Arrangement of the Perthshire Geological Collection in the Museum.*

(Read 11th April, 1889).

I.—THE ROCK SPECIMENS. By H. COATES, F.R.P.S.

Owing to a variety of circumstances, the arrangement of the geological department of the Museum was longer delayed than that of any other section. Until last summer the shelves were adorned by only a few odd specimens, which were interesting in themselves, but did not convey a very connected or comprehensive idea of the stratigraphical structure of Perthshire. Our former President, Dr.

James Geikie, had kindly undertaken to form and arrange the collection, but just as he had commenced to do so he was called to fill the chair of geology in Edinburgh University. It must not be supposed that the work of collection and arrangement is yet complete. It is, in fact, only begun; but I think it will be found that the outline which we have endeavoured to trace by means of the specimens and labels is fairly representative.

First, let us see what a collection representing the Geology of Perthshire should be, and then we shall see how far this has been attained. Even to a casual observer, it is obvious that the stones he finds in different parts of the county differ from each other in various essential particulars, as colour, texture, hardness, chemical composition, &c. Some are red, others white, others green. Some can easily be broken with the hand, others hardly with the hammer. Some contain lime, others alumina, others only silica. Some are of one homogeneous structure throughout, others are built up of various crystalline forms, while others consist of non-crystalline particles more or less compactly cemented together. Now, supposing we bring representatives of all these different kinds of rock together, and arrange them according to the various characters which I have enumerated, we have then advanced a step towards a systematic arrangement, but we have not yet fully attained our object; that is to say, the specimens will help us towards a study of comparative petrology, or the study of rocks as such, but they will not teach us much about the history and mode of occurrence of the rocks of Perthshire. What we want is that our specimens should form the illustrations, as it were, to a geological history of Perthshire.

Let me sketch this history in the briefest possible outline. More than two-thirds of the county lies within the Highlands, and the rest within the Lowlands, terms which, in this case, mark a distinction not only of altitude and scenery, which are but superficial characrers, but also of geological structure and age. The boundary line between the two is well defined throughout, and runs in a direction from north-east to south-west, passing approximately through Alyth, Birnam, Comrie, and Callander. This line represents what is known as the Great Fault of the Highlands, although the boundary between the two formations does not at all points correspond with the line of the fault. To the north-west of this line—that is, in the Highland division—the rocks are of (so-called) Silurian age, while in the south-eastern, or Lowland division, they are of Old Red Sandstone age. Each consists of a succession of sedimentary rocks piled layer upon layer, and into these have intruded, in each case, vast masses of igneous rock, but the characters, both of the sedimentary and of the igneous rocks, are very different in the two cases.

We will look at the Old Red Sandstone, or Lowland rocks, first, because these, being newer than the others, are less altered, and therefore more easily understood. Here we find beds of conglomerate and sandstone, varying, just as shingle and sand do at the present day, in the composition, size, and compactness of their component particles, and also in the proportion in which the different mineral constituents occur. The igneous rocks associated with this division are more distinctly volcanic in their character than those found in the Highland division, partly, perhaps, because their origin was more analogous to that of modern volcanic products, and partly because they have been less altered by subsequent pressure and heat. They are generally dark in colour, distinctly crystalline in structure, and basic in chemical composition, and many of them exhibit such special volcanic characters as steam-holes, regional variation of texture, &c. They occur both as interbedded layers and as intruded masses or dykes.

If we next examine the sedimentary rocks of the Highland division, we shall see at a glance that they are totally different from those of the Lowland division. I would here say in passing that nowhere can the transition from the one series to the other be better seen than in Glen Turret, near Crieff, where the texture and contour of the mountain sides at once change as we pass from the one formation to the other, the flowing lines of the unaltered newer beds being exchanged for the fantastic curves and bold irregularities of the hard and gnarled rocks of the older formation. When closely examined, these sedimentary rocks are, generally speaking, found to be very hard and compact, the component particles being welded together into a crystalline mass, and the parallel lines of bedding are exchanged for curved lines, which often flow in the most grotesquely contorted manner, sometimes doubling back upon themselves again and again. Such at least are the characteristics of the most abundantly developed group, the schists. The other sedimentary rocks of the Highlands, such as the quartzites, grits, limestones, &c., though not contorted in the same manner, are all crystalline and compact, so that all of these rocks help to impart to the scenery of the Highlands its bold and rugged character.

The igneous rocks of the Highlands present a more varied aspect than those of the Lowlands, consisting of granite, felsite, porphyry, &c. Many of these differ only in the proportion in which their principal mineral ingredients are present. Thus, if we suppose a quartz-porphyry to lose part of its quartz, and gain a corresponding increase in its felspar, we have a felsite, and *vice versa*. It is this variability of composition which makes these old crystalline rocks so difficult to identify, except by the aid of the microscope, and especially the polariscope. Regarding the origin of many of these so-called igneous rocks much doubt still exists. Some have no doubt been forced into their present position in a molten condition by volcanic action, while others appear to owe their origin to a gradual alteration of older rocks, through the action of heat and pressure and other agencies.

Such, in the briefest possible outline, is a sketch of the rock-structures of Perthshire. As I have already said, our collection does not by any means fully illustrate these as yet, the reason being that only certain limited areas have been worked up with a view to augmenting the collection, and even these not exhaustively. The districts immediately around Perth and Crieff, and the Breadalbane mountains, are the localities from which most of the specimens have been obtained, and this fact alone will indicate what a large field still remains to be examined. Before the collection can be considered complete it must embrace a comprehensive series of specimens representing the rocks of each district of the county.

Should any member desire to assist in the work of augmenting the collection, all that he or she will require in the way of appliances are a strong geological hammer, a strong canvas bag, and—perhaps I should add—a strong pair of shoes. To a beginner in this work I would give the following hints. Always carry a supply of old newspapers, and wrap up each specimen separately, to prevent it from being scratched. Label each specimen at the time it is gathered, with the date, locality, and mode of occurrence. Always take specimens from the living rock, if at all practicable. Loose stones are of no use as rock specimens, except in certain cases to illustrate some special characteristic. Always take your specimens from a fresh surface of the rock, except in cases where you wish to study special effects of weathering and denudation. Select the specimens so as to show the grain—whether of crystallization or bedding—in different directions. Lastly, as to the size of specimens, this is a matter more of convenience and appearance than of scientific importance, and yet it is a point worth attending to. For instance, when we began to arrange the collection we found some specimens of the Porphyrite of Kinnoull Hill, weighing about a quarter of a hundredweight, which illustrated the characters of the rock in question equally well after we had reduced them to a quarter of a pound! On the other hand, specimens of rock the size of a pigeon's egg, or less, look equally absurd. A handy size to which to shape specimens is about three inches by four inches surface, and about one inch thick. There are of course cases where it is advisable to have larger specimens, and cases where it is impossible to obtain them even as large.

In conclusion, let me say a word in commendation of this study of the rocks. I know there is a general impression that geology is a dry and matter-of-fact study, and probably my remarks this evening have not done much to remove this impression, but to any one who takes it up in earnest I think I can promise that they will not find it so. If any are doubtful on this point, let me advise them to read Dr. Archibald Geikie's "Scenery and Geology of Scotland." I think they will then admit that a knowledge of the geology of a country imparts to its scenery an interest, and even a romance, which it did not possess before.

The following is a list of the different Rocks in the collection. Most of these are represented by several specimens, in order to show variations of structure, weathering, or mode of occurrence, or to illustrate the distribution of the rock in different localities :—

I.—ROCKS OF LOWLAND PERTHSHIRE.

Conglomerate.
Altered Conglomerate.
Brecciated Conglomerate.
Tuffaceous Conglomerate (interbedded with Porphyrite).
Baked Tuffaceous Conglomerate (interbedded with Porphyrite).
Grit.
Baked Tuffaceous Grit (interbedded with Porphyrite).
Sandstone.
Flaggy Sandstone.
Altered Sandstone.
Micaceous Sandstone.
Sandstone with Clay Nodules.
Pebble in Sandstone.
Porphyrite.
Amygdaloidal Porphyrite (also specimens of the same showing vesicles filled with Calcite and with Green Earth).
Joint-face of Porphyrite coated with Chlorite.
Porphyrite in contact with Tuff.
Porphyrite in contact with Tuffaceous Sandstone.
Porphyrite interbedded with Baked Tuffaceous Grit.
Basalt (Fine, Medium, and Coarse-grained).
Dolerite.
Diabase.
Tuff.
Altered Tuff.
Tuff veined with Calcite.

II.—ROCKS OF HIGHLAND PERTHSHIRE.

Mica Schist.
Hydro-Mica Schist.
Hornblende Schist.
Orthoclase Schist.

Quartz Schist.
Quartz Schist with veins of Quartz.
Garnetiferous Mica Schist.
Contorted Sericite.
Conglomerate.
Grit.
Quartzite.
Micaceous Quartzite.
Quartzite with Copper Pyrites.
Crystalline Limestone.
Crystalline Limestone coated with Calcite.
Clay Slate.
Clay Slate with Quartz Veinstone.
Micaceous Clay Slate.
Chlorite Slate.
Gneiss.
Granite.
Foliated Granite.
Granitite.
Porphyritic Granitite.
Hornblendic Felstone.
Felspar Porphyry.
Quartz Felsite.
Minette.
Kersantite.
Gabbro.
Diorite.
Dolerite.
Serpentine.

II.—The Minerals. By P. Macnair.

In laying before you the following notes anent the Minerals and their mode of arrangement in the Perthshire geological collection, I may say at the outset that no attempt has been made at classifying them under any system. The reason for this is obvious when you reflect upon the fact that the minerals represented in Perthshire alone cannot be said to be very numerous, and again, that the Perthshire minerals are probably not nearly all represented by those in the Museum. Thus, any attempt at arranging them under a system of classification would, as yet, be entirely superfluous, and might tend more to confuse than aid the student of the Perthshire minerals. However, should the student wish to find the relationship of our local minerals to others, or their position in a system of classification, he can easily do so by referring the said mineral to its representative in the Index Collection, which has been arranged according to the system adopted in Dana's "System of Mineralogy," and which was specially selected with reference to the minerals occurring in Perthshire. Thus, though no system of classification has been adopted with regard to the chemical constituents of the minerals themselves, yet they have been divided into two divisions with relation to the system of rocks in which they occur. The first division contains all those minerals associated with the crystalline and sub-crystalline rocks of Highland Perthshire, while the second embraces all those found in the sedimentary and associated crystalline rocks of Lowland Perthshire.

On first inspection this mode of arranging the minerals may seem to be more of an arbitrary than a scientific method, as many minerals might be mentioned which are common to both areas; yet, when we remember that the nature of a rock and the history of its formation, as well as the evidence that is required towards the building up of that history, is often intimately dependent upon its mineralogical structure, we shall see that the division is not so arbitrary as it may appear to be at first sight.

The study of the origin and history of a rock mass is greatly dependent upon the science of Petrology, which attempts to define and classify the great rock masses that form the solid crust of the earth. For instance, it shows that a great part of the earth's crust is composed of what have been termed sedimentary rocks, which vary in their mineralogical composition, some being formed of one mineral, such as limestone (calcite), and some of grains of pure white quartz, such as sandstone; others are composed of a greater variety of minerals, and are therefore not so simple. On the other hand, we have the metamorphic rocks, which are but altered forms of the above sedimentary rocks, in which a more or less crystalline structure has been superinduced by the action of pressure, heat, etc. Again, we have the igneous rocks, which have been ejected to the earth's surface in a molten state and have subsequently cooled, assuming a definite crystalline structure. We will see further on that the whole of these divisions are represented in the county of Perth, and that the distribution of these various classes of rocks influence to a great extent the mineral wealth of the county.

As will be seen from the paper already read by Mr. Coates on the Rock Specimens in the Museum, and the general geological structure and distribution of the rock masses in the county, we have represented within its area the three great divisions already mentioned into which geologists have subdivided the various rocks occurring on the surface of the earth. The county may be geographically and geologically divided into two great and distinctly marked divisions, known as Lowland and Highland geographically considered, and as the Old Red Sandstone and Silurian (?) divisions from a geological point of view.

The rocks occupying the Lowland area of the county are mostly of sedimentary origin, and the minerals associated with them are consequently very few. Even the associated crystalline rocks of the Old Red Sandstone very seldom contain minerals sufficiently well developed to demand the attention of the mineralogist; yet in the cavities of the porphyrites are to be found such minerals as calcite, agate, quartz jasper, green earth, etc. These cavities, or steam holes, in the porphyrites have long been known as the habitat of the zeolitic class of minerals, but there seems to be a decided absence of these minerals in the porphyrites that surround Perth, where they are replaced by agates or some of the aforementioned minerals. Only one zeolitic mineral is represented in the Museum, that being a specimen of Thomsonite from Glenfarg.

On the other hand, the crystalline and sub-crystalline rocks of Highland Perthshire supply by far the largest percentage of the minerals found in the county. The Highland area consists for the larger part of great beds of sedimentary rocks, which have been metamorphosed into gneiss, mica-schists, quartzite, hornblende-schist, crystalline limestone, etc., and have assumed in a greater or less degree a crystalline structure. Into these altered sedimentary rocks have been intruded great masses of igneous rock, such as granite, diorite, felsite, quartz-porphyrite, etc., all of which, having their mineral constituents more or less developed, present a happy hunting-ground alike for the petrologist and mineralogist. It is also amongst these rocks that we find the lodes or fissures which have become the principal receptacle for such metallic ores as galena, copper-pyrites, blende, etc. They are very numerous in Breadalbane, Perthshire, and present a most interesting field of research for the mineralogist. Such, then, is the principle under which we have classified the minerals in the Museum. It is the simplest, and perhaps the best, that could as yet be adopted. To each mineral is appended a ticket, bearing its name, mode of occurrence, locality, and collector, all of which are of the greatest importance, and without which the specimen is almost entirely useless.

In going over the collection we found many good specimens wanting one or other of these particulars, which we had in consequence to leave out. It is therefore of the greatest importance that those collecting minerals for the Museum should note the above particulars, as the value of the specimen is almost wholly dependent upon them.

We now pass on to give a brief description of the minerals already in the Museum, detailing some of their local characteristics, such as their mode of occurrence, etc.

Quartz.—Quartz is one of the most common minerals in the county, and is generally found in the Highland area coating fissures in the rock, in which very good crystalline specimens are often to be found. It is also to be found massive, as veins of segregation in the schists. In the Lowland area it is usually to be met with in the cavities of the porphyrites. There are specimens in the Museum illustrating its occurrence in both localities.

SMOKY QUARTZ.—Smoky Quartz, or Cairngorm stone, is very common on the Breadalbane hills, north of Loch Tay. It is generally found massive, associated with the schists. Smoky Quartz also occurs in the vesicles of the porphyrites.

AMETHYSTINE QUARTZ.—Amethystine Quartz is often to be met with in the cavities of the porphyrites. The specimen in the Museum is from Kinnoull Hill.

OPAL OR MILKY QUARTZ.—Opal Quartz has also been found in the cavities of the porphyrites. The specimen in the Museum is from Kinnoull Hill.

AGATE, OR SCOTCH PEBBLE.—There are some very fine specimens of this variety of quartz in the Museum. They are all from the associated igneous rocks of the Old Red Sandstone, and have been found filling the cavities in these rocks. They occasionally enclose crystals of transparent quartz, the apex of these crystals pointing inwards, and thus showing that the growth of the agate has been from the outside inwards. Some of the specimens presented to the Museum have been beautifully polished. One specimen shows the vesicles in the porphyrite filled up with hundreds of almost microscopic agates. These agates are only to be found where the interbedded porphyrites crop out. The specimens in the Museum are from Kinnoull Hill and Glenfarg.

CALCITE.—Calcite is another very widely distributed mineral in the county. In the Highland area it is generally found associated with the crystalline limestone, which is itself but a massive form of this mineral. In the Lowland area it is usually found in the cavities of the porphyrites, and also as veins and masses in the sandstones. Specimens from both the igneous and aqueous rocks of the Old Red Sandstone System are to be found on the shelf allotted to the Lowland minerals, and specimens from the Highland area are to be found on the shelf allotted to the Highland minerals. Quartz and calcite, as well as the mineral about to be mentioned, often occur as veinstones deposited in fissures made in the solid rock, and enclosing metallic minerals, such as pyrites, blende, galena, etc. One specimen in the Museum shows such a veinstone, in which fragments of the surrounding rock have been enclosed, having been cemented together in the matrix of calcite. This specimen is from Kinnoull Hill, and the enclosed fragments are pieces of subangular porphyrite.

Other specimens from the Highland area show fragments of quartzite and schist cemented together in the matrix of pure white quartz.

Barytes.—All the specimens of this mineral in the Museum are massive in their form. It occurs very commonly in the Highland area as a veinstone, the specimens in the Museum being from Glen Artney. Other specimens, representing the Lowland area, are from the quarries near Perth. This mineral and calcite are about the only minerals to be found in these unaltered rocks.

Muscovite (?).—A species of mica, occurring in the Highland area as a constituent mineral in mica-schist. The sandstones of Strathmore are often flaked with scales of this mineral, when they receive the name of micaceous sandstones. Specimens of this mineral in the Museum are from Glenshee and Rannoch.

Serpentine.—Serpentine has been classed both as a rock and as a mineral. It occurs as a bed, associated with the mica-schists, in Glen Lochay, near Killin. This bed of serpentine is mentioned in Rutley's "Mineralogy."

Chrysolite.—A fibrous form of serpentine, found in veins amongst the massive form just described. Also from Glen Lochay.

Steatite, or Soapstone, has also been found in veins associated with serpentine. The specimens in the Museum are from the serpentine aforementioned as occurring in Glen Lochay, near Killin.

Tremolite has been found in Glen Tilt with a fibrous or radiated structure. It has been found associated with the limestones of that district.

Garnet.—Garnet occurs as a very common mineral, associated with the schists of the Highland area. In some instances the garnets have been weathered out from the surrounding matrix of schist, when their crystalline form is very well displayed. They are to be found varying in size from about as large as a pea to about an inch in diameter. Specimens are shown both weathered out of the rock and enclosed in the surrounding matrix of schist.

Chlorite.—Chlorite has been found in long filaments coating the joint faces of the porphyrites. Specimens from Birnam Hill are shown, which have been found in a veinstone of quartz running through the clay-slates of that district.

Iron Pyrites.—A very common mineral in the Highland area. Specimens are shown from Tomnadashan, where it has been found associated with intrusive rocks; also, very finely developed specimens from Craig-na-Caillich, which occur in a bed of quartzite in that mountain.

Chromite.—Specimens of this mineral have been found disseminated in grains and masses through the aforementioned serpentine occurring in Glen Lochay. The chrome-iron ore was mined in a small way by the Marquis of Breadalbane.

Hæmatite.—Specimens of this mineral have been found on the Binn Hill, at Seggieden. For mode of occurrence, etc., see *Proceedings* for session 1882-83.

Specular Iron (a variety of Hæmatite).—The specimens in the Museum are from Birnam Hill, where they have been found enclosed in a veinstone of quartz, with fragments of clay-slate.

Copper Pyrites are very common in the Highland area, associated with the schists and other rocks. They are usually to be found in the veins of metallic ores traversing these rocks. There are some specimens in the Museum both from the above habitats and also from the intrusive rocks at Tomnadashan.

Galena.—Most of the specimens of this mineral in the Museum are from Tyndrum, which has been the most extensively worked vein in this county. Numerous veins of this mineral have been found in the valley of the Tay. There is a series of veins of it to be found to the south of Ardeonaig.

Sodalite, a pale blue mineral having a radiated structure, occurring in the limestones of Glen Tilt.

Manganite.—This mineral occurs as dendritic markings in the tuffs and sandstones of lower Perthshire. The specimens in the Museum are from Errol and Moncreiffe Tunnel.

Thomsonite, the only representative of the Zeolitic family as yet in the Museum, has been found associated with the porphyrites of Glenfarg.

Such is a description of the leading characteristics of the minerals already in the Museum. As I said at the outset, even all the minerals already known to occur in the county are not represented in our collection. For instance, the ridge of mountains to the north of Loch Tay have long been famed for the splendidly developed crystals of Rutile that are to be found there, yet not one specimen of this mineral has ever found its way into our collection.

Other minerals might be named, though they are of rare occurrence. Native gold has been found at Corrie Bui, to the south of Ardeonaig. Silver has been found in the Tomnadashan mines, while cobalt bloom has been found at Tyndrum.

I have no doubt that a careful search would greatly augment the list of our minerals, and reveal, especially in the Highland area, a greater amount of mineral wealth than is generally supposed to exist.

XVI.—*On the occurrence of supposed Annelid Tubes in the Quartzites of Perthshire.* By PETER MACNAIR.

(Read 9th May, 1889).

In the following paper I intend to give an account of certain bodies discovered by myself in the quartzites of Perthshire supposed to be of organic origin, and analogous to certain annelid tubes found in the quartzites of Sutherlandshire. Great importance is ascribed to the discovery of anything organic in these more or less altered rocks, as it will enable us to correlate them with other strata, and thus settle for ever the problem of the antiquity of these mountains.

In his "Scenery of Scotland"* Dr. Geikie mentions in a foot-note the discovery of annelid tubes in the quartzites of Perthshire by one of the officers of the survey; but the fact is only mentioned, and no account is given of their locality or their mode of occurrence. Lately, however, the subject was once more brought forward by the Duke of Argyll, who discovered in the quartzites of Inveraray certain bodies which he holds to be organic in their origin, and similar in every respect to the annelid tubes of Sutherlandshire.

The scope of this paper, then, is to determine how far these tubes, or ovates, may be considered as organic, and their importance in settling the position of the Highland rocks in the geological scale.

Before entering into a description and discussion of the origin of these bodies, I may here, at the outset, give a brief account of the nature of the Highland problem, and also of the true "pipe rock," or annelid tubes, occurring in the quartzites of Sutherlandshire, for the benefit of those who have not made this department of geological inquiry their special study.

The Highlands of Scotland have long presented to the geologist a most difficult problem for solution, they having undergone a certain amount of regional metamorphism, which has entirely obliterated the original structure of the rock masses of which it is built.

The most characteristic rocks of the Highland area are gneiss, mica-schist, quartzite, clay-slate, grit, etc., all of which are now determined to be but altered conditions of ordinary sedimentary rocks. Thus the grits of the Highland area find their analogues in the ordinary grit of any unaltered sedimentary rocks, while the schists and quartzites are found to be but altered conditions of shale and sandstone.

But though the alteration of these rocks has not been so complete as to destroy all traces of their original clastic origin, yet it has been sufficient to entirely obliterate any signs of life which may probably

* "Scenery of Scotland," page 121.

have existed upon the earth's surface at that time; and so for a long time geologists classed them as belonging to a period anterior to the advent of life upon the globe, giving them the name of *azoic*—meaning without life. They thus interpreted the absence of anything organic in these rocks on the ground that life had not existed at that time, never for a moment thinking that these rocks belonged to a fossiliferous horizon, and that the traces of life had only been destroyed by a subsequent metamorphism.

The first indication of anything organic in these rocks was discovered by Maculloch, who, in the year 1819, described the occurrence of what he called concretions in the quartzites of the north-west of Scotland, these so-called concretions taking the form of cylindrical rods, which penetrated the beds of quartzite from top to bottom, lying at right angles to the planes of bedding. These cylinders of quartz often presented certain characteristic features upon the surface of the beds of quartzite in which they occurred, due to the manner in which they had been weathered, perhaps the predominating one being that of little knobs, or buttons, standing out from the surrounding matrix of quartzite, which is accounted for in the more rapid weathering of the surrounding matrix of quartzite than the cylinders or tubes, which, being composed of finer and harder grains of quartz, resisted the weathering agents to a greater extent. It was afterwards recognised, and is now universally accepted, that these rods are not the consequence of an aggregation of the grains of quartz around a centre, but that they are the remains of worm burrows, or tubes, formed in the quartzites when they were in a soft or sandy condition. I have a small specimen of this quartzite, showing these rod-like bodies, or worm burrows, with the orifices of the tubes weathered into little knobs.

Amongst all the rocks found in the Highland area the quartzites present to us in a most marked degree traces of their original aqueous or sedimentary origin. On inspecting a piece of quartzite by the aid of a magnifying glass, it may be seen to be made up of little spherical grains of quartz, bound together in a matrix of siliceous cement, and giving every appearance of an ordinary sandstone, the grains of which have been transfused into one another. There can be no doubt, then, that this quartzite was once a sandstone, and that the sandstone, on the other hand, was but the solidified remains of some ancient sea-beach or shore. Thus we see that, when the sandstone was in a soft condition, multitudes of worms, boring in the loose sand, formed the burrows, or little cylindrical tubes, which were afterwards filled either by the castings of the worms themselves or by the subsequent introduction of grains of quartz in some manner or other,—for this is, perhaps, the most difficult part in the details of the whole subject. It is with the occurrence of these burrows in the quartzites of the Scottish Highlands, and more especially of those in Perthshire, that this paper is intended to deal; but, before passing to the discussion of this, the more immediate purpose of this paper, I should like to give a short account of the manner in which they were brought under my notice.

Often, while perambulating over the hills near Killin, I would keep my eyes open, always on the outlook for something organic; but I began latterly to give it up in despair: the rocks seemed to be so much altered as to make it almost hopeless to expect that anything organic should have survived the metamorphism. One day I was aroused from my inactivity by a friend telling me that he had discovered a shell turned into stone in the bed of the Dochart. Here, I thought, was the long-looked-for come at last; and, sure enough, upon seeing it, it turned out to be a fossil shell. But my knowledge of Palæontology was too limited to enable me to determine the species and formation from whence it had come; I, however, got it sent to Professor Geikie, who informed me it was a *Gryphæa incurva*, from the oolitic formation, and that it had probably been thrown into the Dochart by some one. This reminded me sadly of those lines which Pope wrote of other fossils, and which were equally applicable to mine, as no oolitic strata is to be found for many miles around.

One day, however, while viewing a collection of the neighbouring rocks made by a friend of mine, I happened to notice a piece of quartzite all pitted over with little circular holes, being the consequence of the weathering away of the material inside the rings or tubes, and in this manner the occurrence of pipe-rock in the quartzites of Perthshire was first brought under my notice. I discovered that the specimens were from a bed of quartzite high up the side of Craig-na-Caillich, a mountain situated at the western end of Loch Tay, and pieces of which I now place before you. The rock, as you will notice, is undoubtedly a quartzite, and is found ranging along the hillside from Craig-na-Caillich eastwards. The succession from the base of the mountain to the top is as follows:—

(1) A series of quartz-schists.
(2) A band of crystalline limestone.
(3) Another great series of quartz-schists, mica-schists, etc., passing upwards into beds of true quartzite and greywacke.

On first seeing the specimens I immediately came to the conclusion that they might probably represent the burrows of annelids, and that their occurrence in the quartzites of Craig-na-Caillich might lead to an identification of these quartzites with those of the north-west, and thus help to determine the age of these rocks. We consequently showed them to Mr. G. S. Grant Wilson, who was then mapping the district for the Geological Survey; but he seemed disinclined to commit himself to any opinion upon the subject. I also sent specimens to Dr. A. Geikie, and received in reply the following letter :—

"28 Jermyn Street, July 11th, 1888.

Dear Sir,—At Mr. Geikie's request, I write to say that it appears to be very doubtful if either specimens are organic. The one marked 'A' may possibly be annelid tube, but this is very uncertain.—Yours truly,

(Signed) EDWARD BEST."

But though Dr. Geikie thus negatived their organic origin, I still continued to believe that they were annelid tubes, and when the Duke of Argyll read his paper* "*On certain bodies apparently of organic origin from a Quartzite Bed near Inveraray*," I recognised in his description of those ovate bodies, which he now unhesitatingly declares to be but deformed annelid tubes, a similarity in every respect to those of my own. I accordingly sent my specimens for the Duke's inspection. He did not doubt for one moment their organic origin, remarking that Dr. Geikie's hesitation was incomprehensible to him, and saying, further, that if the specimens had been from Sutherlandshire Dr. Geikie would have had no doubt at all as to their being annelid tubes. Such is the history of the discovery of these specimens. I will now enter into a description of these bodies and the various theories that have been given to account for their origin.

The bodies themselves are invariably of an ovate or spheroid form, and are found to penetrate from top to bottom the quartzites in which they occur, which indicates that they are not merely of a surface origin. Their structure is often well shown by the manner in which they have been weathered. Sometimes the weathering of the surface of the quartzite causes the spheroids to stand up in little knobs, or buttons, all over the surface of the quartzite, presenting to the eye the same effect as that caused by the weathering of the annelid tubes of the north-west. At other times the hardness of the ring or wall causes it to assume a crater-like form, and presents on the surface of the quartzite a series of rings, which marks the limit to which the spheroid has been weathered. Still another form is that in which the material forming the spheroid has been weathered out of the surrounding rock, presenting to the eye a series of little pits or holes. The material of which the ovate is made up seems to be in general the same as the surrounding rock, but in a more

* "Proceedings of Royal Society of Edinburgh," Session 1888-89.

argillaceous or finer state. This we will see further on is accounted for by the Duke of Argyll in the selection of the finer particles by the worm. Another characteristic is the presence of oxide of iron in these bodies. An examination of the specimens now before you will exhibit all these, their main characteristics.

We now pass to describe the various theories that have been put forward to account for the origin of these bodies. In his paper before the Royal Society, the Duke of Argyll maintained their organic origin, holding that they are the burrows of annelids, and bringing forward a series of arguments based upon personal observations, and experiments with living annelids, to show that these bodies have many features in common with the present-day annelids of our sea-shores. The following is a short résumé of the Duke's arguments for the annelid origin of these bodies:—At one time the beds of quartzite must have formed an old sea-shore, similar in every respect to those of the present day, and existing, therefore, under similar conditions. This ancient sea-beach or shore would be the habitat of annelids, which, boring in the loose moist sand, would produce burrows in a manner similar to those of our living annelids. The Duke shows how that, by the selection of the finer from the coarser particles of sand, and the voidance of the former into the burrow which it had made, the annelids would leave traces in the rock of their existence. These traces would be still further perpetuated by the process of metamorphism, which would convert the finer particles into mica, or develop within the tube a more highly micaceous substance than that outside. But though metamorphism would thus better perpetuate the difference between the substance inside the tube and that outside, yet, as the process of metamorphism has, in the case of the Scottish Highlands, been the consequence of a great deal of pulling out, or shearing, of the beds of rock, the tube would not retain its original form, but become altered into some other shape, and that most probably an ovate, or some modification of it, varying according to the degree of metamorphism.

A simple experiment will illustrate the manner in which these tubes have been deformed. If you take a piece of clay and pierce a hole in it to represent the burrow of the annelid, afterwards filling up the hole with some fine-grained sand, and pressure be brought to bear upon the clay to represent the pulling out of the beds, it will be found, upon cutting a perpendicular section through the clay, that the cylinder has become deformed into an ovate.

As we have seen, the primary form must have been more or less cylindrical, but the subsequent pressure and drawing out of the beds has been the direct cause of their present ovate or spheroidal form. The lesser the drawing out of the beds the nearer these ovates will approximate to their original forms, while an extreme drawing out or lengthening of the beds might, on the other hand, reduce them to a mere linear streak. The presence of oxide of iron is also well seen in these specimens, especially in the one where the substance has been weathered out of the surrounding tube or ovate. The metamorphism of the more argillaceous particles into mica is conspicuously displayed in one specimen.

I also exhibit a specimen of annelid tube from the Old Red Sandstone at Dunbar, which has never undergone the process of metamorphism. This specimen will enable us better to understand the relationships of these ovate bodies in our Perthshire quartzites to the worm burrows in an unaltered sandstone. The sandstone, as you will notice, is highly micaceous, and is penetrated through and through, at right angles to the planes of bedding, with these worm tubes. It presents all the foregoing characteristics which I have named as being typical of an unaltered burrow. Inside each cylinder or tube we can distinctly perceive the finer argillaceous material selected by the worm and voided into the tube behind. It is not difficult, then, to conceive how such a specimen as this, which, after undergoing a greater or less degree of metamorphism, and deformation of the tube into an ovate by the shearing of the sandstone in which it occurs,—I say we would have no great difficulty in conceiving how such a specimen as this would ultimately become identical in every respect with the specimens from the Perthshire quartzites.

It now remains for us to notice the theory advanced by Dr. Geikie in opposition to the annelid origin of these bodies. Dr. Geikie ascribes their origin to mineral concretions, or aggregations of sulphide of iron, on the sea-margin, which, by a process of mineralisation, crystallised into these ovates. As the Duke points out, his theory is purely hypothetical, and, when contrasted with the simplicity and apparent completeness of the annelid theory of their origin, not a little fanciful. There is another theory that I may here mention in passing, though it has more of a humorous than scientific aspect. Some one has suggested that these ovates were the consequence of the escape of steam (steam-holes) while the quartzites were in a lava form. I suppose this requires no refutation.

In conclusion, let us glance for a moment at the importance of placing the annelid origin of these bodies beyond dispute. Sir R. Murchison believed the whole of the Highland area to be overlaid by rocks having a similar succession to that revealed in the Sutherlandshire sections, and, though Murchison's interpretation of these sections must now be abandoned, yet I still believe that, when the upward succession of the rocks has been finally established, and when the mapping of the central Highlands has been completed, it will be found that the succession all over the Highland area is similar, and that the great overthrusts and inversions of the strata in the north-west are only local. Mr. Peach, of the Geological Survey, questioned, as he well might, the identifying of the quartzites of Jura and those of the central Highlands with those of the north-west on the mere grounds of their similarity in mineralogical composition. Undoubtedly we must have stronger grounds than mineralogical sameness for identifying the horizon of any rock. For instance, in Perthshire I have seen a pure white quartzite at Tyndrum faulted up against a great series of schists, presumably the schists that occupy the whole of that area; while at Killin we find beds of pure white quartzite capping the topmost beds of these schists, so that between each of these beds of quartzite hundreds of feet of quartz-schist and mica-schist are interposed. However, if the annelid origin of these bodies were placed beyond doubt, they might help to mark particular horizons in the rocks of the Highland area, in the same manner as the pipe-rock of the north-west has enabled the geological surveyors to unravel the complicated structure of that district; and it is even quite reasonable to suppose that they might ultimately be of great value in helping to co-ordinate the strata of the central Highlands with the known succession in the north-west.

It would be beyond the scope of our paper to trace the various cycles of change through which these rocks must have passed ere they assumed their present configuration of mountain and valley; yet what we have already said gives us a glimpse of the mutations through which the surface of our country must have passed in the long geologic past. Far away from the roar and noise of the wild sea waves, on the mountain peak, where nothing is heard but the rustling or sighing of the wind as it sweeps through the forests below, we find the traces of an old sea-beach or shore. At one time the ocean must have rolled over what is now the highly mountainous region of the Highlands, depositing these sediments out of which its mountains and valleys were afterwards to be carved. Subsequently these sediments were raised high above what is now the level of the sea, to be cut and carved into their present wild and fantastic forms by the action of river, rain, and tempest. And so, by analogy, from the past we can glance into the future, and predict a time when these mountains shall again be reduced to the level of the sea by the slow but unceasing action of the denuding forces.

"They are raised for ever and ever,
And sink again into sleep."

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XVII.—*Flora of the Right Bank of the Tay, between Perth and the mouth of the Earn.* By WILLIAM BARCLAY.

(Read 9th May, 1889. Revised to 15th July, 1890).

One of the most picturesque parts of the Tay is that which begins immediately below Perth. Here the river, coming with rushing speed from the north, bursts through the Sidlaws, then, turning in an easterly direction, slackens its pace as if wearied with the effort, and, spreading out as it goes, slowly seeks its way to the ocean. The two sides of the river present a very different appearance to the eye of the beholder. On the north runs a series of steep and rugged crags rising from dark woods—the grey cliff of Kinnoull, continued by the hills of Kinfauns and Glencarse. Between these and the river there stretches a level plain of varying width, sometimes so narrow as to be imperceptible at a distance, but at length widening out into the broad and fertile Carse of Gowrie. On the south bank, with the flora of which my paper is concerned, there is much less level ground. Indeed, speaking generally, and excepting a stretch of plain immediately above the mouth of the Earn, the long slope of the Hill of Moncreiffe may be said to begin almost at the very brink of the river; and usually the level space between is only a sort of muddy fringe, with here and there a marshy tract, formed doubtless of mud and sand brought down by the stream, probably destined in the distant future to become a dry and fertile haugh. The higher tides, of course, completely cover all these lower levels, so that on them no plants can flourish except those, like the Reed and the Bulrush, which delight in swampy borders, or those, like the Marsh Marigold and the Celandine, which seem to thrive none the worse of an occasional dip under the surface of the water. You have therefore quite a number of plants growing here which are not found higher up the river, beyond the flow of the tide. Here, also, even on higher ground, which is never under water, the flora is somewhat different, species which are found in the upper reaches of the river being here either very scarce or completely wanting. This arises, doubtless, from various causes—difference of soil, a lower elevation, and most of all, perhaps, from full exposure to the chilling influence of easterly winds from the German Ocean. On the whole, the flora is not only rich, but singularly interesting, and there are, as we shall see in the sequel, not a few rather puzzling questions connected with it to which various botanists would doubtless return very various answers.

We shall now take a walk down the river-side, noting as we go the stations at which the more notable plants are to be found.

Starting, then, from the Shore, we shall find growing about the paling that encloses the first saw-mill some straggling specimens of *Urtica urens*, the smaller Stinging Nettle, a weed common enough in many parts of the country, but not so common in Perthshire as to be passed over without remark. Taking the right-hand side of the railway as far as the lade, we observe on the bank of the latter a fine clump of the great Hairy Willow Herb, *Epilobium hirsutum*, a tall plant, with large and handsome rose-coloured flowers, scarcely inferior in beauty to the Willow Herb of our gardens. Like the latter, too, it not only maintains its ground wherever it is planted, but, by pushing out long subterranean suckers, which root at the joints, it endeavours to take possession of all the ground in its neighbourhood. Crossing the railway, let us go down the left side of the harbour and pay a visit to the wood-yard attached to the creosote works of Calder & Co. Here is a perfect nursery for casual and stranger plants. It was only this summer of 1890 that Dr. Buchanan White and myself happened to stray into it for the first time, and very much astonished we were at what we found there. *Trifolium glomeratum* growing intermixed with *Medicago maculata*, *Erodium moschatum*, *Brassica monensis*, *Anthemis tinctoria*, *Melilotus alba*, *Melilotus altissima*, and *Dipsacus sylvestris*, are some of the plants which we picked up on the rubbish with which this yard has been covered. On subsequent visits there was found growing in a place which had previously escaped notice a fine clump of *Scrophularia aquatica*; moreover, we also found one plant of *Alyssum incanum*, specimens of *Salvia Verbenaca*, *Herniaria glabra*, *Lycopus europæus*, and many other plants less worthy of notice, but which one would not have expected to find in such a place. Returning, let us now take the footpath which runs between the railway and that stretch of marshy ground which lies above the lower harbour. On the bank of the railway, amidst Poppies and Dyers' Rocket, we can see a good many plants of *Senecio viscosus*, the Sticky Groundsel, a clammy and dusty weed not common anywhere, and generally found on rubbish heaps and in the vicinity of railways. At the side of the footpath I found the other summer a few specimens of *Poa compressa*, a grass which is either very rare in Perthshire or which has been hitherto overlooked. In the marsh itself there is not much calling for notice, although it is, in summer, gay with many of the commoner wild flowers. I may note, however, as occurring here *Lysimachia Nummularia*, the Creeping Money-Wort, its long and slender stem crawling on the mud amongst the taller plants, but decked with pretty yellow flowers peeping like stars among the rank herbage. Here also, we may mention, though not for its rarity, *Mimulus luteus*. This American plant is now naturalised all over the country, and below Perth it occurs in plenty as far, at least, as the mouth of the Earn. Passing the Friarton, we proceed on our way to Orchardneuk. Opposite the lower end of Moncreiffe Island we shall find growing among the stones at the edge of the river another American stranger, but making itself quite at home here and at various places from the Woody Island downwards. This is a species of Aster which has long been known to occur on both sides of the river. It differs so much in appearance at different places that there were supposed to be two or three distinct species, which were variously named by various authorities. In the autumn of 1888 I gathered specimens of all the forms I could find, choosing those most unlike in character, and sent them to Kew to Mr. J. G. Baker. He reported that they were all of one species, *Aster Novi-Belgii.* He added that this species is a very variable one, and this has probably given rise to the doubt that has hitherto prevailed as to the proper designation of the plant.

We now come to a long stretch of marshy ground immediately above Orchardneuk. In this there is found in abundance *Carum Carui*, the Common Caraway. This is not regarded as a plant native to Britain, but on what ground it is refused a place in our flora I do not know, as it seems to be found in Europe from Scandinavia southwards. Possibly the reason is that it usually occurs in small quantity and in places where it might easily have escaped from cultivation. In this marsh, however, it is not only very plentiful, but extends in nearly equal profusion for a considerable way farther down the river. If not native, therefore, it is at least thoroughly naturalised. Amongst some bushes immediately above Orchardneuk we shall find a tall plant, with showy yellow heads, that look like Sunflowers on a reduced scale. It belongs in reality to a genus closely allied to that of the Sunflower, and is yet another American come to dwell in the old country, *Rudbeckia laciniata.* It may be found here and there for about half-a-mile downwards, but is rather more plentiful on the opposite side of the river. On a dry bank immediately below Orchardneuk, amidst Peppermint and Lady's Fingers, we shall find yet another plant which the authorities declare to have no business there, a species of Garlic, *Allium carinatum.* It is abundant for a long distance, and is still more abundant and for a longer distance on the opposite side. It is recorded for only three counties in Britain, and how it came to the banks of the Tay is not an easy question to answer. We now come to the peninsula of Sleepless, a tongue of dry land nearly surrounded by mud and bog. Beside the fishing-lodge we shall find in the marsh numerous specimens of *Œnanthe fistulosa*, this time certainly a native, an umbellifer with a remarkably hollow stem and pipe-like leaves. This plant is abundant on both sides of the river for many miles, and the wonder is how it escaped notice until four or five years ago, when it was detected at Elcho marsh by Dr. Buchanan White. A probable explanation is that the herbage of all these marshy spots is cut down for bedding or thatching purposes in the middle of summer, so that this, with other plants, might easily be missed unless the locality were visited within a comparatively limited part of the season. Sleepless is the highest point on the river at which this *Œnanthe* has yet been detected. Proceeding now down the river on our way to Elcho, we come a short distance below Sleepless to a bed of *Carex aquatilis.* This I first discovered in the summer of 1889, and, whilst looking at it, I noticed growing in and around it a grass which struck me as being different from any species with which I was acquainted. Specimens of this I showed to Dr. Buchanan White, and he recognised it as *Poa palustris*, Lin., a grass which has not hitherto been found in a wild state in Britain. At this station it is found more or less abundantly for a distance of about three hundred yards, in the narrow strip of marsh which here stretches along the side of the river. It grows also on the bank alongside the marsh. This bank, which carries the footpath, is artificial, and is periodically mended and elevated by means of earth, or rather divots, taken from the marsh. Plainly the grass has in this way been carried from the marsh to the bank. How it came to the marsh is a more difficult problem to solve. It may be indigenous, and the fact that we found it some weeks afterwards at the Loch of Bennybeg, near Muthill, seems to point to that conclusion. On the other hand, it is, I believe, sold by the seedsmen in some parts of the county as an agricultural grass, though there is no reason to believe that it has ever been sown in Perthshire. Further researches may throw light on the matter, but as the case stands at present we must look upon the claim of *Poa palustris* to be considered native as doubtful. It is, however, thoroughly established, and must have been in the marsh for a considerable time. No one who has seen it growing, as it does here, amid rank and tall grasses, *Deschampsia cæspitosa*, *Festuca elatior*, *Poa trivialis*, *&c.*, will think it strange that it has been hitherto overlooked.

From Sleepless downwards we now encounter at intervals great beds of *Phragmites communis*, the Common Reed, growing to a height of ten or twelve feet, the tallest of British Grasses, and, when crowned with its dark purple plumes of flowers, not the least handsome. We now arrive at Elcho marsh, where several very interesting plants may be found. Col. Drummond Hay has thoroughly explored this part of the river, and in the third volume of the "Scottish Naturalist," in an article on the flora of the Carse of Gowrie, he has given an account of most of the rarities. On one or two occasions, also, he acted as guide to a small party of us, showing us the exact localities of the more notable plants which he had discovered, and giving us much interesting information concerning them. The most striking and best deserving to be mentioned first is *Butomus umbellatus*, the Flowering Rush. This plant, rare in Scotland, with long bayonet-like leaves rising stiff and straight from the root-stock, and with its spreading umbel of rose-coloured flowers, is one of the most beautiful and conspicuous of water-loving plants. It is to be found here and there throughout the marsh, and it also occurs on the opposite side of the river, but farther down. Col. Drummond Hay argues that it is indigenous at Elcho, and, although the question is not perhaps capable of being answered with absolute certainty, the balance of evidence may be said to be in favour of his opinion. Another and much rarer plant growing in the marsh is *Lysimachia thyrsiflora*, the Tufted Loosestrife. This is undoubtedly an introduction. It was brought from the Loch of Rescobie by Col. Drummond Hay about the year 1872, and planted in Elcho, where it has maintained its ground ever since. At some distance below may be seen *Rumex Hydrolapathum*, the Great Water-dock, rising to the height of four or five feet, and with leaves often a foot long. Nor can we help noticing here, as we pass along the edge of the marsh, the tall stiff spikes of *Typha latifolia*, which is sometimes called the Bulrush, but more correctly the Cat's Tail or Reed Mace. These two have likewise been declared to be interlopers, chiefly, as Col. Drummond Hay remarks, because this part of the Tay has got a bad name for harbouring all sorts of strangers and outcasts. There seems really to be no valid reason for refusing their claim to be truly sons of the soil, or rather of the mud. Here, also, occurs a large bed of *Carex acuta*, a sedge of which this is, I think, the only known station in Perthshire. To Dr. White belongs the honour of its discovery about five years ago. Still farther down may be seen *Veronica montana*, not a very common plant in Perthshire. Some scattered specimens also occur here of *Epipactis latifolia*, the Helleborine. I have never seen this orchid anywhere in very great abundance, though it is pretty widely spread. Darwin has figured and described it in his charming work on the "Fertilisation of Orchids." He says that it is fertilised by wasps, and is of opinion that if wasps were to become extinct in any locality, so would the Helleborine.

Between this and the mouth of the Earn there is hardly anything worthy of special notice. Three years ago Mr. Meldrum and I discovered here *Allium Scorodoprassum*, the Sand Garlic, and, as there was a good deal of it, the plant is doubtless still to be found, though I have not seen it since. *Lythrum Salicaria* grows sparingly in Elcho marsh, and a great bed of it occurs two hundred yards or so up from the mouth of the Earn, but on the bank of the latter, so that it is just beyond our limit.

In the list which I subjoin there are enumerated, of Phanerogams, 376 species, belonging to 53 orders, and of Cryptogams, 7 species, belonging to the two orders of *Filices* and *Equisetaceæ*. Of the Phanerogams there are four species which are undoubtedly American plants naturalised here, as in some other parts of Britain. These are *Aster Novi-Belgii*, *Rudbeckia laciniata*, *Mimulus luteus*, and *Elodea canadensis*. About thirty others, including those already mentioned as having been found at the harbour, and such plants as *Astrantia major*, *Lythrum Salicaria*, *Calystegia sepium*, *Allium Scorodoprassum*, and *Allium carinatum*, are certainly not indigenous in this quarter. Then there are about half-a-dozen—*Butomus umbellatus*, *Poa palustris*, &c.—concerning which doubt must be entertained as to whether they are indigenous or not. Deducting, however, these three classes, there are more than 300 species which, though sometimes occurring in small quantity, are certainly native plants. When I undertook the task of making a census of the flora of this part of the Tay, I did not expect that the list would be so extensive as it has proved to be, nor am I confident that it is yet complete. It is not easy to search thoroughly some parts of the ground, such as the marshes at Sleepless and Elcho; and, though I have had the powerful aid of Dr. Buchanan White in the work of exploration, it is quite possible that some species have escaped our notice. These, however, cannot be numerous, and, on the whole, the list may be accepted as a fairly complete and accurate catalogue of the flora of this part of the Tay.

LIST OF FLOWERING PLANTS AND FERNS GROWING ON THE RIGHT BANK OF THE TAY BETWEEN PERTH AND THE MOUTH OF THE EARN.

Ranunculaceæ.

Anemone nemorosa, L.
Ranunculus sceleratus, L.
  Flammula, L.
  auricomus, L.
5 acris, L.
  repens, L.
  bulbosus, L.
  Sardous, Crantz.
  Ficaria, L.
10 Caltha palustris, L.
Trollius europæus, L.
Aconitum Napellus, L.
  (Garden escape).

Papaveraceæ.

Papaver Rhœas, L.
  dubium, L.

Fumariaceæ.

15 Fumaria pallidiflora, Jord.
  densiflora, D.C.
  officinalis, L.

Cruciferæ.

Nasturtium officinale, R.Br.
  sylvestre, R.Br.
20 palustre, D.C.
Barbarea vulgaris, R.Br.
  præcox, R.Br.
  (At Orchardneuk).

Cardamine amara, L.
pratensis, L.
25 hirsuta, L.
flexuosa, With.
Alyssum incanum, L.
(Yard at Perth Harbour).
Erophila vulgaris, D.C.
Sisymbrium Thaliana, Hook.
30 officinale, Scop.
Alliaria, Scop.
Brassica monensis, Huds.
(Yard at Perth Harbour).
Sinapis, Visiani.
Diplotaxis muralis, D.C.
(Yard at Perth Harbour).
35 Capsella Bursa-pastoris, [Mœnch.
Lepidium Smithii, Hook.
Raphanus Raphanistrum, L.

Resedaceæ.

Reseda Luteola, L.

Violarieæ.

Viola palustris, L.
(Moncreiffe Island).
40 sylvatica, Fr.
tricolor, L.
arvensis, Murr.

Caryophylleæ.

Silene Cucubalus, Wibel.
Lychnis alba, Mill.
45 diurna, Sibth.
Flos-cuculi, L.
Cerastium tetrandrum, Curt.
(In small quantity at Orchardneuk).
glomeratum, Thuill.
triviale, Link.
b. holosteoides, Fr.
50 Stellaria media, Cyr.
Holostea, L.
graminea, L.
uliginosa, Murr.
Arenaria serpyllifolia, L.
55 Sagina ciliata, Fr.
(Yard at Perth Harbour).
procumbens, L.
Spergula arvensis, L.
Lepigonum rubrum, Fr.

Portulaceæ.

Montia fontana, L.

Hypericineæ.

60 Hypericum perforatum, L.
quadratum, Stokes.
hirsutum, L.

Malvaceæ.

Malva moschata, L.
sylvestris, L.
(Yard at Perth Harbour).
65 rotundifolia, L.
(Yard at Perth Harbour).

Geraniaceæ.

Geranium sylvaticum, L.
pratense, L.
molle, L.
dissectum, L.
70 Robertianum, L.
Erodium cicutarium, [L'Hérit.
moschatum, L'Hérit.
(Yard at Perth Harbour).

Ilicineæ.

Ilex Aquifolium, L.

Sapindaceæ.

Acer Pseudo-platanus, L.

Leguminosæ.

75 Ulex europæus, L.
Cytisus scoparius, Link.
Ononis repens, L.
Medicago lupulina, L.
maculata, Sibth.
(Yard at Perth Harbour).
80 Melilotus altissima, Thuill.
(Yard at Perth Harbour).
alba, Desr. do.
parviflora, Lam.
(Perth Harbour).
Trifolium pratense, L.
medium, L.
85 arvense, L.
(Yard at Perth Harbour).

Trifolium striatum, L.
(Yard at Perth Harbour).
glomeratum, L.
(Yard at Perth Harbour).
hybridum, L.
repens, L.
90 procumbens, L.
dubium, Sibth.
Anthyllis Vulneraria, L.
Lotus corniculatus, L.
pilosus, Beeke.
95 Vicia hirsuta, Koch.
Cracca, L.
sepium, L.
lathyroides, L.
(Yard at Perth Harbour).
Lathyrus pratensis, L.
100 macrorrhizus, Wimm.

Rosaceæ.

Prunus insititia, L.
Avium, L.
Spiræa Ulmaria, L.
Rubus Radula, Weihe.
105 corylifolius, Sm.
b. conjungens, Bab.
Geum urbanum, L.
rivale, L.
Fragaria vesca, L.
Potentilla Fragariastrum, Ehrh.
110 Tormentilla, Neck.
reptans, L.
Anserina, L.
Alchemilla vulgaris, L.
Rosa mollis, Sm.
b. cærulea, Bkr.
115 tomentosa, Sm.
rubiginosa, L.
canina, L.
a. lutetiana, Leman.
e. dumalis (Bechst.)
g. urbica (Leman.)
j. dumetorum, Thuill.
o. Andegavensis, Bast.
s. cæsia, Sm.
v. glauca, Vill.
w. subcristata, Baker.
z. coriifolia, Fr.
**a.* Watsoni, Baker.
Cratægus Oxyacantha, L.

Saxifrageæ.

Saxifraga granulata, L.
120 Chrysosplenium oppositifolium, L.
Ribes Grossularia, L.
rubrum, L.
nigrum, L.

Crassulaceæ.

Sedium Telephium, L.
125 acre, L.

Halorageæ.

Callitriche vernalis, Koch.

Lythrarieæ.

Lythrum Salicaria, L.

Onagrarieæ.

Epilobium hirsutum, L.
montanum, L.
130 obscurum, Schreb.
montanum × obscurum, [forma verticillata]
(Named by Rev. E. S. Marshall).
palustre, L.

Umbelliferæ.

Astrantia major, L.
(In small quantity at Orchardneuk).
Carum Carui, L.
135 Ægopodium Podagraria, L.
Conopodium denudatum, Koch.
Myrrhis Odorata, Scop.
Anthriscus sylvestris, Hoffm.
Œnanthe fistulosa, L.
140 crocata, L.
Æthusa Cynapium, L.
(Casual at Shore, on rubbish).
Angelica sylvestris, L.
Heracleum Sphondylium, L
Daucus Carota, L.

Caprifoliaceæ.

145 Sambucus nigra, L.

Rubiaceæ.

Galium boreale, L.
Cruciata, Scop.
verum, L.
palustre, L.
150 Aparine, L.

Valerianeæ.

Valeriana officinalis, L.
Valerianella olitoria, Mœnch.

Dipsaceæ.

Dipsacus sylvestris, L.
(Yard at Perth Harbour).
Scabiosa succisa, L.
155 arvensis, L.

Compositæ.

Bellis perennis, L.
Aster Novi-Belgii, L.
Erigeron canadensis, L.
(Yard at Perth Harbour).
Rudbeckia laciniata, D.
160 Achillea Millefolium, L.
Ptarmica, L.
Anthemis tinctoria, L.
(Yard at Perth Harbour).
arvensis, L.
(Yard at Perth Harbour).
Chrysanthemum Partheni-
[um, Pers.
165 Matricaria inodora, L.
Tanacetum vulgare, L.
Tussilago Farfara, L.
Petasites vulgaris, L.
Senecio vulgaris, L.
170 viscosus, L.
Jacobæa, L.
aquaticus, Huds.
Arctium minus, Schk.
Cnicus lanceolatus, Hoffm.
175 palustris, Hoffm.
heterophyllus, Willd.
(In small quantity).
arvensis, Hoffm.
Centaurea nigra, L.
Cichorium Intybus, L.
(Perth Harbour).
180 Lapsana communis, L.
Crepis virens, L.
paludosa, Mœnch.
Hieracium pilosella, L.
Hypochœris radicata, L.
185 Leontodon autumnalis, L.
Taraxacum officinale, Wel.
Sonchus oleraceus, L.
asper, Hoffm.
arvensis, L.
190 Tragopogon pratensis, L.

Campanulaceæ.

Campanula latifolia, L.
(Here and there, brought from above).
rotundifolia, L.

Ericaceæ.

Calluna Erica, D.C.
(In very small quantity at Orchardneuk).

Primulaceæ.

Primula vulgaris, Huds.
195 veris, L.
Lysimachia thyrsiflora, L.
Nummularia, L.
nemorum, L.
Anagallis arvensis, L.
(Yard at Perth Harbour).

Oleaceæ.

200 Fraxinus excelsior, L.

Boragineæ.

Symphytum tuberosum, L.
Lycopsis arvensis, L.
Myosotis cæspitosa, Schultz.
palustris, With.
205 arvensis, Hoffm.
versicolor, Reichb.

Convolvulaceæ.

Calystegia Sepium, R.Br.

Scrophularineæ.

Scrophularia aquatica, L.
(Yard at Perth Harbour).
nodosa, L.

210 Mimulus luteus, L.
Digitalis purpurea, L.
Veronica hederæfolia, L.
polita, Fr.
agrestis, L.
215 persica, Poir.
serpyllifolia, L.
officinalis, L.
Chamædrys, L.
montana, L.
220 scutellata, L.
Beccabunga, L.
Euphrasia officinalis, L.
Bartsia Odontites, Huds.
Pedicularis palustris, L.
225 Rhinanthus Crista-galli, L.

Labiatæ.

Mentha hirsuta, L.
arvensis, L.
Lycopus europæus, L.
(Yard at Perth Harbour).
Origanum vulgare, L.
(Yard at Perth Harbour).
230 Thymus Serpyllum, Fr.
Calamintha Clinopodium, [Benth.
(Brought from above).
Salvia Verbenaca, L.
(Yard at Perth Harbour).
Prunella vulgaris, L.
Stachys palustris, L.
235 sylvatica, L.
Galeopsis speciosa, Mill.
Tetrahit, L.
Lamium purpureum, L.
album, L.
240 Teucrium Scorodonia, L.

Plantagineæ.

Plantago major, L.
lanceolata, L.
maritima, L. (Shore).

Illecebraceæ.

Herniaria glabra, L., *b.* sub-
245 ciliata, Bab.
(Yard at Perth Harbour).
Scleranthus annuus, L.

Chenopodiaceæ.

Chenopodium album, L.
Atriplex patula, L.

Polygonaceæ.

Polygonum Convolvulus, L.
250 aviculare, L.
Hydropiper, L.
Persicaria, L.
lapathifolium, L.
amphibium, L.
255 Bistorta, L.
(Moncreiffe Island—introduced).
Rumex conglomeratus, [Murr.
sanguineus, L., *b.* viridis, Sibth.
obtusifolius, L.
acutus, L.
260 crispus, L.
aquaticus, L.
Hydrolapathum, Huds.
alpinus, L.
Acetosa, L.
265 Acetosella, L.

Euphorbiaceæ.

Mercurialis perennis, L.
Euphorbia Peplus, L.

Urticaceæ.

Ulmus campestris, Sm.
Urtica dioica, L.
270 urens, L.

Cupuliferæ.

Betula alba, L.
Alnus glutinosa, L.
Corylus Avellana, L.
Quercus Robur, L.
275 Fagus sylvatica, L.

*Salicineæ.**

[Willows are not very abundant in the district. Solitary bushes occur here

* Dr. Buchanan White has kindly furnished the list of Salices, along with the appended notes. To him I am also indebted for much assistance in the detection and determination of plants throughout the whole catalogue.

and there throughout its length, and small clumps on Sleepless, on and near Balhepburn, and near Elcho. The forms noticed are as follows. The × indicates a hybrid form.]

Salix fragilis, L.
(Common about Balhepburn.)
alba, L.
(Balhepburn, but not common.)
× viridis, Fr.
(One tree near wooded bank above Elcho is a well-marked form, though inclining to S. alba. Forms very near S. fragilis occur about Balhepburn. All the plants that I have seen are female.)
× decipiens, Hoffm.
(A little below Friarton.)
280 × subdola, B.W.
(A small clump, all female, below Balhepburn. This Willow, which appears to be a hybrid between S. triandra and S. alba, has not yet been found anywhere else. Though S. triandra has not been found on the ground examined, it occurs on the opposite bank of the river).
cinerea, L.
(Not uncommon.)
aurita, L.
(Moncreiffe Island.)
× Reichardti, Kern.
(Sleepless.)
nigricans, Sm.
(Wooded bank above Elcho.)
285 phylicifolia, L.
(Sleepless.)
× strepida, Schleich.
(Wooded bank above Elcho.)
viminalis, L.
(Below Friarton.)
× stipularis, Sm.
(Several bushes, possibly planted, on Balhepburn. Farther down the river a self-sown bush grows, and is a male, which sex is almost unknown in this hybrid.)
purpurea, L.
(A few widely-scattered bushes.)
290 × sordida.
(A few bushes on Sleepless.)

Coniferæ.

Pinus sylvestris, L.

Hydrocharideæ.

Elodea canadensis, Mich.

Orchideæ.

Epipactis latifolia, All.
Orchis latifolia, L.
295 maculata, L.

Irideæ.

Iris Pseudacorus, L.

Liliaceæ.

Allium Scorodoprassum, L.
carinatum, L.
ursinum, L.
300 Scilla nutans, Sm.

Juncaceæ.

Juncus bufonius, L
glaucus, Ehrh.
effusus, L.
conglomeratus, L.
305 supinus, Mœnch.
lamprocarpus, Ehrh.
acutiflorus, Ehrh.
Luzula maxima, D.C.
campestris, D.C.
310 multiflora, Lej.

Typhaceæ.

Typha latifolia, L.
Sparganium ramosum, [Curtis.

Alismaceæ.

Alisma plantago, L.
Butomus umbellatus, L.

Naiadaceæ.

315 Potamogeton nitens, Weber.
crispus, L.

Cyperaceæ.

Eleocharis palustris, R.Br.
Scirpus setaceus, L.
Tabernæmontani, Gmel.
320 maritimus, L.
sylvaticus, L.
Eriophorum angustifolium, [Roth.
Carex pulicaris, L. (Sleepless).
distícha, Huds. (Marsh above Orchardneuk).
325 echinata, Murr.
remota, L.
curta, Good.
ovalis, Good.
acuta, L.
330 aquatilis, Wahl.
Goodenovii, Gay.
glauca, Murr.
pallescens, L. (Sleepless).
panicea, L.
335 flava, L.
hirta, L.
rostrata, Stokes.
vesicaria, L.

Gramineæ.

Phalaris arundinacea, L.
340 Anthoxanthum odoratum, L.
Alopecurus geniculatus, L.
pratensis, L.
Phleum pratense, L.
Agrostis canina, L.
345 alba, L.
Agrostis vulgaris, With.
Aira caryophyllea, L.
præcox, L.
Deschampsia cæspitosa, [Beaur.
350 Holcus mollis, L.
lanatus, L.
Trisetum flavescens, Beaur. (Orchardneuk—introduced.)
Arrhenatherum avenaceum, [Beaur.
Phragmites communis, Trin.
355 Cynosurus cristatus, L.
Koeleria cristata, Pers. (In small quantity at Orchardneuk.
Dactylis glomerata, L.
Poa annua, L.
nemoralis, L.
360 palustris, L.
compressa, L.
pratensis, L.
trivialis, L.
Glyceria fluitans, R.Br.
365 aquatica, Sm.
Festuca sciuroides, Roth. (Sleepless).
ovina, L.
elatior, L.
arundinacea, Schreb.
370 Bromus giganteus, L.
secalinus, L.
commutatus, Schrad.
mollis, L.
Lolium perenne, L.
375 Agropyron repens, Beaur.
Hordeum murinum, L.

Filices.

Athyrium Filix-fœmina, [Roth.
Polystichum lobatum, Presl.
Lastrea Filix-mas, Presl.
380 dilatata, Presl.

Equisetaceæ.

Equisetum arvense, L.
palustre, L.
limosum, Sm.

XVIII.—*Remarks on the Black-throated Thrush and its occurrence in Scotland.* By Col. H. M. Drummond Hay, C.M.Z.S.

(Read 12th December, 1889).

The Black-throated Thrush (*Turdus atrogularis*, Temminck) is one of those wanderers from the east which occasionally visit Europe. There are no less than five or six species of the Thrush family alone, besides others, which do so.

"The cause of these visits," says Mr. Gould, "seems to be totally unknown. They cannot be regarded," he remarks, "as the result of migration, for they only occur as solitary examples at uncertain periods, generally in the months of autumn, and then, mostly, when the birds are in a state of immaturity." He goes on to say, "Of these visitations, that of *Syrrhaptes* (Pallas' Sand Grouse) in 1863 was the most remarkable." With all due deference to the late Mr. Gould's opinion, I scarcely think that these abnormal autumnal visits of the wandering Thrushes, and other Siberian birds, can be looked upon quite in the same light as those great immigrations into Europe of the Sand Grouse which took place in 1863, and again in equally great numbers in 1888, five-and-twenty years afterwards. Whatever the cause of these great irruptions may have been, they can scarcely be put in comparison with the stray visits of birds (mostly the young of the year) of other species which visit Europe from time to time, chiefly in autumn. Scarcely a season passes without some one sort or other being recorded, which inclines me rather to Mr. Seebohm's view, that they are merely young birds that have missed their way in the autumn migration and wandered into Europe instead of South Asia. It is not so with the Sand Grouse. These seem to be impelled westward, after long intervals, by some strong influence bearing upon them immediately prior to the breeding season. They cross Europe in large bands, and, on arrival at some suitable locality, at once enter, "if unmolested," on the duties of the season. We had an example of this, almost at our very doors, in the successful breeding of these birds on Tents Muir, at the mouth of the Tay, two years ago, soon after their arrival. A few still remain on the ground this year, but what has become of the bulk? They seem to have vanished. They have not been shot down as formerly, being under the protection of the law, at least in this country. What has become of them, and of the large flocks that were noticed always moving westwards two years ago? This we may expect soon to hear of, as I understand their movements are being worked out under the superintendence of Professor Newton, who so ably traced the wanderings of these birds through Europe in 1863.

But, to return to the Thrush now under consideration. This is a true Asiatic species, the distribution of which is well laid down by various eminent naturalists. The breeding-grounds extend eastwards from the Ural Mountains, throughout the greater part of Siberia, the region of Lake Baikal, and the mountains of Northern China, and northwards to near the Arctic Circle. In a southerly direction, it is found along the mountain ranges of Eastern Turkestan, the Hindoo Coosh, Thibet, and the Himalayas, as far as the mountains of Nepaul, which possibly form the extreme southern breeding limit. Dr. Otto Finsch, naturalist to the Bremen Expedition to Western Siberia and Northern Turkestan in 1876, observed it in the month of May on the great steppes, though the whole region was destitute of trees. When at Beresov, on the River Obb, not far from the Arctic Circle, he met with young birds of this species as late as the middle or end of September; and Mr. Seebohm fell in with them early in August, between the latitudes of 61° and 63° N., in the valley of the Yenesay, and describes them as noisy, active birds, and very wary, loving water courses, and frequenting the neighbourhood of villages on the banks of the river, in open spots where the forest had been cut down for firewood. A favourite place he also found to be among clumps of small trees scattered over the rough pastures where cattle were turned out in summer, preference being given to spots occupied by the fir tree. Mr. Swertzoff, the Russian naturalist, found it breeding in Eastern Turkestan, in the cultivated districts, gardens, grassy steppes, and salt plains, up to 4000 feet above sea-level. In the Himalayas, Colonel Tytler, of the East India army, while on a march from Simla to Mussoorie, in the summer of 1867, during the nesting season, found it at all heights from 4500 to 10,300 feet. In the cold season, Mr. Jerdon says that it frequents the lower ranges in all the north-west provinces, as well as in the plains of Lower Bengal; and Mr. Blyth mentions it as having occasionally been got in winter as far south as the vicinity of Calcutta. It is also to be found at that season throughout Beloochistan and Northern India, where it is quite common. At that time it feeds on the berries of the *Eleagnus* (Oleaster, or Wild Olive), a small tree allied to the *Hippophäe*, or Sea Buckthorn, of this country. Of this plant there are several hardy kinds, two of them natives of the south of Europe; but the one here meant is no doubt *Eleagnus orientalis*, the flowers of which are highly fragrant, and the fruit much esteemed in some parts of the east. At other seasons, when berries and small fruits become scarce, the food of this bird, like that of others of the tribe, consists chiefly of worms and insects.

The Black-throated Thrush, as before mentioned, has several times occurred in Europe, but, as might be expected, more frequently in those countries which lie to the east, nearer its own home. In Western Europe, besides this country, occasional stragglers have appeared in Norway, Denmark, Belgium, and France, and two have been got in Heligoland. It has also been got as far south as Italy. The first notice we have of it in Britain is contained in a communication to the "*Ibis*," dated 30th December, 1868, by the late Mr. Gould, in which mention is made of his having just received a letter from Mr. T. J. Monk, of Mountfield House, Lewes, Sussex, stating that a fine male of the species, in excellent condition, had been shot there on the 23rd of that month. This same bird is figured in his work on British birds. For many years we hear no more of it in this country, and it was only in the early part of this present year (1889), more than twenty years afterwards, that, by mere chance as it were, in talking to Mr. Young, our Janitor, who takes much interest in the Society's collections, I learned for the first time that such a bird had been shot in the vicinity of Perth some years ago. I at once instituted inquiries, and eventually ascertained that, in the month of February of the very severe winter of 1878-1879, ten years previously, Mr. Robert Gloag, stone-mason, a keen observer of nature, with a good knowledge of birds, as he was going down the road by the Friarton with his gun, was suddenly arrested by hearing the noisy call-notes of a couple of birds, which struck his ear as perfectly new to him. He observed the birds down on a spit of waste ground running into the river, and covered with docks and wild sorrel, on the seeds of which they seemed to be feeding. Cautiously approaching within shot, as the birds were very wary, he fortunately secured one. Its companion, flying on to the farther end of the spit, would not admit of a sufficiently near approach to get within shot, and, again taking wing, it crossed the Tay, over Moncreiffe Island, into the woods below Kinnoull Hill, and was no more seen. It is deserving of remark that the vociferous call-notes, the wary manner displayed, and the locality occupied on the water-side, so perfectly tally with Mr. Seebohm's experience of the habits of these birds in Siberia, that they add another link to their identification, were such required. Fortunately Mr. Gloag had the bird preserved, and gave it to his brother, Mr. John Gloag, living at Almondbank, in whose possession it has remained ever since. The latter, on being informed of the rarity of the bird, after I had identified it, at once most kindly presented it to the Perthshire Society of Natural Science, for their Local Collection, where it is now deposited. This is the first instance ever recorded of its occurrence in Scotland, and only the second, up to this time, so far as I am aware, in Great Britain. To say that other stragglers of the species have never visited these Islands since 1868 would perhaps be saying too much, for I think it not improbable that they may occasionally have done so without having been detected. Their sombre plumage, which at a little distance so resembles that of a female Blackbird, would be their safeguard, unless they chanced to come under the notice of an ornithologist, or of some observer gifted with the same discriminating ear as the one above noticed. With regard to many of these Asiatic Thrushes, there has been a good deal of doubt, from their being in some stages of plumage most difficult to distinguish. This is especially the case with the present species and the Red-throated Thrush (*Turdus ruficollis*, Pall.), of which Mr. Seebohm says, "So nearly allied are they, that there seems every reason to believe that they sometimes interbreed." He also mentions that a complete series of intermediate forms from the one to the other, including both extremes, is to be met with in the Berlin Museum, all collected on the southern shores of Lake Baikal during April and May by Dybowsky. The description given of the adult male of the Black-throated Thrush, when in breeding plumage, is, that it has the throat and breast black, belly white, turning to greyish brown on the flanks, upper parts olive brown, darker on the wings and tail. In winter the throat feathers have light margins, and the general plumage is duller. Young males—of which I have every reason to believe Mr. Gloag's bird to be one—resemble the adult female, in which the feathers of the throat are not completely black, but have merely dark centres, forming a streaked gorget, and the under parts dull white. The under-wing and axillaries in both sexes are golden buff, the bill dark brown above, pale below, and the legs and feet pale brown. This exactly agrees with the markings of the specimen we have in the Museum; and I think I may well congratulate the Society on its being in possession of so great a rarity. In their name I have to thank Mr. John Gloag for his liberality, as well as Mr. Robert Gloag, who, on seeing his bird in the Museum, remarked to me that he was glad to see it there, as it was in the right place.

XIX.—*A Geological Sketch of East Fife.* By R. Dow.

(Read 13th February, 1890).

St. Andrews, "the grey little Oxford set by the Northern Sea," is a city of contrasts—of the present with the past. The relics of a dead past lend a charm to the place; as Cicero said of ancient Athens, "Every stone you tread on has its history." They recall the historical personages and momentous movements of a bygone day that irresistibly attract and fascinate the poet and the painter, the antiquarian and the historian. To the student of geology or of botany St. Andrews offers a happy hunting-ground, and specially in the variety of its coast scenery. The wide Tents Muir, between St. Andrews Bay and the mouth of the River Tay, presents a remarkably fine example of the effects of blown sand. This huge sandy waste covers an area of nearly fifteen square miles, and, with its fringe of sand-dunes, is a characteristic feature of the north-east corner of Fifeshire. Landwards the parallel lines of successive sand-ridges are well developed. The Golf Links of St. Andrews—unsurpassed in Scotland, and the Mecca of all golfers—extend for a distance of two miles on the opposite shore of the Eden. It belongs to the same geological formation as Tents Muir, being simply the result of seashore sand which has been carried landwards by successive storms. The line of sand-dunes, so familiar a feature of the Links, is mainly due to the planting of hardy grasses some fifty years ago. These form an effective barrier to the inroads of the blown sand. The Lyme Grass *(Elymus arenarius)* grows to a height of 4 to 5 feet above the surface of the sand, and, as it keeps pace with the sand, its roots must descend to a great depth. The Sea Reed or Mat Grass *(Ammophila arundinacea)* has also been planted.

On the landward side of the Links and Tents Muir a fine example of a raised or ancient sea beach extends from St. Andrews to the village of Tayport. The railway line between these two stations is constructed upon it. The beach marks a gradual upheaval of the old sea margin. We have several notable examples along our coasts at heights of 10, 20, 40, 50, and even 100 feet above the present sea level. In the present case the average height is 50 feet. Landwards this strip of ancient sea margin is backed by the bedded porphyrites of the Tayport district, by the upper beds of the Old Red Sandstone in the Leuchars district, and by the Calciferous Sandstones of St. Andrews.

At St. Andrews the character of the sea-shore and its geological formation undergoes an entire change. Instead of low sand wastes extending for miles, we have bold precipitous sea-cliffs, so conspicuous a feature of the coast scenery at St. Andrews. These cliffs at St. Andrews afford abundant evidence of the mighty contest that unceasingly exists between sea and land, a contest the ultimate issue of which can hardly be doubted. It is impossible that any cliff can endure such a terrible assault which must of necessity be renewed at every gale. The results of this mighty bombardment of centuries are everywhere visible. Cardinal Beaton's castle is said to have been situated in his day some distance from the sea, but to-day it overhangs the beach below, and, to protect this historic pile from the attack of the waves, the cliffs are now protected by retaining walls of masonry. There is a tradition that the ancient Culdee, Regulus, and his companions had a cell dedicated to the Blessed Virgin about a bow-flight to the east of the sea-shore at St. Andrews, a little beyond the end of the pier, upon a rock known as Our Lady's Craig, now seen only at low water. In the parish of Crail some slender remains of a Priory existed down to the year 1803. These, with the gardens and walls, are now wholly removed, but the adjoining grounds still retain the name of the croftlands of the Priory.

The cliffs to the east of St. Andrews, locally known as the Kinkell braes, extend for a distance of over four miles. Still eastwards the cliffs disappear, and, instead of crag and cliff, the sea-shore sinks into lurking reef and dangerous shelf. At ebb tide these run out to sea for a long distance, culminating still eastwards in the Carr Rocks. These dreadful reefs are a terror to the mariner, and many a ship has come to grief upon them. Lurking underneath the waves these dangerous reefs stretch away out to sea for a mile and three-quarters at right angles to the shore. It has been calculated that on an average over two ships are lost or run ashore here every year. A lifeboat is now placed at this point, and a costly new lightship has been lately anchored outside the Carr Rocks. Eastwards still is the East Neuk of Fife, or Fife Ness, the very personification of ruggedness and loneliness. The bold rocky character extends for two miles to Crail, the limit in this direction of our botanical and geological ramble. Crail possesses a peculiar fascination and charm, especially for artists. Exquisite "bits" from Crail yearly adorn the walls of the Royal Academy in Edinburgh. The sea-green of the Firth, the bright red of the roof tiles, and deeper red of the cliffs, and the old pier, all lend a charm to the scene, which once seen can never be forgotten.

Although the surface of Fifeshire seems quiet and peaceful to-day, and undisturbed by those internal forces which devastate less favoured regions, yet it was not always so. There is abundant evidence that, in the dim past, volcanic forces burst through the crust of what was then the surface of the earth on a most extensive scale. This molten mass was poured upwards from below during the laying down of the carboniferous sandstones and shales. The entire surface of the northern half of the county is covered by rocks of igneous origin, forming vast sheets of bedded porphyrites of Old Red Sandstone age. The southern half belongs to the carboniferous or coal era. This part is dotted with the stumps of ancient volcanic mountains, not equally denuded, of course; the harder bosses intervene, as these have withstood the assaults and attacks of the elements. They represent the hardest and most indestructible rocks.

Dura Den.—This classic field of geology falls to be included in the geology of the East of Fife. At Dairsie, some three miles down from Cupar, the River Eden is augmented by the Ceres Burn from the carboniferous limestone hills to the south. Throughout the last two miles of its course the stream flows through a charming hollow, enclosed by high precipitous rocks on both sides, which are diversified by the various colours of the interlaminated beds of shales, sandstones, traps, and ironstones. This is the well-known Dura Den. The yellow sandstone deposits have excited considerable interest among geologists for many years. The *Poissons Fossiles* of Agassiz contains descriptions of their organic remains, which have given great celebrity to the spot ever since. The Den has been visited by many of our most famous geologists. Sir Charles Lyell visited it in the summer of 1842 with Dr. John Anderson, the latter of whom has written a most interesting monograph of the Den. Hugh Miller and Sir Roderick Murchison explored it some years later, and when the British Association visited Dundee in 1867 the *savants* had an excursion to the Den. The lower portion belongs to the upper Old Red Sandstone system, and without doubt is on the same geological horizon with the organic deposits at Clashbennie, near Errol. It is to these deposits that the famous fossil fishes belong. Magnificent collections are to be seen in the Museum of St. Andrews University and at Rossie Priory. Specimens are also to be seen in the Albert Institute, Dundee. Dr. Anderson's finest specimens are in the British Museum.

"The remains of these fish," writes Dr. Anderson, "are so very abundant in the yellow sandstone deposits of Dura Den that a space of little more than three square yards yielded about a thousand fishes, most of them perfect in their outline, the scales and fins quite entire, and the forms of the creatures often starting freely out of the hard stony matrix in their complete armature of scale, fin, and bone." This peculiarity of entireness, and even of freshness, in these old denizens of the waters is so remarkable that, when first exposed to view on the newly split-up rock, there is such a lifelike glistering over the clear shining scaly forms that one can scarcely divest himself of the idea that, instead of the innumerable series of geological terms to be counted, he is looking actually upon the creatures of yesterday. "Here is a living one!" exclaimed a workman, as he raised from the bed of the stream a large flagstone on which were counted upwards of fifty fishes, one being pre-eminently beautiful, full and rounded in its form. Those figured in Dr. Anderson's monograph are *Holoptychius Andersoni*, Ag., *Phaneropleuron Andersoni*, Huxley, *Glyptoleumus Kinnairdi*, Ag., and *Pterichthys hydrophilus*, Eg. These fishes are all of the ganoid type, and modelled after the same plan. The scaly covering is true bone; the backbone extends to the extremity of the tail fin, hence called *heterocercal*, in contrast to all existing fishes, whose backbone terminates within the tail fin, and are termed *homocercal*. The existing shark and sturgeon are exceptional cases.

Immediately above the upper Old Red Sandstone deposits of the Eden Valley, but clearly distinguished from them by the abundance of their vegetable remains, we find the lower members of the Carboniferous system. This system occupies the whole of the southern portion of Fifeshire, and the system is clearly marked off from the sandstones of the Eden Valley by a great line of fault or dislocation. The carboniferous deposits in all probability extended over these Eden Valley deposits, but by repeated faults have been let down, and so escaped denudation.

The Carboniferous system of Scotland is divided into four groups of strata—(1) The first, or lowest, are the calciferous sandstones of the east of Fife; (2) the carboniferous or mountain limestone; (3) the moor rock, or millstone grit; (4) the upper, or true coal measures. It is only the first of these we have to describe—viz., the calciferous sandstones. These are splendidly exposed at St. Andrews, and indeed all round the coast of Fife as far as Pittenweem. At St. Andrews the strata consist of thick bedded white and yellow sandstones, dark bituminous shales, thin seams of coal, and of limestone with abundant encrinite fossils. The white sandstones are the ordinary building stones of St. Andrews and Edinburgh. The term "calciferous sandstone" has been applied to the whole group from the abundant deposits of encrinite and myalina beds. These encrinites are an extensive family of fossil radiata, having a long jointed stem surmounted by a lily-shaped branching body. The calcareous skeletons of these encrinites are so abundant in all the limestones of St. Andrews as to compose the greater portion of the mass, and hence it is sometimes called encrinite limestone.

At St. Andrews the bedding dips to south, and is remarkably regular, but this cannot be said of the bedding to the east of the town. There it is shattered, altered, and tilted at every conceivable angle, caused partly by repeated faults and partly by volcanic action. The results of this volcanic action are well exposed at the "Rock and Spindle," so well known to visitors to St. Andrews. The "Rock and Spindle" is simply the consolidated lava flow and ashes of former volcanic activity. The spindle is a series of prismatic columns of basalt radiating from a centre, as Fingal's Cave or the Giant's Causeway is a series of prisms in a vertical position. The rock is a mass of "soft agglomerate"—a term first employed by Sir Charles Lyell to designate those accumulations of angular fragments which are thrown up by volcanic eruptions and showered to greater or less distances around the cone of eruption. The dark green of the agglomerate contrasts well with the reddish hue of the much harder spindle. These agglomerate necks are dotted all over this part of the county.

XX.—*On the Arrangement of the Geological Collections in the Museum.*

(Read 10th April, 1890).

III.—The Index Collection of Rock Specimens.* By H. Coates.

The Index Collection of Rocks is one of the departments of the Museum in which much yet remains to be done. It is, in fact, little more than commenced. The specimens which it contains are good so far as they go, but they represent only a very few of the different kinds of rocks. Instead, therefore, of describing it as it is, I shall endeavour to show what it should be.

In my paper last year I said that the Perthshire Geological Collection, when complete, ought to supply the illustrations to a description of the Geology of Perthshire. In like manner the Index Collection ought to supply the illustrations to a general text-book of Petrology. It should present in outline a survey of the classification of rocks, in order that we may see at a glance the relative positions

*For Parts I. and II. see p. 105.—Ed.

which the Perthshire rocks occupy in the general system of rock formations. To do this it should contain specimens representing at least all the main divisions, and the more varieties represented in each division the more complete and useful will the collection be.

The classification of rocks is a matter on which geologists are not by any means agreed. The reason of this is evident when we consider how many different methods might be adopted. We might arrange them according to their mineral constitution, irrespective of their origin or mode of occurrence, or by their microscopic structure, irrespective of composition. Or we might classify them according to age, or position, or crystallisation. Each of these arrangements would be instructive, but perhaps the most practicable method is one combining them all. Such is the plan adopted by Rutley in his "Study of Rocks." He divides all rocks first into two great classes according to origin, namely, *Eruptive* rocks, or those which show signs of having been in a molten condition, and *Sedimentary* rocks, or those which have been formed by the accumulation of material under water. Each of these is sub-divided into those which are unaltered and those which are altered. Formerly, all altered, or metamorphic, rocks were classed by themselves, but it is more logical to speak of altered Eruptive and altered Sedimentary rocks.

In the further sub-division of Eruptive rocks reference is made to mechanical structure, those which are glassy in structure being placed in one division, and those which are distinctly crystalline in another. Then, again, in classifying each of these we have recourse to yet another method, and arrange the groups according to mineral composition.

In the classification of the Sedimentary rocks, also, each different method is called into play. Thus the coarse-grained conglomerates are placed in a division by themselves, whatever their chemical composition may be, whereas the slates and shales are separated from the sandstones, because the former contain a large percentage of alumina, while the latter consist of little else than pure silica.

It would be out of place here to give a detailed statement of the classification of rocks. My only object was to indicate some of the methods adopted and some of the difficulties met with.

If we compare the specimens now in the Museum with a complete table of the classification of rocks, we shall find that there are many blanks to fill up. Thus we have no specimens of the glassy Intrusive rocks, nor of such typical crystalline rocks as syenite, trachyte, and diabase. In the Sedimentary rocks the main divisions are represented, but it is very desirable to have more specimens, so as to illustrate variations in grain, cleavage, hardness, &c.

For most of the specimens in the Index Collection the Society is indebted to Dr. Buchanan White and Professor James Geikie.

IV.—The Index Collection of Minerals. By Peter Macnair.

As you are aware, we have two collections of minerals in the Museum—an index and a local collection. Last session I had occasion to read a paper on the collection of minerals which are entirely local—*i.e.*, those which have been found in Perthshire. I now wish to supplement that paper by giving a short notice of the index collection.

The local collection is the outcome of the scientific aspect of our Society, inasmuch as it has for its end the discovery and collecting of all the minerals native to Perthshire. The index collection, on the other hand, is the outcome of its educational aspect, and has for its direct object the illustration of the great principles of mineralogical science.

One of the principal ends we had in view while forming the nucleus of our index collection was to include all the minerals that are characteristic components of the rocks of Perthshire. The reason for this is almost self-evident when you reflect that the science of Petrology belongs to no small extent to the domain of the mineralogist. Undoubtedly such questions as the mode of occurrence and the age of any rock-mass belong essentially to geological science; but, on the other hand, when questions arise as to the mineralogical affinity of any given rock, or its position in a scheme of classification, mineralogical science must be called in to aid the geologist.

Another and very important end of a mineral collection should be to include all the ores—*i.e.*, minerals that can be profitably worked for those metals, etc., which are so essential to the multifarious needs of every-day life. In the Highlands of Perthshire, as seen from our last paper, some of these ores, such as lead, copper, iron, etc., have been found and worked, though not to any great extent. Yet another, though perhaps less important, end might be the collecting of all those minerals which contain precious stones. Some of these ornamental stones are to be found in our local collection, as cairngorm, agate, garnet, etc.

Minerals occur primarily as the original constituents of rocks, but they occur in other ways also. For instance, fissures in the rocks are often found lined with certain minerals. This is the mode in which most of our metallic minerals occur. Elsewhere they are found filling cavities in the rocks, as in the case of agates and the zeolitic minerals. These cavities are in many instances the steam holes of the consolidated lavas, and the zeolites have been filtered into them, their chemical composition always bearing some relationship to that of the rocks in which they occur. This infiltration is well seen in the banding of the agate, each band of colour representing different layers of deposition which has gone on at successive periods. Sometimes the agate contains crystals of quartz, with the apex of each pyramid pointing towards the centre, showing that the mineral has grown from the outside inwards.

There is still another mode in which minerals occur—namely, as veins, occupying a fissure or fault in the rock. This fault, being originally empty, has become filled up with ores and minerals of different kinds. In this manner the following ores often occur:—copper, lead, tin, iron, zinc, antimony, mercury, silver, etc.; as well as the following common minerals:—calcite, quartz, barytes, fluor spar, etc.

It is almost impossible in a type collection to indicate the mode of occurrence of a mineral, and therefore this characteristic does not obtain a place on the label of each specimen; but, if the origin and history of a mineral is to be traced, it is evident that we require to know something of its mode of occurrence. We have therefore added this most important characteristic to our descriptions of the local minerals.

A mineral is a substance having a constant chemical composition. As this is an important characteristic, the principal constituents of each specimen in the collection are given on the descriptive label attached to it. Each mineral also assumes a definite crystalline form, which is as characteristic of it as its chemical composition. For instance, the mineral quartz very often crystallizes in the form of a hexagonal prism, capped with a hexagonal pyramid, and belongs to what is termed the hexagonal system. This crystalline form, therefore, also obtains a place on the descriptive labels.

The plan upon which our index collection has been arranged is the same as that adopted by Dana in his Manual and System of Mineralogy. Beginning at the left-hand end of the case, the first tray contains all the minerals that are formed of a single chemical element, such as native lead, copper, bismuth, sulphur, gold, silver, etc. The next tray contains all the minerals of which the chief elements are sulphur, chlorine, and fluorine. The remaining trays include all those minerals which contain oxygen, comprising by far the largest part of the collection. The sub-divisions are as follows:—

I.—Oxides, or Binary Oxygen Compounds.

II.—Tertiary Oxygen Compounds.

Under the first division we have the mineral quartz, with all its varieties, which are well represented. The second division includes the silicates, anhydrous and hydrous.

Finally, the lower half of the last tray contains a few specimens of minerals of which carbon and hydrogen are the principal constituents.

XXI.—*Some New Perthshire Localities for Rare Mosses.*

By R. H. Meldrum.

(Read 10th April, 1890).

I have chosen as the subject of my paper "Some New Perthshire Localities for Rare Mosses," and I may say at once that, as these are few in number, my paper will have at least the merit of being brief. This paucity of new records is *not* due to the fact of the county being so thoroughly explored that little remains to be discovered. That is far from being the case. One or two small areas have indeed been pretty carefully searched, but these bear a small proportion to the remainder of the county which practically has not been bryologically examined at all. When we consider how minute many species of mosses are, how readily they escape observation, how rare and local many of them are; further, when we consider the great extent of the county of Perth, and the difficulty of reaching many parts of it, we cannot doubt that a great number of habitats for rare species still remain to be discovered. We may also be sure that, while the number of local moss-students remains as at present, and their enthusiasm in prosecuting their researches continues at its present pitch, it will be hopeless to look for a long list of discoveries. This want of workers is the reason why so few additions are now made to our knowledge of the Perthshire Moss Flora.

For my own part, I have been able to do very little to the investigation of our species, as I find that I cannot combine satisfactorily the search for Phanerogams and Mosses on the same excursion. Mosses require a much more minute and careful scrutiny of localities than flowering plants do, and hence one soon falls out of line with the other members on an excursion. For this reason I have usually confined myself during the summer to the phanerogams, and only casually picked up a few specimens of mosses. During the winter, however, I could devote my whole attention to the latter plants; but at that season my botanical rambles have hitherto been confined to my own immediate neighbourhood, and, besides, have not been by any means of frequent occurrence.

I think, however, it is now time to set about obtaining a more complete knowledge of what species of mosses occur with us, and what their distribution is within the county. The Phanerogamic Flora of Perththire is now approaching completion in the hands of our President, and I would suggest that after its publication all the botanists of the Society become bryologists, and that excursions be arranged specially to investigate the Moss Flora of the county.

Assistance can be given by any member of the Society. No botanical knowledge is required beyond the ability to distinguish a moss from other plants, and the labour involved is small. Country members could give valuable aid, especially in the winter and spring months, by collecting all the species in their neighbourhood which they can distinguish as being different. The appliances required for this are few—first, a bag for holding the packets, and, secondly, some pieces of paper to wrap each specimen in when gathered. These papers should be numbered before beginning to collect, and as each is filled the number should be entered in a note-book, with the habitat, locality, and date. On reaching home the papers should be opened, and left thus for a day or two till the contents are dry, when they should be folded up again, with the particulars from the note-book enclosed. When convenient, these packets should be sent here to the Museum, where the species would be determined. That is the whole procedure. Anyone, everyone can help, and I earnestly hope that such assistance will be forthcoming soon.

I shall now proceed to enumerate the most noteworthy of the recent discoveries.

The first species to be noticed is *Cynodontium Wahlenbergii* Brid. This moss is considered by many authors to be a variety of *Cyn. virens* Hedw., a species which is not uncommon on the Grampians. Dr. Braithwaite, however, maintains that they are quite distinct. Compared with *virens*, the stems of *Wahlenbergii* are more slender, the leaves longer and narrower, with an abruptly dilated base, and the capsule is shorter. This plant was first added to the British Flora by the Rev. J. Fergusson, who found it in Glen Callater in 1871. It is very rare, and I have not seen it recorded for Perthshire. However, two years ago, I gathered a tuft of it on the Sow of Athole while searching for *Menziesia*.

Campylopus subulatus Schimp., another member of the large family of *Dicranaceæ*, is a species first authentically recorded from this country by the same acute bryologist who found the last species. It was obtained by him near Fern, in Forfarshire. Subsequently he found it on Kinnoull Hill and also on Moncreiffe Hill. A friend informed me of the exact locality in which Mr. Fergusson found it on Moncreiffe, and on visiting the neighbourhood recently I found a good supply of the plant at another spot than that indicated. Since its first discovery in this country it has been got in several other localities, and I believe its rarity is more apparent than real, as not only is it of small size, and therefore easily overlooked, but it also is liable to be mistaken for *Camp. fragilis* B. & S., of which, indeed, Mr. Fergusson suspected it to be little more than a depauperated form. It differs from *fragilis* in its smaller size and the want of tomentum on the stems.

Another moss which has recently been found near Perth is *Tortula canescens* Mont., a species which Dr. Braithwaite in the British Moss Flora declares to be quite a Mediterranean plant, and he records it only from the Channel Coast in England. This was sent to Dr. Buchanan White by Mr. Fergusson along with several other rarities discovered by him in this neighbourhood, and I include these in this paper, as I am not aware of their having been published hitherto. This species is said by the finder to be abundant in more than one locality near Perth. The occurrence of this plant so far from its other localities in Britain is very curious, but it is probable that it does occur in the intervening area. Its strong resemblance to the common *Tort. muralis* Hedw. may be the cause of its apparent absence.

The genus *Grimmia* includes a considerable number of species, and several of these show a marked predilection for trap rocks. Hence the hills in the neighbourhood of Perth are specially rich in these forms. Indeed, one species, *Gr. subsquarrosa* Wils. was first described from specimens found on Kinnoull by Dr. Buchanan White, and another species, *Gr. commutata* Hueben., was recorded as British for the first time from Moncreiffe Hill. Both these mosses have been found elsewhere since their first discovery, but in a few localities only. On Callerfountain grow other two trap-loving species which do not occur, so far as I know, on either Moncreiffe or Kinnoull; these are *Gr. leucophæa* Grev. and *Gr. Schultzii* Wils.

On Kinnoull Hill occurs another rare Grimmia, *G. orbicularis* Bruch., which, unlike the foregoing species, prefers a calcareous habitat. I was pleased to find a second Perthshire station for this on the garden wall at Dupplin, where it exists in considerable quantity. It bears a striking likeness to a very common moss—*Gr. pulvinata* Sm.,—but is easily enough separated from it if examined before the calyptra has fallen off, as this organ is of a different shape in the two species. The lid of the capsule also affords a means of distinction, though not an infallible one, since a variety of *Gr. pulvinata* possesses a similar lid.

A genus closely allied to *Grimmia*, but differing from it in the calyptra, affords the next species, *Coscinodon cribrosus* Spruce. This moss resembles *Grimmia anodon* B. & S. and *Gr. crinita* Brid., but is easily distinguished, even when barren, by the plicate leaves. It is very rare, and has not been long known as a native of Britain. As a Perthshire species its discovery is due to Mr. Fergusson, who found the male plant sparingly near Perth.

The genus *Orthotrichum* includes a number of species which are in many cases difficult to separate, owing to their great similarity in habit and foliage. Two species require notice, and, fortunately, these can be made out with comparative ease. They are both plants which confine themselves to the immediate vicinity of water.

The first species, *Orth. rivulare* Turn., I find on stones and trees by the river Earn from Dupplin downwards. I have not examined the river above this point, so cannot say how much farther up it extends. According to Dr. Braithwaite, this moss is more frequent in this country (where, however, it is not common) than in any other part of Europe.

The other species, *Orth. Sprucei* Mont., I find on the willows and alders by the old course of the Earn at Kirkton. The Rev. Mr. Fergusson found it previously above Bridge of Earn. In the British Moss Flora it is recorded for Birnam, and the only other Scottish locality given is near Glasgow. It is exceedingly rare on the Continent, and Boulay, in recording it from a single French locality, mentions that it was up to that time only known from a few stations in Great Britain. Yorkshire seems to be its headquarters in this country.

In a paper contributed to the *Scottish Naturalist* for 1879 Mr. Fergusson says, "One of the most interesting discoveries of recent years is that of *Aulacomnion turgidum* Wahl. This plant, which is so remarkably abundant within the Arctic circle, and advances southward to the Styrian Alps, was gathered by Professor Barker on Ben More, Perthshire, in July, 1871, but was only determined last year. Last year it was gathered in a second British locality, on Whernside, Yorkshire, by Messrs. West and Lees. Now that attention has been called to this new British species, it is probable that it will be found in other localities, though it is likely to prove local, or even rare." Since the above was written I know of only one new locality for this rarity, which makes the second Perthshire and third British station for it. It was sent to me in 1888 by Mr. Brebner from Corrie Ceothach, at the head of Glen Lochay.

The next species, *Buxbaumia aphylla* Linn., is a very peculiar moss.

As its specific name implies, it is leafless, with the exception of a few minute bracts at the base of the pedicel. It is stemless, so that the whole plant seems to consist of the capsule and seta. The capsule itself presents an appearance quite unlike that of the same organ in other mosses, and on seeing it for the first time one is inclined to doubt its being a moss at all. In fact, it was for some time looked upon as a fungus until Dillenius referred it to the mosses. Dr. Braithwaite says of it, "The sporadic character of its distribution, and the scanty numbers in which it is found, have invested it with rarity, and its discovery is generally hailed with acclamation by collectors, while its peculiar structure will always render it an object of interest to the bryologist." In 1888 I found three capsules of this moss on an upturned tree-root in a wood near Cherrybank. The following year only one capsule was to be seen, and this year none, thus exemplifying another extract from the Moss Flora—"This strange plant has an annoying habit of disappearing from the stations it occupies, probably due to some change in the substratum on which it is produced, and thus one can never rely upon finding it a second time in the same locality."

On a single tree in the backwater at Kinfauns Railway Station, and in a single patch, I found, two years ago, another rare moss—*Myrinia pulvinata* Wahl. This species is of very limited Continental distribution, occurring in Scandinavia, the Tyrol, and in one locality in France. It occurs in a few stations in England, and I believe Mr. Fergusson found it some years ago on the Earn above Bridge of Earn.

Scleropodium illecebrum Schwaeg. is a moss which attains its greatest development in the Mediterranean region. It becomes less frequent and more dwarfed as it recedes from that quarter. In England it is found chiefly in the southern counties, and I have not seen it recorded from Scotland. Mr. Fergusson, however, has obtained it in a station near Perth, where he states it to be plentiful, and to fruit, though sparingly. The same gentleman has also sent the other species of the genus, *Scleropodium cæspitosum* Wils., from a locality east from Perth, where he found one large patch of it.

I shall conclude my list with a pretty alpine moss, the variety *compacta* of *Andreæa alpina* Sm. This was found by me on Stuc-a-chroin, and seems to be of rare occurrence, as I find it recorded only from Ben Nevis and North Wales.

I trust, when next I have an opportunity of noting the additions to this department of our Flora, that the list will be much longer. I hope it may contain as large a proportion of noteworthy species.

XXII.—*Additional Aculeate Hymenoptera for 1889.*

By T. M. M'Gregor.

(Read 8th May, 1890).

In presenting our annual report of the additional Aculeate Hymenoptera for 1889, we are pleased to notice the occurrence of seven species of Ants which have been collected in the district, and which are as follow:—

Formica rufa, Linnæus.
,, *fusca*, ,,
Lasius niger, ,,
,, *flavus*, De Geer.
Leptothorax acervorum, Faber.
Myrmica rubra, Linnæus,
race 2, *ruginodis*, Nyl.
race 4, *scabrinodis*, Nyl.

Most of these ants we find generally distributed throughout the district. *Lasius flavus* we have only met with on one occasion, on Moncreiffe Hill. It is not intended at present to enter into any particulars of these insects, but simply to note their occurrence. It is to be hoped, however, that on a future date we may be able to give a fairly complete list of the ants native to Perthshire, with notes on their habits, and the localities and situations in which we find them.

With regard to the bees and wasps we have been less fortunate than in preceding years, but this is what we must now naturally expect, as most of the commoner orders have already been collected. We have only succeeded in adding three wasps and one bee; but, however humble the list, it is to be hoped it will still be worthy of record.

The first on our list is *Ceropales maculatus*, of which we have only obtained a single specimen, taken at the Linn of Campsie. It is a member of the family *Pompilidæ*, or spider-wasps, of the economy of which little is known. This genus is remarkable for beauty of colour. The hind-legs are exceptionally long, and the insect, like other members of the group, remarkably active. The specimen we have secured is of a beautiful indigo blue, with bands of yellow across the abdomen, the legs being of a reddish colour.

The next insect is *Mimesa equestris*, Smith, which was also obtained at the Linn of Campsie, on the hemlock. The insect is black, with a bright red abdomen.

The third and last of the wasps is *Crabro tibialis*, one of the bramble-mining wasps, which we bred from perforated bramble sticks, collected during the winter months. A few of these bramble sticks are here shown split open, showing the pupæ of different kinds of these bramble-mining Hymenoptera in them.

The only additional bee we have obtained is *Megachile circumcincta*, which belongs to the family of leaf-cutters, and on which we append a few notes.

On 6th July of last year a visit was made to the Linn of Campsie, where we had the good fortune to capture a very dilapidated specimen of this bee; and only by obtaining better specimens on a subsequent visit were we able to identify it. By careful examination of the adjoining sandbanks, we discovered their burrows, and obtained many of their cells. The nests contained from one to six cells, but most of them contained only three.

When the first of these cells were obtained in July the bees were busy constructing them, and one bee was caught with a piece of leaf in its mandibles as it entered the burrow. Many of the cells were consequently in different stages of construction. Some of the bees were caught in them, and these made no effort to escape, but remained inside, emitting a peculiarly plaintive and shrill cry; and when touched they would invariably turn over on their backs and show their stings. When digging the cells out of the sand many were damaged, exposing the maggot-like larvæ. In one case, where the larva was thus deprived of its natural supply of bee-bread, we attempted to feed it artificially with honey, but in a few weeks it died. The cells are constructed of rose, willow, or other leaves, and, as each contains between 20 and 30 pieces, are a work of much labour.

The number of pieces contained in four cells examined were as follows :—

Cell	No. 1	contained	26	pieces.
,,	No. 2	,,	22	,,
,,	No. 3	,,	20	,,
,,	No. 4	,,	25	,,

I am unable to say from actual observation how long the bee is occupied in the construction of a cell; but if we suppose that in selecting and cutting each leaf, or piece of leaf, she occupies five minutes, then, on the journey to and from the nest, and in arranging the piece in the burrow, she consumes other five, we may fairly assume that the construction of an ordinary cell occupies the greater part of a working day, and that the provisioning of the cell with honey and propolis will consume the remaining portion. It will thus be evident that a cell per day is a fairly good accomplishment for even such an industrious insect as a bee.

We cannot conclude this brief list without giving vent to our annual expression of regret that the workers in this branch of entomology are so few. Indeed, in general entomology, we, as a society, are particularly far behind. We have no record whatever of the Perthshire phytophagous, or plant-feeding hymenoptera; nor in that beautiful group the *Ichneumonidæ*, or true parasitic hymenoptera; and, at present at least, the *Hemiptera*, *Diptera*, &c., are also neglected. The *Coleoptera* and the *Araneidæ* (beetles and spiders) of Perthshire are not so well known as they should be. It has often been matter of regret to us that many of the very beautiful insects we meet with in our country rambles have to be cast aside because none of our fellow-members collect them.

Mr. Meldrum, in his recent paper on Mosses, expressed the hope that when the phanerogamic botany of Perthshire was thoroughly worked up, his botanical friends would turn their attention to the cryptogams.

As the Lepidoptera of Perthshire is now fully exhausted, might we not also suggest that some of our entomological friends turn their attention to some of the many neglected orders enumerated? They would at least have the novelty of a practically unworked field. We are confident that if those members of our Society who take no active interest in its workings knew of the many pleasant hours we spend in the pursuit and home-study of these insects, we should have many more collectors in the field than we can at present boast of, and consequently a comparatively larger addition to Perthshire insect fauna, of which we possess so very imperfect a record.

XXIII.—*A Catalogue of the Perthshire Willows in the Museum Herbarium.*

By F. BUCHANAN WHITE, M.D., F.L.S.

(Read 8th May, 1890).

Perthshire being specially rich in species and forms of Willows, it is very necessary that our Herbarium should contain a supply of material amply sufficient for the study of these very puzzling plants. With this object I have prepared a catalogue of all our specimens, in order to show to what extent the distribution is represented in our collection, with a view to a yet more extended illustration thereof by the increased energies of our botanical members.

At present the collection includes seventeen species and twenty-eight hybrid forms, out of a total of seventeen British species and forty British hybrids.* The number of sheets already mounted is one thousand and sixty-one (containing two thousand eight hundred and six pieces); but, in addition, there is a not inconsiderable number of unmounted specimens, which are in course of being incorporated in the Herbarium.

The numbers prefixed to many of the specimens (and mentioned in the catalogue) refer to the numbers in my note-book.

In collecting Willows it is always desirable to note in the living plants certain particulars of colour and form which often become more or less obscure in the dried specimens. Some of these particulars I have given under the number of the specimen, that they may be at the service of those botanists who have collected or who may receive specimens of the numbered plants. They will also serve to indicate to collectors of local examples some of the points which should be noted. With regard to these notes it is perhaps unnecessary to point out that they are not full descriptions, but merely memoranda of certain characteristics better or more easily seen in the living than in the dried example.

For some matters of synonymy, descriptions of new hybrid forms, &c., reference may be made to my "Revision of the British Willows" (*Journal of the Linnean Society—Botany*, vol. xxvii).

1. SALIX TRIANDRA L.

Number of Specimens.—Seventeen sheets; thirty-five pieces.

Distribution.—Almost confined to the banks of the Tay from the

* Several of these of which we have not yet obtained specimens occur in Perthshire.

Linn of Campsie (or perhaps Meikleour?) to Darry Island, but also occurs in Quarrymill Den and beside the Earn below Dupplin. Plants with female catkins have been seen in Darry Island only, but some of the leaf specimens from other stations may possibly belong to female individuals. Whether *S. triandra*—like some other lowland willows—is to be considered as truly indigenous is doubtful. No bushes which were evidently introduced have been seen, and many which have certainly not been planted have been observed.

Variation.—No great range. The leaves vary a little in size and shape, and in the colour of the underside being green or glaucous. Most of our specimens have the underside green, though in some cases with a slight tendency to be subglaucous. Decidedly glaucous examples are rare.

Specimens—

MALE.

No. 239. Marshy ground at Darry Island. A small tree.
[Bark of twigs yellowish brown, furrowed; youngest shoots paler yellow, furrowed. Leaves paler green above than No. 238 *(infra)*, glaucous and dull below, especially the larger leaves. Scales ciliate, with a few long hairs. Filaments glabrous, except at the very base. Nectary in two pieces, the one next the rachis broadly square, that next the scale narrowly and shortly linear.]

No. 277. Marshy ground at Darry Island. A small tree.
[Bark of twigs yellowish brown, shining, slightly furrowed; young shoots greenish yellow, furrowed. Leaves rather dull dark green above; below, especially the young leaves, glaucous. Nectary in two pieces.]

No. 395. Woody Island. Dwarf bushes.
[Bark of twigs pale brown, shining. Leaves shining dark green above, shining pale green below; youngest leaves very slightly hairy. Catkins about one inch long, on leafy peduncles, whose leaves are stipulate and have buds in the axils. Scales oval, concave. Filaments woolly at the base.]

No. 396. Woody Island. Dwarf bushes.
[Characters similar to those of No. 395. Shoots varying from green to brown, shining, not furrowed. Leaves bright green, shining, with slightly impressed veins, above; below paler green and shining, with the veins nearly flat.]

Not numbered. Linn of Campsie. Dwarf.

FEMALE.

Nos. 238 and 238*. Marshy ground at Darry Island. Small trees.
[Bark of twigs brownish fuscous, very slightly furrowed; younger twigs greenish yellow, furrowed. Leaves pale but not glaucous below, and rather shining. Leaves of peduncle stipulate, and often with buds in the axils. Nectary in one subquadrate piece. Style almost obsolete. Stigmas broad, short, recurved, and having the appearance of being three-lobed.]

LEAF SPECIMENS.

Not numbered. Cat Hole, near Stanley; Almond mouth; Woody Island; Quarrymill Den; Sauchie, near Dupplin.

2. × Salix decipiens Hoffm.
(*S. triandra* × *S. fragilis*).

Number of Specimens.—Nineteen sheets; forty-two pieces.

Distribution.—Almost confined to the banks of the Tay from Balnaguard to Darry Island, of the Almond for a mile or so of its lower course, and of the Earn from Aberuthven to the Dead Waters. All the flowering specimens which have been seen are male, so that if the female occurs, it must be in Perthshire, as it is in the rest of Britain, rare. As in the case of *S. triandra*, there is no evidence that *S. decipiens* is an introduced species, but it must be noted that its range of distribution in Perthshire is apparently wider than that of *S. triandra*, which species I believe to be one of its parents.

Variation.—Not excessive. The leaves vary a little in size and shape and in being green or glaucous below. The catkins are remarkably uniform, and the flowers have generally two stamens only, but occasionally have three. Some leaf specimens are difficult to distinguish from *S. triandra;* in others the leaves resemble those of *S. fragilis.*

Specimens—

Male.

No. 139. North side of Almond above Bridge of Almond. A bush.
[Stamens two. Nectary in two pieces—the inner slightly notched, the outer two to three-lobed.]

No. 174. Woody-Island. A small tree.

No. 276. Darry Island marsh. A small tree.
[Bark of twigs shining pale brown; younger shoots yellowish green. Young leaves dark green, somewhat shining, above; pale green, rather dull, below, with all the veins, even the smallest, darker green; both surfaces with minute white dots. Nectary surrounding the base of the stamens, with an outer and an inner lobe.]

No. 411. South side of Almond above Bridge of Almond. A bush 10 ft. high.
[Branches erect; bark inclined to split off. Bark of twigs shining, clay-coloured. Shoots (in autumn) crimson on the side exposed to the sun, rather dull, longitudinally furrowed. Buds (in spring) pale brown. Leaves pale or glaucous green below. Flowers centripetal. Inner nectary one to three-lobed.]

No. 502. Woody Island. Small trees.
[In spring. Bark of the usual colour, but perhaps a little browner. Buds brown, covered by an outer scale which, on bursting, shows two inner scales, at first green and then pink. (In *S. fragilis* all the scales come off together?) Catkins very deciduous, falling even before they are past flowering. Scales obovate. Stamens mostly two, but in every catkin examined occasionally three. Filaments mostly glabrous, but sometimes with a few hairs at the very base.]

Not numbered. Tay side at Birnam (C. M'Intosh).

LEAF SPECIMENS. Not numbered.

Dead Waters of the Earn. Small bush, which has been once cut over.
[Bark of the older twigs of the usual colour. Young shoots tinged with reddish, some of them crimson. Upper leaves paler, but scarcely distinctly glaucous below.]

Below Sauchie, near Dupplin. Small tree.
[Bark as usual. Upper leaves somewhat glaucous below.]

Tay side at Barnhill; Woody Island; Tay side below Stanley; Linn of Campsie; Tay side above Kinnaird House; Tay side at Balnaguard (J. Brebner); Earn side at mouth of Ruthven Burn (W. Martin).

3. × SALIX SUBDOLA Buchanan White.
(*S. triandra* × *S. alba*).

Number of Specimens.—Five sheets; ten pieces.

Distribution.—One wide bush (No. 458) on the marshy side of the Tay below Balhepburn Island. For particulars see the "Revision."

4. × SALIX UNDULATA Ehrh.
(*S. triandra* × *S. viminalis*).

Number of Specimens.—Fourteen sheets; twenty-six pieces.

Distribution.—Banks of some of the small streams in the Carse of Gowrie. Abernethy Glen (one tree). In all cases it has probably been planted.

Variation.—The form *S. lanceolata* Sm. is the only one which occurs, and, as usual, the female plant only. Our specimens vary a little in the breadth of the leaves, which, on the whole, are narrow.

Specimens—

The following are from the banks of the Huntly or Monorgan Burn, below Longforgan Station:—Nos. 97, 98, 104, and 117.

No. 264. Inchyra Pow, below Cairnie Mill.
[Bark of twigs greenish brown. Peduncle leaves stipulate. Pedicel of ovary about twice as long as the quadrate nectary. Style short and thick. Stigmas about as long as the style, half bifid, recurved, greenish yellow.]

No. 286. Pepperknowes Mill Dam, near Glencarse. Small bush.
[Bark of twigs shining pale yellowish brownish green. Shoots rather dull green on one side, reddish brown on the other. Leaves undulate, dark green shining above, pale green and dull below. Pedicel of ovary about twice as long as the small quadrate nectary. Style short, cleft. Stigmas half bifid.]

No. 288. Same locality and characters as No. 286, except that the plant (cut over) was a tree with a stem about one foot in diameter.

No. 292. Tay side above Errol.

Not numbered. Inchyra Pow.

Not numbered. Abernethy Glen.

5. Salix pentandra L.

Number of Specimens.—Five sheets; eleven specimens.

Distribution.—Very rare and local. I have seen about six plants only in five different localities, in two of which it has probably been planted.

Variation.—The leaves vary somewhat in shape and breadth, but not to a very marked degree.

Specimens—

Male.

No. 316. North shore of Loch Freuchie. A shrub. Native.
[Young bark yellowish brown, very shining. Leaves slightly glaucous below. Catkins short, dense-flowered, on long leafy peduncles. Rachis hairy. Scales yellow, apex greenish, glabrous except at the base on the outside, more pubescent on the inner side. Stamens four. Filaments twice as long as the scales, very hairy at the base. Nectary with several divisions.]

Not numbered. Ardoch. A tree, probably planted.

Not numbered. Glendey Burn (W. Martin). A wild shrub.

Female.

Not numbered. Near Minkie Dam. A wild shrub.

Leaf Specimens.

No. 317. North shore of Loch Freuchie. A wild shrub, with leaves much broader than No. 316.

Not numbered. Tay side at Barnhill. A small tree, probably planted.

6. Salix fragilis L.

Number of Specimens.—Forty-six sheets; seventy-nine pieces.

Distribution.—Common on the banks of the larger streams throughout the county, but most abundant in the lowlands, and especially on the lower part of the course of the Tay. Whether originally a native it is now impossible to say, though I think that such is probable. At any rate it sows itself with great facility.

Variation.—Two varieties occur, viz.:—the continental form and my var. *britannica*. Of the former I know of but one tree—on the side of the Huntly Burn, at Clattering Brigs, near Longforgan Station—which has probably been planted. The leaves of the var. *britannica* vary somewhat in length and breadth, in being quite glabrous or slightly pubescent when young, and in being green or glaucous on the under side.

Specimens—

A. The continental form.

Male.

No. 122. Clattering Brigs, near Longforgan. A large tree.

B. Var. *britannica.*

MALE.

No. 87. Woody Island. A large tree.
[Remarkable in that the catkins, which are mostly composed of male flowers, bear also a few female flowers.]

No. 137. Almond mouth. A small tree.

No. 166. Linn of Campsie. A small tree.
[Scales subobtuse, glabrous except on the margins and towards base of the outside. Stamens two. Filaments hairy at the very base; viewed from the inner side connate at the base, but from the outer side free at the base, as the outer nectary covers the connate part. Nectary in two pieces—that next the rachis the larger, not or scarcely notched; that next the scale much smaller and inserted higher up.]

No. 279. Darry Island.
[Bark of twigs shining greenish brown on one side, reddish brown on the other; young shoots yellowish green. Leaves dull and glaucous below. Filaments hairy at base. Nectary in two pieces.]

No. 290. Tay side near Errol.
[Leaves very glaucous below.]

No. 426. Tay side below Elcho. A large bush.
[Shoots glabrous, shining, dark purple brown on one side, paler brown on the other. Buds glabrous, shining purple brown. Leaves shining yellowish green above, with minute white dots, and veins almost flat; below dull pale green, but scarcely glaucous; primary veins raised. Midrib strong, pale pink above and below.]

No. 474. Tay side above Earn mouth. A small tree.
[Bark of twigs shining pale brown; young shoots shining yellowish. Leaves yellowish green, very shining, minutely white-dotted above; below dull pale green or subglaucous. Marginal glands black. Catkins erect or spreading. Filaments hairy at the base. Anthers bright yellow.]

Not numbered. Tay side at Glenalbert, above Dunkeld (C. M'Intosh).

FEMALE.

No. 255. Inchyra Pow.
[Bark of twigs rather dull brownish green. Leaves very glaucous below. Pedicel of ovary at first subequal in length to the nectary, but lengthening with age. Style very short. Stigmas bifid, recurved.]

No. 256. Inchyra Pow.
[Bark of twigs rather dull greenish brown. Leaves very glaucous below. Pedicel of ovary two and a half times as long as nectary.]

Nos. 257, 258, and 265. Inchyra Pow. Characters the same as No. 256.

No. 267. Tay side at Seggieden.
[Bark of twigs rather dull greenish brown. Leaves somewhat shining, and with white dots above; below dull glaucous. Pedicel of ovary twice as long as the broadly quadrate nectary.]

No. 274. Tay side near Kinfauns Station.
[Bark of twigs rather dull greenish brown. Peduncle leaves stipulate. Nectary quadrate one-half the length of the pedicel of the ovary. Style short, cleft. Stigma short, thick, semibifid, erect-spreading.]

No. 280. Tay side near Kinfauns. A bush.
[Bark of twigs rather dull olive brown. Leaves glaucous below.]

No. 291. Tay side above Errol.
[Leaves very glaucous below.]

Not numbered. Tay side below Barnhill.

Not numbered. Kinloch-Rannoch.

It is to be noted that in all these female *fragilis* the underside of the leaves is glaucous.

LEAF SPECIMENS.

No. 103. Huntly Burn, near Longforgan Station.

No. 329. Pepper Knowes Mill Dam, near Glencarse.
[Young shoots rather dull dark red, furrowed. Leaves green below.]

Unnumbered specimens from the Stanners at Perth Bridge (R. Dow); Woody Island; Island at Kercock, Kinclaven; Glen Dochart, Killin (D. A. Haggart); Pepper Knowes Mill Dam; and Dead Waters of the Earn.

7. SALIX ALBA L.

Number of Specimens.—Twenty-five sheets; fifty-one pieces.

Distribution.—Not uncommon in the Lowlands, and occasionally in the Highland valleys; but, except on the lower course of the Tay and Earn, it usually occurs as a planted tree. Much less abundant than *S. fragilis*, and with less pretensions to be considered indigenous, though it certainly occurs self-sown.

Variation.—Varies a little in the size of the leaves, but, on the whole, our specimens are remarkably uniform. None of them show the maximum condition of pubescence. The var. *S. vitellina* L. is very rare, and occurs as a probable introduction only.

Specimens—

MALE.

No. 38. Near Almondbank. A large tree.

No. 235. Tay side near Kinfauns. A tall tree.
[Nectary an irregularly lobed cup.]

No. 254. Inchyra Pow, near Cairnie Mill. A large tree.
[Bark of twigs dull brownish, finally brighter. Inner nectary entire or lobed.]

No. 260. Cairnie Mill, near Inchyra. A tree.
[Bark of twigs rather dull brown. Inner nectary of one, two, or three pieces.]

No. 261. Cairnie Mill. A tree.
[Bark of twigs dull brownish. Leaves very glaucous below. Inner nectary often in two pieces.]

No. 262. Cairnie Mill. A tree.
[Bark of twigs rather dull brown. Inner nectary often in three pieces.]

No. 381. Methven Loch. Large tree.

Not numbered. Near Methven Castle.

Not numbered. Tay side near Castle Menzies.

FEMALE.

No. 259. Inchyra Pow.
[Bark of twigs rather dull brown.]

No. 266. Inchyra Pow. Large tree.
[Bark of twigs rather dull reddish brown.]

No. 268. Tay side near Seggieden.
[Bark of twigs rather dull brown, of the older twigs brighter. Shoots whitish green. Leaves dark green, somewhat shining above, with numerous white dots; below dull and glaucous.]

No. 275. Tay side near Kinfauns Station.
[Bark of twigs dull brown, of the older twigs paler and rather shining. Leaves dark green, shining, with many white points above; below strongly glaucous, with very many white dots. Peduncle leaves stipulate. Ovary sessile. Style almost none. Stigmas short, thick, semibifid, spreading, whitish green. Nectary transversely quadrate.]

No. 285. Pepper Knowes Mill-Dam, near Glencarse. Large tree.
[Young shoots greenish yellow, older yellowish brown, shining. Bark of twigs dull, brownish, pubescent. Leaves glaucous below. Style none. Stigmas short bifid. Nectary quadrate about as long as the pedicel of the ovary.]

Not numbered. Near Kinnaird Castle. Small tree.

NOTE.—The leaves in all cases are more or less pubescent, as usual in this species.

LEAF SPECIMENS.

Not numbered. From Methven Wood; Island near Kercock, Kinclaven; and Pepper Knowes.

Var. *S. vitellina* L. Island in the Earn, near Bridge of Earn. Large tree, doubtless planted. (On the banks of the Almond, a little above Bridge of Almond, an unsuccessful attempt was made to establish a plantation of *S. vitellina* some years ago.)

8. × SALIX VIRIDIS Fr.

(*S. fragilis* × *S. alba*).

Number of Specimens.—Twenty-eight sheets; forty-nine pieces.

Distribution.—Rare. Tay side near Elcho and near Kinclaven. Some of the trees may have been planted, others are undoubtedly self-sown.

Variation.—None of our specimens can be termed good intermediate *S. viridis*—*i.e.*, showing a combination in all parts of the characters of the parent species. In fact some of them are so closely related to *S. fragilis* that it is with hesitation that I refer them to the hybrid.

Specimens—

FEMALE.

No. 459. Tay side above Elcho Castle. A tall tree.
[Twigs slender, rather dull brownish. Leaves dark green, shining, and slightly hairy above; below glaucous and silky; very like those of *S. alba* but more glabrous. Catkins rather small and slender, spreading on leafy peduncles. Scales long, narrow, downy on the lower half of the back, margins ciliate.

Ovaries ovate-conic, narrowed upwards but obtuse. Style short, thick, half-cleft. Stigmas short, thick, bifid, spreading. Nectary surrounding pedicel of the ovary, divided into several lobes, rather shorter than the pedicel. Capsule subacute.]

Closely related to *S. alba*, but its hybrid origin seems to be manifest.

No. 471. Tay side below Balhepburn Island. A large bush.

[Leaves very like those of No. 458 (*S. subdola*). Catkins erect. Scales long, narrow, ligulate, hairy at the base, fringed at the apex. Ovary subulate from a broader base, pedicel twice as long as the nectary. In some flowers an outer nectary, in addition to the inner one, is present. Style short, thick. Stigmas bifid, spreading.]

The catkins are very like those of *S. fragilis*, but the ovary seems to be less gradually acuminate. The shape and size of the leaves are like those of *S. alba*, but in texture and glabrosity those of *S. fragilis*. They are very like those of *S. subdola* (No. 458 *supra*), which perhaps may after all be a form of *S. viridis*.

No. 430. Balhepburn Island. A young tree.

[Bark of twigs rather dull fuscous greenish brown. Leaves dark green; youngest leaves silky below, but soon glabrous. Catkins large, spreading on long leafy peduncles. Scales long—four-fifths the length of the ovary—narrow, greenish; lower half of back downy, margins ciliate. Ovary long, subulate, very slightly obtuse, on a pedicel twice as long as the inner nectary. Style short, thick, cleft, yellowish. Stigmas short, thick, bifid, spreading, yellowish. Nectary in two pieces, the outer very small, the inner larger.]

No. 428. Balhepburn Island. A young tree.

[Shoots dull green tinged with brown, slightly pubescent. Twigs browner and less dull. Buds green, pubescent. Leaves dark green, slightly shining, with many white dots, primary veins paler and raised above; below pale green, scarcely shining, with many white dots, slightly hairy, primary veins raised; leaves of the smaller side-twigs more glaucous green on the under side. Catkin characters similar to those of No. 430.]

No. 429. Balhepburn Island.

[Shoots reddish brown to green, youngest pubescent, older glabrous shining. Twigs dull ashy brown. Buds green to brown, pubescent. Leaves similar to those of No. 428, but perhaps a little more glaucous green on the under side.]

It is not to be denied that these three plants—Nos. 428, 429, and 430,—which grow together, are very closely related to *S. fragilis*. The branches are, however, more erect, forming an acuter angle (40 to 50 deg.) with the stem. The leaves are quite similar to those of undoubted specimens of *S. viridis*, and were conspicuously green in October when the leaves of neighbouring plants of *S. fragilis* were getting yellow and falling. The catkins are scarcely distinguishable from those of *S. fragilis*, but the ovary appears to be a little less acute.

No. 473. Tay side near Balhepburn. Large bush.

[Shoots pale green or brown. Twigs rather dull pale brown. Leaves dark green, rather dull, closely white-dotted above; below glaucous and dull; marginal glands blackish brown. Catkins erect. Ovary on a pedicel about twice as long as the broad nectary. Style short, cleft. Stigmas bifid, recurved, spreading. Branches forming acute angles with the stem.]

Like the above-mentioned Balhepburn specimens, very close to *S. fragilis*.

No. 472. Tay side near Balhepburn.

[Bark of twigs shining, brownish. Shoots pale green or yellowish. Leaves bright green, not very shining, white-dotted above; below glaucous or dull; marginal glands blackish. Catkins erect. Capsule subulate, on a pedicel scarcely twice as long as nectary. Style very short, cleft. Stigmas short, erect, bifid. Branches forming acute angles with the stem.]

This is so near *S. fragilis* that I have great hesitation in placing it under *S. viridis*.

LEAF SPECIMENS. Not numbered.

Lily Loch, Kinclaven. So far as the leaves go this is nearly intermediate, but inclining to the *S. alba* side.

Tay side opposite Meikleour. Inclining rather to *S. fragilis* than to *S. alba*.

Near Kilgraston. An interesting-looking willow, now unfortunately destroyed.

9. SALIX AURITA L.

Number of Specimens.—Thirty-one sheets; sixty-nine pieces.

Distribution.—One of the commonest of our willows, ascending the hills to above 2000 feet. Most frequent on wet moors.

Variation.—Whilst subject to a considerable range of variation, both in the size of the bush and in the size, form, and amount of pubescence of the leaves, *S. aurita* can usually be easily recognised.

Specimens—

MALE.

No. 1. Tay side at Barnhill.

Nos. 94 and 95. Methven Wood.

No. 348. Woodhead Road. Small bush.

[Twigs straight, slender purplish, soon glabrous. Leaves rugose and dull above; below glaucous green, with whitish pubescence, veins all raised reticulate, margin incurved. Scales of catkins tinged with brownish towards the apex. Anthers orbicular. Filaments hairy for about one-fifth from the base.]

Unnumbered specimens from Dalmarnock and Inver Wood (C. M'Intosh), and Aberuthven Wood, with androgynous catkins (W. Martin).

FEMALE.

No. 93. Methven Wood.

No. 352. Woodhead Road.

[Twigs slender, irregular, brown, glabrous, rather shining. Leaves dark green, rugose, and rather dull above; below glaucous green, with whitish pubescence, veins raised reticulate, margins incurved. Catkins spreading; scales with brown tips. Pedicel of ovary two to three times as long as quadrate nectary. Style almost obsolete. Stigmas short, thick, bifid, and somewhat spreading.]

No. 360. Woodhead Road.
[Twigs slender, dull purplish brown, slightly pubescent. Leaves rugose and dull above; below glaucous green, with white pubescence, veins all raised reticulate, margins incurved. Catkins spreading or a little recurved. Capsule white-tomentose, obtuse, on a pedicel nearly four times the length of the subquadrate nectary. Style none. Stigmas very pale, finally brown, erect, short, thick, semipartite.]

No. 349. Woodhead Road.
[Twigs slender, irregular, brown; at first pubescent, soon glabrous and slightly shining. Leaves dark green, rugose, and dull above; below glaucous green, with white pubescence. Catkins on leafy peduncles, spreading or arcuately decurved; scales with brownish black tips. Capsule white-tomentose, pedicel thrice as long as the subquadrate nectary. Style none. Stigmas pale, short, thick, bifid, rather spreading.]

Unnumbered specimens. Barvick, near Crieff; Grandtully; Glen Falloch; Ardoch; Ballinluig; Glen Tilt; Balmacneil and Inver Wood (C. M'Intosh); Tullymet (H. Coates); Kinnaird Burn, Pitlochry (J. Brebner).

LEAF SPECIMENS.

Unnumbered. Blackpark, Rohallion, Loch of Lows, Duncrub, Balnaguard, and Ben Vrackie; Finlarig and Glen Lochay (D. A. Haggart); Corrie Dhubh Ghalair and Corrie Choarach (J. Brebner).

10. × SALIX LUTESCENS A. Kern.

(*S. aurita* × *S. cinerea*).

Number of Specimens.—Sixty sheets; one hundred and seventy-six pieces (representing thirty-eight plants).

Distribution.—Probably of wide distribution, and may be expected to occur wherever the parents grow in sufficient proximity, which they do in many parts of this county.

Variation.—Like most other hybrids, *S. lutescens* shows a wide range of variation, due not only to the degree in which the characteristics of one parent predominates over those of the other, but also from the variation of the parents themselves.

Specimens—

MALE.

All our male specimens come from two localities, viz., the neighbourhood of Logierait Ferry (C. M'Intosh), illustrated by eleven sheets; and Woodhead Road, near Perth, whence we have the following numbered examples:—

No. 342.
[Twigs straight, purplish, soon glabrous. Leaves slightly shining, slightly rugose above; below glaucous green, with sparse white and brown pubescence, margins incurved undulate. Anthers small, orbicular. Filaments hairy.] Approaching *S. aurita*.

No. 346.
[Twigs stout, torulose, fuscous brown, tomentose. Leaves rather pale green,

thin, slightly shining, slightly rugose above; below glaucous green, with white and brown pubescence, veins raised reticulate, tip plicato-recurved, margins slightly incurved. Catkin scales broad, pale brown or blackish brown at the tips. Anthers small, orbicular, tinged with red. Filaments hairy for about one-fifth from the base. Young leaves tinged with reddish brown.] Fairly intermediate.

No. 347. A big bush.

[Twigs stout, torulose, fuscous brown, tomentose. Leaves shining and rugose above; below glaucous, with white and brown pubescence, veins raised reticulate, tip plicato-recurved, margins incurved. Scales half blackish brown. Anthers orbicular, tinged with red. Filaments hairy for one-fifth or more from the base.] Approaching *S. cinerea.*

No. 351.

[Twigs rather slender, brown, at first pubescent. Leaves dark green, shining, and somewhat rugose above; below glaucous green, with white and brown pubescence, veins all raised reticulate, tip plicato-recurved, margins incurved undulate. Catkin scales small, ferruginous brown at the tips. Anthers small, orbicular, tinged with red. Filaments hairy for one-fifth from the base. Nectary oblong, yellow.] Good intermediate.

No. 355.

[Twigs somewhat slender, irregular, brown, densely tomentose. Leaves dark green, slightly shining above; below glaucous, with white and brown pubescence, veins prominent reticulate, margin slightly incurved. Catkin scales small, oblong, brownish black at the tips. Anthers oval, tinged with red. Filaments hairy at base. Nectary small, quadrate, yellow.] Near *S. cinerea.*

No. 367. A big bush.

[Twigs moderate, torulose, fuscous brown, pubescent. Leaves dark green, shining, and somewhat rugose above; below glaucous, with brown and white pubescence, veins raised reticulate, tip plicato-recurved, margins incurved. Catkin scales small, ferruginous, black at the tips. Anthers small, orbicular, tinged with red. Filaments hairy at the base.]

Nos. 404 and 405. Large bushes.

[Twigs dark grey pubescent. Buds pubescent. Leaves dark green, rather shining, and rugose above; below glaucous, with yellowish white and brown pubescence, veins raised reticulate, tip plicato-recurved, margin incurved and rather undulate. Catkins rather large, expansion centripetal, on a very short peduncle, with two or three small leaflets; scales rather narrow, upper half black. Anthers oblong, tinged at first with red. Filaments hairy at base. Nectary oblong, greenish yellow.] A curious form; near *S. cinerea.*

FEMALE.

No. 341. Woodhead Road.

[Twigs rather slender, purplish fuscous brown, tomentose. Leaves shining, rugose above; below glaucous green, sparsely pubescent, with white and brown hairs, veins moderately raised reticulate, margins incurved, tip plicato-recurved. Catkins erect; scales long, narrow, half black. Capsule white pubescent, rather acute, on a pedicel about five times the length of the oblong nectary. Style obsolete. Stigmas small, suberect.] Near *S. cinerea.*

No. 343. Woodhead Road.

[Twigs moderate, reddish brown, at first pubescent, soon glabrous. Leaves shining, somewhat rugose above; below glaucous, with white and brown pubescence, veins raised reticulate, margins slightly incurved, tip plicato-recurved. Catkins suberect; scales half black. Capsule white pubescent, rather acute, on a pedicel about twice the length of the quadrate nectary. Style obsolete. Stigmas very short, thick, erect, notched.] This agrees with Wimmer's form b.

No. 345. Woodhead Road.
[Twigs moderate, dull, brownish, somewhat tomentose. Leaves thick, dark green, shining, slightly rugose above; below glaucous, with white and brown pubescence, veins all raised reticulate, margins incurved, tip plicato-recurved. Catkins suberect; scales half black. Capsule white pubescent, obtuse, pedicel three to four times as long as subquadrate nectary. Style short. Stigmas short, thick, suberect.]

No. 350. Woodhead Road.
[Twigs slender, rather torulose, fuscous brown, tomentose. Leaves shining, rugose above; below glaucous, with rather sparse white and brown pubescence, veins all raised reticulate, margins undulate, slightly incurved. Catkins spreading; scales half black. Capsule white pubescent, obtuse, pedicel two to two and a half times the length of subquadrate nectary. Style none. Stigmas erect, bifid.]

No. 358. Woodhead Road.
[Twigs rather short, straight, dull fuscous brown, finely pubescent. Leaves very slightly shining and slightly rugose above; below glaucous, with brown pubescence, veins somewhat raised, margins slightly incurved, tip more or less plicato-recurved. Young leaves greenish yellow, with brown pubescence above and below. Catkins suberect on leafy peduncles. Capsule on a pedicel about four times the length of the short quadrate nectary. Style obsolete. Stigmas short, thick, suberect, bipartite, pale, tinged with red.] A good intermediate state.

No. 359. Woodhead Road.
[Twigs rather slender, dull reddish brown, somewhat pubescent. Leaves slightly shining and slightly rugose above; below glaucous, with sparse mostly brown pubescence, veins raised, margins slightly incurved. Catkins erect-spreading; scales narrow, half black. Capsule white tomentose, obtuse; pedicel four to five times the length of the quadrate nectary. Style obsolete. Stigmas suberect, bipartite.] A good form.

No. 59. Woody Island.

No. 175. Woody Island.

No. 92. Methven Wood.

No. 363. Wood near St. Magdalene's Farm. A big bush.
[Twigs torulose, black pubescent. Leaves rather rugose above; below glaucous, with white and brown pubescence, veins strongly raised, margin slightly incurved. Catkins somewhat erect; scales short, oblong, spathulate, half black. Capsule white pubescent, obtuse; pedicel nearly three times the length of the oblong nectary. Style obsolete. Stigmas short, suberect, bipartite.]

No. 446. Tay side at Denmark Green. A small bush.
[Twigs stout, straight, brown pubescent. Leaves shining, rugose above; below glaucous, veins raised, margins incurved, tip twisted. Catkins suberect; scales half brown. Capsules crowded, rather small, conical; pedicel

about three times the length of the quadrate nectary. Style none. Stigmas very short, bifid, erect-spreading.] A good form.

Unnumbered. Nine sheets from the neighbourhood of Logierait Ferry (C. M'Intosh).

The following are doubtfully referred to *S. lutescens*:—

No. 449. Stanners, at Perth Bridge (R. Dow).
[Twigs straight, fuscous brown, dull, glabrous. Leaves dark green, somewhat shining, with impressed veins above; below glaucous, veins strongly raised, margins incurved. Catkins erect; scales three-fifths black. Ovary pedicel about three times the length of oblong nectary. Style obsolete. Stigmas crimson, short, broad, bifid, spreading.]

No. 431. Tay side at Orchardneuk. A tall bush.
[Twigs torulose, black pubescent. Leaves dull dark green, with impressed veins above; below glaucous, with white pubescence, veins raised, margins incurved. Catkins subsessile; scales half brownish black. Ovary pedicel three times the length of the oblong nectary. Style very short, stout. Stigmas very short, thick, broad, bifid, subspreading, yellowish.] Very near *S. cinerea*, but the small stigmas and shape of the ovary suggest *S. aurita*.

Not numbered. Coulshill Farm, near Auchterarder Station.

11. Salix cinerea L.

Number of Specimens.—Fifty-nine sheets; one hundred and sixty-four pieces.

Distribution.—The most widely distributed and commonest of all our willows. Most frequent on the banks of rivers, streams, and lakes, but not ascending so high on the hills as *S. aurita*.

Variation.—Subject to a considerable range of variation in every particular.

Specimens.—Our specimens are arranged in two series—one comprehending those states which may be called fairly typical of the species as it occurs with us; the other, less typical forms.

A. Typical Specimens.

Male.

Nos. 21 and 33. Almond side above Bridge of Almond.

No. 193. Woody Island.
[Filaments free, pilose at base. Nectary quadrate, dark green.]

No. 216. Almond mouth.
[Filaments free, pilose. Nectary subquadrate-oval.]

No. 219. Almond mouth.
[Filaments free, pilose. Nectary quadrate.]

No. 226. Almond mouth.
[Anthers at first reddish, soon yellow. Filaments free, pilose for about one-fifth from base. Nectary small, subquadrate-oval.]

No. 229. Almond mouth.
[Anthers at first reddish, then yellow, finally brownish yellow. Filaments free, pilose for about one-fifth. Nectary oblong.]

No. 333. Tay side below Barnhill.

[Filaments almost adnate (*i.e.*, not distinctly free) at the very base, very slightly pilose. Nectary small, quadrate.]

Not numbered.

Auchterarder (W. Martin).

Tay side at Dalguise, Balmacneil, and Glenalbert (C. M'Intosh).

FEMALE.

No. 17. Almond side above Bridge of Almond.

No. 85. Woody Island.

No. 150. Linn of Campsie.

[Subglabrous and short styled. Shoots reddish brown. Leaves medium green, slightly shining above; below paler green.]

Nos. 158 and 159. Linn of Campsie.

No. 176. Woody Island.

No. 339. Woodhead Road.

[Twigs straight, stout, fuscous brown, tomentose. Leaves slightly shining, slightly rugose above; below glaucous, with white pubescence, veins raised, margin incurved, tip straight. Catkins spreading. Scales half black. Style obsolete. Stigmas bifid, spreading. Ovary pedicel about three times the length of the nectary.]

No. 353. Woodhead Road.

[Twigs rather straight, stout, fuscous brown, very pubescent. Leaves dark green, shining, and slightly rugose above; below glaucous, with white and brown pubescence, veins moderately raised, margins incurved. Catkins erect, short but stout. Scales narrow, blackish brown for three-fourths of apex, capsule compressed, pedicel three times the length of the subquadrate nectary. Style short. Stigmas bifid, rather spreading.]

Not numbered. Tay side at Seggieden (Drummond Hay); at Kinnaird House (C. M'Intosh); Woody Island.

LEAF SPECIMENS. Not numbered.

Loch Voil.

B. Less Typical Specimens.

MALE.

Nos. 28 and 34. Almond side above Bridge of Almond.

No. 63. Woody Island.

No. 215 (also numbered 42).

[Anthers at first reddish, soon yellow. Filaments free, pilose. Nectary quadrate.]

All these have more glabrous twigs than usual, and might be referred to *S. lutescens*, though it seems more expedient to place them under *S. cinerea*.

No. 72. Woody Island.

[Twigs brown, pubescent, finally glabrous. Shoots green to fuscous brown, pubescent. Leaves shining, rugose with impressed veins above; below glaucous green, veins raised, margins incurved.]

From the long narrow leaves, this comes near Wimmer's var. *spuria*.

FEMALE.

Nos. 22 and 23. Almond side above Bridge of Almond.

Nos. 54, 64, 66, and 67. Woody Island.

Nos. 153 and 165. Linn of Campsie.

No. 178. Woody Island.

No. 214. Almond mouth.
[Style obsolete. Ovary pedicel four times or more the length of the quadrate nectary.]

No. 217. Almond mouth.
[Style very short. Stigmas short, thick, notched, pinkish, at length brown. Ovary pedicel about twice the length of the quadrate roundish nectary.]

No. 224. Almond mouth.
[Style subevident. Stigmas deeply cleft, erect. Ovary pedicel about four times the length of the subquadrate oval nectary.]

No. 362. Callerfountain Strip (R. H. Meldrum)! Big bush.
[Branches slender, arcuate-ascending. Twigs slender, olive brown, glabrous, subshining. Young leaves yellowish brownish green. Leaves slightly shining and slightly rugose above; below glaucous, with rather sparse brown and white pubescence; veins prominent, reticulate; margin undulate serrate, slightly incurved. Catkins erect. Scales short, oblong spathulate, half black. Ovary pedicel five or six times the length of the oblong nectary. Style obsolete. Stigmas bifid, erect spreading, short, yellowish.]

Not numbered. Tay side at Balmacneil (C. M'Intosh); Aberuthven (W. Martin).

All the above differ from more typical *S. cinerea* chiefly in their greater glabrosity, especially of the twigs. No. 362 is the most remarkable, and is placed here with some doubt.

12. Salix Caprea L.

Number of Specimens.—Forty-one sheets; ninety-eight pieces.

Distribution.—Common throughout the county in damp places in woods; less frequent on river banks.

Variation.—The leaves vary in size, and in shape from orbicular to ovate or oblong lanceolate, the orbicular form being perhaps less common in the Highland districts. The catkins vary a little in the degree in which they are peduncled. I have seen none so excessively silky as some more southern examples.

Specimens.—Our specimens are arranged in several series—A and B are more or less typical; the others, of which some have orbicular and some elongate leaves, depart more or less from the type.

A. Leaves more orbicular.

Male.

No. 2. Tay side at Barnhill.

No. 11. Quarrymill Den.

No. 212. Almond side above Bridge of Almond. Large bush.
[Twigs green. Anthers always yellow. Filaments free, somewhat pilose. Nectary quadrate.]

No. 338. Near Woodlands Quarry.
[Twigs green, shining, glabrous. Expansion of catkins both centrifugal and centripetal. Anthers suborbicular. Filaments pilose on lower half.]

Not numbered. Birnam and Kinnaird House (C. M'Intosh)

FEMALE.

No. 12. Quarrymill Den.

Nos. 35 and 47. Almond side.

No. 211. Almond side above Bridge.
[Young shoots dark reddish brown. Ovary pedicel three to four times the length of the small quadrate nectary. Style evident. Stigmas bifid, linear, somewhat spreading, then erect.]

Not numbered. Inver (C. M'Intosh).

B. Leaves more elongate.

MALE.

No. 222. Almond mouth. Big bush. Twigs very green.

No. 335. Woodlands Quarry.
[Twigs green, dull, pale tomentose. Catkins erect-spreading, centripetal. Scales half black. Anthers suborbicular. Filaments free, pilose at very base.]

No. 337. Woodlands Quarry.
[Twigs greenish, glabrous. Filaments hairy for four-fifths from base.]

Not numbered. Balnamuir, Kincraigie, and Inver (C. M'Intosh).

FEMALE.

Not numbered. South Quiech and Ardoch; Inver, Kincraigie, and Inch Farm (C. M'Intosh); Aberuthven (W. Martin).

C. Catkin varieties.

MALE.

No. 273. Near Kinfauns Station. Dwarf slender bush.
[Catkins peduncled like 272, *infra*. Young shoots green, more downy. Filaments hairy at base.]

FEMALE.

No. 272. Near Kinfauns Station. Dwarf slender bush.
[Twigs brownish green, somewhat shining. Young shoots green. Catkins on a long peduncle with conspicuous leaves. Ovary pedicel at least four times the length of the quadrate slightly notched nectary. Style short but distinct. Stigmas short, but much longer than the style, half bifid, rather erect, pale yellow, finally brown.]

No. 271. Near Kinfauns Station.
[Characters much the same as No. 272.]

These varieties—Nos. 271, 272, and 273—of *S. Caprea* (if, indeed, they are not hybrids) are much the most remarkable I have seen, and require further study.

No. 334. Woodlands Quarry.
[Twigs green, slightly tomentose, dull. Catkins erect, on leafy peduncles. Scales oblong, pointed, half fuscous brown (*i.e.*, paler than usual), with long hairs on each surface. Ovary tomentose, conical-subulate, pedicel twice the length of the quadrate yellowish green nectary. Style obsolete. Stigmas short, filiform, bifid, erect, contiguous.]

No. 336. Woodlands Quarry.
[Twigs brownish green, dull, slightly tomentose. Leaves glaucous green

below, with white pubescence. Catkins erect-spreading, on leafy peduncles. Scales oblong, pointed, fuscous black for the upper two-thirds. Ovary tomentose, subulate, pedicel four to five times the length of the very small quadrate nectary. Style obsolete. Stigmas short, filiform, bifid, suberect.]

No. 354. Woodhead Road.

[Twigs straight, stout, olive brown, rather shining. Leaves dark green, slightly shining, and slightly rugose above; below pubescence yellowish white, veins prominent, undulate margin slightly incurved. Catkins on leafy peduncles. Ovary compressed, pedicel about five times the length of the quadrate nectary. Style obsolete. Stigmas slender, bifid, erect or connivent.]

These—Nos. 334, 336, and 354,—like the previous three, have the catkins on leafy peduncles, but not in so remarkable a manner, and, besides, the bushes are of the ordinary size.

D. Forms with more distinctly tomentose twigs.

FEMALE.

Not numbered. Inver (C. M'Intosh); Kincardine Glen and Damside (W. Martin).

E. Leaf Specimens.

No. 470. Tay side above Almond mouth.

[Branches straight, long, nearly glabrous, shining. Leaves dark bright green, very shining, rugose above; below white-woolly, veins raised, margins undulate, tip twisted.]

Not numbered. Loch Voil and Blair-Athole; Craig-na-Caillich (J. Brebner); Killin (D. A. Haggart).

13. × SALIX REICHARDTI A. Kern.

(S. cinerea × S. Caprea).

Number of Specimens.—Twenty-four sheets; sixty-one pieces.

Distribution.—Might be expected to occur throughout, as the parent species are so widely distributed, but most of the specimens referred to this hybrid have been collected near Perth.

Variation.—Varies according as the affinity is greater with one or other of the parents. None of our examples are very well marked, and the majority of them are more related to *S. cinerea* than to *S. Caprea.*

Specimens—

MALE AND LEAF SPECIMENS.

No. 435. Sleepless Island.

[Twigs slender, brown, glabrous or pubescent. Leaves dark green, veins impressed above; below dull subglaucous, veins raised, margin strongly incurved. Catkins medium in size, subsessile, spreading, centripetal. Scales half brownish black. Anthers yellow, subglobose. Filaments free, hairy at the base. Nectary oblong.]

No. 436. Sleepless Island.

[Characters much the same as No. 435. Leaves yellow green, rather dull, veins strongly impressed above; below pale green, scarcely glaucous, dull, veins strongly raised, margins incurved. Scales less black.] Rather doubtful.

No. 237.* Tayside near Kinfauns.

Leaves only, as the bush has disappeared. Very like *S. cinerea* × *S. Caprea.*

Not numbered. Leaves only, and doubtful. Methven Wood; Loch Tummel (J. Brebner).

FEMALE.

No. 56. Woody Island. Probably *S. Reichardti.*

No. 333. Woodhead Road.

[Twigs stout, purple brown, glabrous, not very shining. Leaves dark green, shining, slightly rugose above; below pubescence whitish, veins rather prominent, undulate margins incurved. Catkins thick, dense-flowered, erect, incurved. Scales oblong, apical two-thirds fuscous black, with long white hairs on each surface. Ovary pubescent, conical, subulate, compressed, pedicel about four times the length of the small quadrate green nectary. Style obsolete. Stigmas short, filiform, bipartite, spreading, or erect.]

Remarkable for the very dense-flowered greenish catkins, which recall *S. cinerea*, the rest of the plant resembling *S. Caprea.*

No. 361. Callerfountain Strip. A small tree.

[Twigs torulose, dull greenish, slightly pubescent. Leaves with thick yellowish white pubescence below, veins prominent, margins slightly incurved. Catkins spreading. Style obsolete. Stigmas short, slender, bipartite, erect, connivent. Ovary pedicel four to five times the length of the quadrate nectary.] Has much affinity with *S. Caprea.*

No. 364. Woodhead Road. Small bush.

[Twigs medium, reddish brown, slightly pubescent. Leaves dull, rather rugose above; below glaucous green, white pubescent, veins moderately raised, reticulate, undulate margin incurved, tip plicato-recurved; young leaves yellowish green. Catkins rather spreading. Scales half black. Capsule narrow, obtuse, pedicel two and a-half times the length of the oblong nectary. Style obsolete. Stigmas erect, bifid, yellow.]

No. 433. Sleepless Island.

[Twigs fuscous brown, glabrous or slightly pubescent. Leaves dark green, rather dull, veins impressed above; below somewhat glaucous, dull, veins raised, margin slightly incurved. Catkins erect, subsessile, or shortly stalked. Scales half brownish black. Ovary pedicel four times the length of the oblong yellow nectary. Style short but evident, yellowish green. Stigmas short, bifid, spreading, yellow.] Near *S. cinerea.*

No. 434. Sleepless Island.

[Twigs fuscous brown, dull, slightly pubescent. Leaves dark green, slightly shining, veins impressed above; below glaucous, dull, veins raised. Catkins subsessile, rather erect. Scales half brownish black. Ovary pedicel four times the length of the quadrate nectary. Style obsolete. Stigmas short, broad, bilobed, rather erect, spreading.] A little doubtful.

No. 440. Tay side above Elcho.

[Twigs rather torulose, fuscous brown, scarcely pubescent. Leaves slightly shining, veins impressed above; below glaucous, dull, veins raised, margins incurved. Catkins subsessile, erect. Scales half black. Ovary pedicel about three times the length of the oblong nectary. Style subevident. Stigmas narrow, bifid, or emarginate, but mostly entire, spreading, yellowish.] Near *S. cinerea.*

14. × Salix capreola J. Kern.

(*S. Caprea* × *S. aurita*).

Number of Specimens.—Eight sheets; twenty-five specimens.

Distribution.—Though the parents are common, the hybrid seems to be rare.

Variation.—Like other hybrids, the variation is chiefly in the degree in which the characters of one or the other parent predominate.

Specimens—

Female.

No. 344. Woodhead Road (R. H. Meldrum)!
[Twigs straight, purple, slightly shining. Leaves dull, rugose above; below glaucous, with white pubescence, undulate margins incurved, tip plicato-recurved. Catkins suberect. Capsule long, obtuse, somewhat white pubescent, pedicel about four times the length of the quadrate nectary. Style obsolete. Stigmas slender, bifid, spreading yellow.] Has also a look of *S. cinerea*.

No. 356. Woodhead Road.
[Twigs straight, purplish, glabrous, slightly shining. Leaves thin—slightly rugose above; below glaucous, with moderate white pubescence, undulate margin incurved. Catkins rather erect. Capsule long, obtuse, pedicel about four times the length of the quadrate nectary. Style obsolete. Stigmas short, erect, bifid.] Also with a look of *S. cinerea*.

No. 410. Almond side above Bridge of Almond. Small bush.
[Shoots densely brown pubescent, at length shining reddish brown, rather slender. Twigs glabrous, shining rich brown. Buds red, glabrous. Leaves slightly shining, undulate, somewhat rugose, and veins much impressed above; below glaucous, veins all raised, margin slightly incurved. Catkins shortly peduncled. Ovary white pubescent, pedicel about four times the length of the quadrate nectary. Style obsolete. Stigmas slender, bifid, erect.]

Leaf Specimens.

Doubtful. Glendochart, Glenlochay, and Finlarig Burn (D. A. Haggart).

15. Salix repens L.

Number of Specimens.—Twenty-five sheets; ninety-two pieces,

Distribution.—Widely distributed throughout the county, and often abundant on wet moorlands; more rare in dry places.

Variation.—Exceedingly variable in all its parts.

Specimens—

Male.

No. 320. Ben Vrackie. On a rather dry rock at 2000 feet elevation.
[Young bark shining chestnut. Leaves dark green, glabrous, slightly shining, veins impressed above; below very glaucous, glabrous. In cultivation the young leaves become silky below. Catkins oblong, on short leafy peduncles. Scales straw-coloured, some becoming brownish at the apex. Anthers rather large, broader than long, bright yellow. Filaments somewhat subadnate at the very base, glabrous. Nectary green, long, oblong.]

Nos. 365 and 366. Woodhead Road.

Not numbered. Strathbraan (C. M'Intosh); Hatton Hill, Blairgowrie (A. Sturrock); Loch Mullion.

FEMALE.

Not numbered. Moneydie, Loch Mullion, Balnaguard, Arnbathie, The Byres near Ben Chat, Glen Tilt, Loch Tummel, Ballinluig, Kinclaven, Murthly, Luncarty; Edinchip (Miss Robertson); Aberuthven (W. Martin); Pitlochry and Grandtully (J. Brebner); Strathbraan (C. M'Intosh).

LEAF SPECIMENS.

Not numbered. Aberfeldy, Ben Vrackie, Ben-a-Chuallaich, Loch Tummel, Glen Tilt, Struan Station, Farrochel near Aberfeldy, Muirhall, Minkie Dam, Glenartney, Blackpark, Rohallion; Killin (D. A. Haggart); Loch Broom (J. Brebner).

16. × SALIX AMBIGUA Ehrh.

(*S. repens* × *S. aurita*).

Number of Specimens.—Six sheets; twenty-one pieces.

Distribution.—Widely distributed and of almost certain occurrence where the parents grow in proximity.

Variation.—Since one of the parents is exceedingly, and the other tolerably, variable, the hybrid has necessarily a wide range of variation.

Specimens—

No. 340. Woodhead Road. Very small bush.
[Twigs straight, olive brown. Leaves rather dull, somewhat rugose above; below glaucous green, with white pubescence, veins raised reticulate, tip plicato-recurved, margins incurved. Catkins (male) rather past flowering; more persistent than those of *S. aurita.*] Intermediate in character.

No. 406. Woodhead Road. A very small bush.
[Twigs slender, subglabrous, dull brown or purplish brown. Shoots purplish brown, with white pubescence. Leaves dark green, shining, rugose above; below with white half-silky half-crisped pubescence, veins raised reticulate, margins slightly incurved, tip plicato-incurved. Catkin scales narrow, spathulate, acute, half brownish. Anthers globose, orange to yellow, finally subfuscous. Filaments with a few hairs at base. Nectary short quadrate.] Inclining to *S. aurita*.

Not numbered. Blackpark, Murthly, Blair-Athole, Glen Tilt, between Balnaguard and Aberfeldy—more or less intermediate forms. Ben Vrackie. Nearer *S. repens*.

17. × SALIX NIGRICANS-REPENS Heidenr.

Number of Specimens.—Ten sheets; twenty-five pieces.

Distribution.—Rare, or more probably overlooked.

Variation.—From the great degree of variation in both the parents the hybrid ought to be very variable, but our specimens show no very great range.

Specimens—

Not numbered. Both male and female from the Tay side at Glenalbert and Dalmarnock (C. M'Intosh). I have found leaf specimens, which probably belong to this hybrid, on the banks of the Garry near Blair-Athole.

18. Salix phylicifolia L.

Including *S. nigricans* Sm. and *S. phylicifolia-nigricans* Wmr.

Number of Specimens.—Two hundred and forty-four sheets; six hundred and forty-three pieces. (*S. phylicifolia*, 44 and 127; *S. nigricans*, 123 and 335; and *S. phylicifolia-nigricans*, 77 and 181). These represent upwards of two hundred bushes.

Distribution.—Throughout the county, but most frequent on the banks of streams and on alpine rocks.

Variation.—One of if not the most polymorphic of willows, being excessively variable in all its parts. *S. nigricans* Sm. is usually considered to be a species distinct from *S. phylicifolia* L., and *S. phylicifolia-nigricans* Wmr. is often regarded as a hybrid form; but I am disposed to think that they all belong to one variable species. For the sake of convenience, however, the specimens supposed to belong to each of the three forms have been kept separate in the Herbarium, the space devoted to *S. phylicifolia-nigricans* being allotted to those forms which do not seem capable of being placed under either of the other two. At the same time, some of the forms might with almost equal justice be regarded as belonging to *S. phylicifolia* and others to *S. nigricans*.

I. S. phylicifolia L.

Specimens—

Female.

A. Capsule more or less pubescent. None numbered.

(i) With small or medium-sized leaves.

Mirehaugh near Glen Devon, Loch Voil, Foulford near Crieff, Craig-ma-Grianich (at 2000 feet), Ballinluig.

(ii) With long leaves.

Tayside at Barnhill, Loch Freuchie, Loch Rannoch, and Meall Odhar; Ben Dubh Chraigie (E. S. Marshall).

(iii) With broad leaves.

Loch Voil, Barvick near Crieff, Ben Laoigh, and Logierait.

B. Capsule glabrous.

No. 44. Almond mouth. A small bush.

No. 227. Almond mouth.

[Ovary pedicel about twice the length of the quadrate nectary. Style rather long. Stigmas short, thick, cleft, both yellowish green.]

Not numbered. Hills near Killin (D. A. Haggart); Almond mouth.

LEAF SPECIMENS.

(i) With small leaves.

Minkie Dam near Perth, Loch Marlee, Struan Station, Am Binnein, Loch Voil, Loch Lubnaig.

(ii) With medium-sized leaves.

No. 321. Corrie Dhubh Ghalair, at 2625 feet (J. Brebner).

[About 12 inches high, with the lower part of the stems buried in moss. Young twigs bright pale yellow with a greenish tint; older yellow-brown. Leaves thin—yellowish green, slightly shining, veins impressed above; below somewhat glaucous, the chief veins raised, the others reticulate pellucid, margin slightly incurved. Stipules minute, convex, with glandular margins. Remarkable for its yellow-green colour.]

Not numbered. Earn side near Crieff, Loch Freuchie, Loch Voil, Glenartney, and Blair-Athole; Corrie Dhubh Ghalair and Am Binnein (J. Brebner); Killin and Glen Dochart (D. A. Haggart).

(iii) With large leaves.

No. 318. Woody Island.

Not numbered. Loch Voil, Glen Falloch, and Loch Rannoch; Ben Lawers (J. Brebner); Glen Dochart, Glen Lochay, and Finlarig Haugh (D. A. Haggart). Some of these may belong to *S. laurina*, but, in the absence of catkins, are better placed here.

II. S. NIGRICANS Sm.

MALE.

(i) With narrow leaves.

Tay side near Dalmarnock (C. M'Intosh).

(ii) With medium leaves.

No. 15. Almond side above Bridge of Almond.

No. 60. Woody Island. A tall bush.

No. 145. Linn of Campsie. A tall bush. Late flowering.

No. 146. Linn of Campsie. A tall bush.

No. 172. Linn of Campsie.

[Shoots dark brown. Leaves thick, firm, dark green. shining above; below paler green.]

No. 223. Almond mouth.

[Anthers always yellow. Filaments free, glabrous. Nectary quadrate.]

Unnumbered. Tayside at Dalmarnock, Glen Albert, and Balmacneil (C. M'Intosh).

(iii) With broad leaves.

Nos. 220 and 221. Almond mouth.

[Anthers always yellow. Filaments free, glabrous. Nectary quadrate.]

Unnumbered. Little Trochrie, Tay side at Dalmarnock and Balmacneil (C. M'Intosh); Tayside at Castle Menzies.

FEMALE.

A. Capsules glabrous.

(i) With small leaves.

Unnumbered. Glen Devon, Coulshill near Auchterarder, Ardoch, Loch Loch, Meall Odhar, and Sow of Athole; Tayside at Glenalbert, Dalmarnock, and Balmacneil, and Little Trochrie (C. M'Intosh).

(ii) With narrow leaves.

No. 138. Almond side above Bridge of Almond.

[Shoots moderate, moderately tomentose, reddish brown on one side. Leaves rather thin—somewhat shining, and veins impressed above; below paler and duller, veins raised. Catkins small, with short leafy peduncles. Scales thin, half fuscous brown. Ovary and pedicel glabrous, pedicel more than twice the length of the quadrate nectary. Style cleft. Stigmas rather short, bifid, thick, erect, spreading.]

No. 394. Tay side near Dalmarnock, Tall bush, with very large catkins.

Not numbered. Ben Lawers.

(iii) With medium leaves.

No. 86. Woody Island.

No. 241. Darry Island.

[Catkins peduncled. Ovary pedicel about four times the length of the oblong nectary. Style rather long subbifid. Stigmas somewhat thick, bifid.]

Unnumbered. Glenalbert, Dalmarnock, Balmacneil, Dalguise, Strathbraan, and Little Trochrie (C. M'Intosh); Abercairney.

(iv) With broad leaves.

No. 234. Tay side near Lairwell.

[Ovary pedicel less than twice the length of the quadrate nectary. Style moderate. Stigmas short, bifid, yellowish green.]

No. 413. Almond side above Bridge of Almond.

[Shoots moderate, moderately downy, reddish brown on one side, Leaves shining, with impressed veins above; below paler, dull, veins raised. Catkins peduncled. Style yellow, stout. Stigmas stout, bifid, spreading.]

No. 414. Almond side above Bridge of Almond.

[Shoots rather stout, downy. Twigs chestnut, glabrous, not very shining. Leaves rather pale green, slightly shining, with impressed veins above; below, paler, dull, sometimes glaucous, veins raised. Style stout. Stigmas rather capitate.]

No. 37. Almond mouth. Not typical.

No. 45. Almond mouth. Not typical.

No. 156. Linn of Campsie. Tall bush.

[Shoots green to dark brown. Leaves thick—dark green, shining, above; below green to glaucous.]

Not numbered. Dalguise (C. M'Intosh); Woody Island, Loch Tay side at Acharn.

B. Capsules pubescent.

(i) With small leaves.

No. 308. Hills near Killin (D. A. Haggart).

[Catkins subsessile, with a few small bracts. Ovary pedicel three to four times the length of the short transverse nectary. Style very short, stout, yellowish. Stigmas short, half bifid.]

No. 309. Hills near Killin (D. A. Haggart).

[Catkins peduncled; peduncle with two to four leaves, some of which have buds in the axils. Structure otherwise as in No. 308.]

Not numbered. Glenalbert and Balmacneil (C. M'Intosh).

(ii) With narrow leaves.

Unnumbered. Loch Tay side at Acharn. Glenalbert (C. M'Intosh).

(iii) With less hairy medium leaves.

No. 88. Woody Island.
[Stigmas short, thick, cleft.]

No. 186. Woody Island.

Not numbered. Glenalbert and Balmacneil (C. M'Intosh).

(iv) With more hairy medium leaves.

Not numbered. Tay side at Glenalbert, Dalguise, and Balmacneil (C. M'Intosh), Barvick Burn near Crieff, Acharn, Corrie Dhubh Ghalair, and Loch Loch.

(v) With broad leaves.

No. 210. Almond side above Bridge of Almond.
[Style moderate. Stigmas short, thick, deeply cleft, spreading; greenish yellow.]

No. 251. Woody Island.
[Twigs rather shining chestnut, almost quite glabrous. Ovary pedicel more than twice as long as the quadrate nectary. Style rather long, stout. Stigmas short, rather stout, bifid; greenish yellow.]

No. 269. Tay side at Seggieden.
[Twigs dull green. Leaves subglaucous below, the older ones green, with no evident white dots. Ovary pedicel twice as long as the quadrate nectary. Style medium. Stigmas short, bifid, spreading; greenish yellow, then brown.]

Unnumbered. Little Trochrie (C. M'Intosh); Barvick near Crieff, Ballinluig, Ben Lawers.

NOTE.—As represented by our specimens, which have not been selected with any special purpose in this respect, glabrous capsules occur in 34 bushes of *S. nigricans* and in 4 of *S. phylicifolia*, and more or less pubescent capsules in 27 bushes of *S. nigricans* and 14 bushes of *S. phylicifolia*. It would seem from this that pubescent capsules are comparatively commoner in *S. phylicifolia*—the much more glabrous plant in other respects—than in *S. nigricans*.

LEAF SPECIMENS.

No. 310. Hills near Killin (D. A. Haggart).

Unnumbered. Methven Wood, Meikleour, Linn of Campsie, Loch of Lows, Meall Odhar, Blair-Athole, Acharn, Loch Freuchie, Larig-an-Lochan, Cam Creag, and Craig-na-Caillich; Corrie Dhubh Ghalair (Brebner and Haggart).

III. S. PHYLICIFOLIA-NIGRICANS Wimm.

Of this form the series from the Linn of Campsie is kept separate from the others. In that locality, whilst a few plants which have been referred to *S. nigricans* occur, satisfactory *S. phylicifolia* appears not to grow. Some of the bushes of *S. phylicifolia-nigricans* are very close to *S. nigricans*, and, if they did make part of the series, might as readily be referred to that form.

A. All from Linn of Campsie.

NOTE.—The numbers are not given in consecutive order, but according to the affinities of the shape of the leaves.

MALE.

No. 155. Inclining to *S. nigricans*.
[Shoots green to brown. Leaves rather thin—dark green, shining above; below glaucous to green.]

No. 421. Inclining to *S. nigricans.*
[Shoots green to reddish brown. Leaves flat, dark green, shining, rugose from the much impressed veins above; below glaucous green, with raised reticulate veins.] A remarkable-looking plant, whose leaves call to mind *S. reticulata.*

No. 148.
[Twigs dark brown. Leaves thick, firm—slightly shining above; below glaucous to glaucous green.]

No. 160.

No. 423. Inclining to *S. nigricans.*
[Shoots dark brownish green. Twigs brighter, shining. Leaves dark green, shining above; below green to glaucous.]

No. 147.
[Shoots dark reddish brown. Twigs brown. Leaves thick, firm—rather shining above; below green to glaucous green.

No. 151. Inclining to *S. nigricans.*
[Shoots reddish brown. Leaves rather thick—medium green, slightly shining above; below glaucous green.]

No. 144.

No. 424.
[Shoots chestnut brown. Twigs dull brown. Leaves rather thick—dark green, slightly shining above; below paler green.]

FEMALE.

No. 152. Inclining to *S. phylicifolia.*
[Shoots chestnut to brownish green. Leaves firm—dark green, shining above; below green to glaucous green.]

No. 425.
[Shoots chestnut. Leaves thick, firm—dark green, shining above; below paler green. Petiole red.]

No. 154.
[Shoots chestnut, shining. Leaves firm—dark green, shining above; below pale green.]

No. 168.
[Shoots chestnut brown. Leaves moderately thick—dark green, shining above; below glaucous green.]

No. 161.

No. 142.
[Shoots greenish brown. Leaves firm—medium green, shining above; below glaucous to glaucous green.]

No. 162. Inclining to *S. nigricans.*
[Leaves medium green, slightly shining above; below paler green.]

No. 141.
[Shoots reddish brown to green. Leaves thick, firm—medium green, slightly shining above; below green to glaucous green.]

No. 171.
[Shoots reddish. Twigs reddish brown. Leaves rather thick—pale green, slightly shining above; below paler green.]

No. 143. Inclining to *S. phylicifolia.*

Nos. 164, 163, 169, and 140.

No. 157.

[Shoots reddish brown. Leaves dark green, slightly shining above; below green to glaucous green.]

No. 149. Inclining to *S. nigricans.*

[Shoots green to brown. Leaves moderately thick—medium green, slightly shining above; below glaucous green.]

No. 422.

[Shoots chestnut. Twigs pale brown. Leaves rather pale green, with sometimes a reddish tinge, scarcely shining above; pale green or slightly glaucous below.]

No. 167.

[Shoots green to brown. Leaves moderately thick—dark green, slightly shining above; below glaucous green.]

B. From other localities.

MALE.

No. 31. Almond side above Bridge of Almond.

No. 89. Woody Island. Near *S. nigricans.*

No. 450. Stanners at Perth Bridge (R. Dow).

[Twigs straight, rather stout, purple brown, glabrous, shining. Catkins with leafy peduncles; scales tipped with fuscous or crimson. Anthers yellow. Filaments hairy at the base. Nectary quadrate green.]

Not numbered. Tay side at Glenalbert (C. M'Intosh).

FEMALE.

No. 46. Almond mouth.

No. 179. Woody Island. Near *S. nigricans.*

[Shoots green to fuscous brown, pubescent. Twigs pale brown, glabrous, rather shining. Leaves firm—dark green, very shining, subrugose, veins impressed above; below green to glaucous, chief veins raised, margins slightly thickened, incurved.]

Nos. 183 and 185. Woody Island. Towards *S. nigricans.*

No. 287. Pepper Knowes Mill-Dam. Near *S. nigricans.*

[Twigs dark reddish or green, dull. Leaves nearly glabrous, veins impressed above; below glaucous, veins raised, irregularly thickened and reticulate. Ovary pedicel three times the length of the small quadrate nectary. Style long, cleft. Stigmas half bifid.]

No. 432. Sleepless Island.

[Twigs straight, pale brown, glabrous. Leaves shining dark green, veins impressed above; below pale dull, veins raised, margins incurved. Catkins small, peduncled; scales half black. Ovary glabrous, pedicel three times the length of the quadrate nectary. Style short, thick, green. Stigmas short, thick, bilobed, spreading.] Near *S. phylicifolia.*

No. 447. Tay side at Denmark Green. Near *S. phylicifolia.*

[Twigs slender, shining rich bright chestnnt. Leaves very shining, dark green, veins impressed above; below dull pale green, but scarcely glaucous, margins wavy. Ovary glabrous. Style yellowish.]

No. 452. Stanners at Perth Bridge (R. Dow)!

No. 453. do. do. do.

[Twigs straight, stout, greenish brown to pale brown. Catkins elongate, erect-spreading, with leafy peduncles; scales half fuscous black. Ovary glabrous, pedicel slightly hairy at the base, three times the length of the small quadrate yellow nectary. Style medium, yellow. Stigmas short, slender, bifid, spreading.]

Not numbered. Almond mouth, Struan Station, and Acharn. Logierait Ferry (C. M'Intosh).

LEAF SPECIMENS.

Not numbered. Tayside at Stanley, Cathole, Hell's Hole, and Balnaguard; Loch Marlee, Loch of Lows, Almondbank, Lynedoch, Loch Freuchie, Blair-Athole, Ben-a-Chualich (at 2500 feet), and Struan Station. Killin Hills (D. A. Haggart). Kincraigie (C. M'Intosh).

19. × SALIX WARDIANA (Leefe MS.) B.W.

(*S. phylicifolia* × *S. cinerea*).

Number of Specimens.—Fourteen sheets; thirty-five pieces.

Distribution.—Apparently rare, but probably overlooked.

Variation.—The range of variation is theoretically on the same lines as other hybrids, but most of our specimens incline to *S. cinerea*, for forms of which it might readily be mistaken.

Specimens—

FEMALE.

All are from the Woody Island, in the Tay, near Perth.

No. 129.

[Twigs dull brown, rather pubescent. Shoots brownish green, pubescent. Leaves dark green, veins impressed, subrugose above; below glaucous, veins raised, margins slightly incurved.] Very like *S. cinerea*.

No. 136.

[Leaves cordate at the base. Catkins small, ovate. Ovary pedicel more than twice the length of the subquadrate green then yellow nectary. Style evident. Stigmas short, thick, cleft, green, then brown. A shy flowerer, and late in opening its buds.]

No. 188.

[Branches wand-like, brownish red, somewhat shining. Shoots greenish to reddish brown, at the very first pubescent. Leaves dark green, shining, rugose, veins impressed above; below glaucous green or green, veins strongly raised, undulate margins incurved. Petioles and buds often red. Young leaves yellowish. Catkins erect. Ovary pedicel about three times the length of the square nectary. Style and stigmas crimson; style rather short; stigmas short, cleft.]

No. 324.

[Twigs purple brown, somewhat shining. Catkins spreading; scales one-third fuscous black. Ovary pedicel two to three times the length of the quadrate nectary. Style subevident. Stigmas rather erect, bifid, yellow. Capsules spreading, compressed, downy.]

No. 420.

[Shoots long, slender, greenish brown to reddish brown, at first slightly pubescent, then glabrous and shining. Twigs glabrous, rather dull brown. Leaves somewhat shining, subrugose, veins impressed above; below glaucous green, margins undulate, slightly incurved. Petioles often reddish.

Catkins erect, shortly peduncled. Scales narrow, half black. Ovary pedicel about three times the length of the rather long nectary. Style short. Stigmas erect, slender.] Very like No. 188, and perhaps from the same root.

LEAF SPECIMENS.

From Loch Rannoch and Loch Tummel—both doubtful.

20. × SALIX LUDIFICANS B.W.

(*S. phylicifolia* × *S. aurita*).

Number of Specimens.—Two sheets; four pieces.

Distribution.—Very rare, or overlooked.

Variation.—Theoretically as other hybrids.

Specimens—

FEMALE.

Tayside at Balmacneil (C. M'Intosh).

21. × SALIX TEPHROCARPA Wimm.

(*S. phylicifolia* × *S. cinerea* × *S. Caprea?*)

Number of Specimens.—Six sheets; fourteen pieces.

Distribution.—Very rare.

Specimens—

FEMALE.

Tay side at Balmacneil (C. M'Intosh).

22. × SALIX LATIFOLIA Forbes.

(*S. nigricans* × *S. Caprea*).

Number of Specimens.—Twelve sheets; twenty-nine pieces.

Distribution.—Rare, or overlooked.

Variation.—On the same lines as other hybrids.

Specimens—

FEMALE.

No. 25. Almond side above Bridge of Almond.

[Shoots stout, densely fuscous tomentose. Twigs becoming glabrous, brownish green. Leaves rather thick, not very flat—dark green, shining, veins impressed above; below pale or glaucous green, veins raised, pubescence *Caprea*-like, margins slightly incurved, serrate-crenate, with the glands often dark brown. Catkins rather erect, on conspicuous leafy peduncles, whose leaves have stipules and buds in the axils; scales half black. Ovary conical, subulate, with dense white pubescence, pedicel about three times the length of the small quadrate yellow nectary. Style one-half the length of the stigmas, cleft. Stigmas short, thick, shortly bifid, erect.] Inclining to *S. nigricans*.

No. 32. Almond side above Bridge of Almond. Tall bush.

[Shoots stout, with dense greyish green pubescence. Twigs soon glabrous and green. Leaves dark green, shining, rather rugose, veins impressed above; below glaucous or glaucous green, veins raised, pubescence rather *Caprea*-like, margins incurved. Catkins spreading and curved upwards on leafy peduncles; scales narrow, half black. Ovary pedicel four or five times the length of the small quadrate nectary. Style rather slender. Stigmas longer than the style, rather slender, bifid, erect-spreading, and connivent.] A handsome willow.

Not numbered. Tayside at Glenalbert (C. M'Intosh). Loch Tay side at Acharn—rather doubtful.

23. × SALIX STREPIDA Forbes.

(*S. nigricans* × *S. cinerea*).

Number of Specimens.—Forty-one sheets; one hundred and sixteen pieces.

Distribution.—Rather widely spread on the banks of the Tay. Possibly local, but probably overlooked.

Variation.—On the same lines as other hybrids—some forms being near *S. cinerea*, some near *S. nigricans*, and others intermediate.

Specimens—

I. More or less intermediate.

MALE.

Nos. 69 and 70. Woody Island.

[The same general characters apply to both, though they differ a little in detail. Shoots green to brownish, pubescent. Twigs grey-brown pubescent, finally glabrous. Leaves rather dark green, subrugose, veins impressed above; below glaucous, veins raised, thickened margin incurved.]

Not numbered. Little Trochrie, Strathbraan (C. M'Intosh).

FEMALE.

No. 173. Woody Island, and close to Nos. 69 and 70.

[Shoots brownish green, pubescent. Twigs greyish brown, dull, finally glabrous. Leaves dark green, rugose, veins impressed above; below glaucous, veins raised, thickened margin incurved. Ovary pedicel two to three times the length of the quadrate nectary. Style moderate. Stigmas yellowish at the base of the catkins, becoming crimson towards the apex, about as long as the style, rather broad, half bifid. A tall bush, with slender branches.]

No. 228. Almond mouth.

[Shoots and twigs grey pubescent. Leaves dark green, rather dull, slightly rugose, veins impressed above; below glaucous green, with white pubescence, veins raised, margin undulate, incurved. Style short or very short. Stigmas entire or bifid, slender, somewhat spreading. Ovary pedicel about twice as long as quadrate nectary. Catkins peduncled.]

Nos. 245, 246, 248, and 249. Near Kinfauns Station.

[Leaves thin, veins raised above; below rather glaucous, with many white dots, veins raised, reticulate. Ovary pedicel two to three times the length of the linear oblong nectary. Style moderate. Stigmas, linear, half bifid.]

No. 415. Almond mouth.

[Shoots with moderate white pubescence, finally glabrous. Some of the twigs black pubescent. Leaves dark green, slightly shining, veins impressed above; below glaucous green, with white pubescence, veins raised, undulate margin incurved. Catkins very shortly stalked. Ovary pedicel about three times the length of the quadrate nectary. Style short. Stigmas short, entire, spreading.] Resembles *S. latifolia*, but appears to be *S. strepida.*

No. 416. Almond mouth.

[Characters the same as No. 415, but the pubescence of the underside of the leaves becoming reddish brown as in *S. cinerea.*]

No. 441. Tay side above Elcho.

[Twigs torulose, black pubescent. Leaves dark green, slightly shining, veins impressed above; below pale green, scarcely glaucous, veins raised, margins slightly incurved. Catkins spreading horizontally, subsessile scales at the top of the catkin crimson, lower down just tipped with black, or half black, or black and red. Ovary white pubescent; pedicel about twice the length of the quadrate nectary. Style very short, cleft. Stigmas short, thick, bilobed.]

No. 442. Tay side above Elcho.

[Twigs torulose, brown, pubescent. Leaves dark green, slightly shining, veins impressed above; below pale green, scarcely glaucous, dull, veins raised, margin incurved. Catkins erect-spreading, shortly stalked. Ovary pedicel three times the length of the oblong nectary. Scales half black. Style short. Stigmas short, erect, bifid, yellow.]

II. Less intermediate forms.

FEMALE.

No. 30. Almond side above Bridge of Almond.

No. 54. Woody Island. Near *S. cinerea.*

No. 58. Woody Island.

Not numbered. Tay side at Balmacneil (C. M'Intosh).

[Var. *nitida* Wimm. Capsules more or less glabrous.]

Not numbered. Logierait Ferry (C. M'Intosh).

[Near *S. cinerea.*]

Not numbered. Kinnaird House (C. M'Intosh).

[Very near *S. nigricans.*]

24. × SALIX CORIACEA Forbes.

(*S. nigricans* × *S. aurita*).

Number of Specimens.—Ten sheets; twenty pieces.

Distribution.—Rare or overlooked.

Variation.—After the same manner as other hybrids.

Specimens—

FEMALE.

No. 393. Tay side near Dalguise. A small tree.

[Twigs torulose, black pubescent, then greyish brown, dull. Catkins spreading, subsessile and without leaves at the base. Scales narrow, spathulate, apical four-fifths fuscous, brownish black, with long white hairs. Capsule conical subulate, with adpressed pubescence; pedicel four to five times as long as the small quadrate nectary. Style medium, Stigmas erect-spreading, emarginate, about as long as the style.] Much like *S. strepida*, but seems better referred to *S. coriacea.*

Not numbered. Tay side at Dalguise (C. M'Intosh)—is the same as No. 393. Glenalbert (C. M'Intosh)—near *S. aurita.*

In addition to these, Mr. M'Intosh has found a plant near Balmacneil which may be a hybrid between *S. coriacea* and *S. Caprea—i.e., S. nigricans* × *S. aurita* × *S. Caprea.*

25. Salix Arbuscula L.

Number of Specimens.—Twenty-three sheets; oue hundred and five pieces.

Distribution.—Common and widely distributed on the Breadalbane Hills, to the west of Loch Tay, from Ben Lawers to Ben Laoigh. It occurs also on Ben Chonzie, near Crieff.

Variation.—There is a considerable degree of variation in the size of the bush, shape and structure of the leaves, and in the structure of the catkins.

Specimens—

Male.

No. 305. Hills near Killin (D. A. Haggart).

[Young bark greenish, shining. Leaves with numerous minute white dots, flat above; below glaucous, with veins slightly but not reticulately raised. Catkins on a peduncle with about four leaves, which have stipules and buds in the axils; scales pale, slightly tinged with pink at their tips, those at the top of the catkin more coloured. Anthers finally dirty yellow. Filaments glabrous. Nectary comparatively large, linear oblong.]

No. 315. Hills near Killin (D. A. Haggart).

[Young bark reddish yellow-brown, shining. Leaves with small stipules, flat above; below glaucous, with the primary veins raised. Peduncular leaves more shining, and with the veins impressed above. Catkins on peduncles with two to four rather large leaves, which have buds in their axils, and are stipulate. Scales pale green, those towards base of catkin nearly unicolorous, those at tip more strongly tinged with crimson; hairy, and ciliate with straight hairs. Unopened anthers shortly oval, yellow, thickly mottled with purple, finally (when past) fuscous brown. Filaments glabrous. Nectary linear.]

Not numbered. Cam Creag.

Female.

No. 253. Cultivated from a Breadalbane plant.

[Prostrate, with long wand-like branches extending horizontally. The catkins erect at nearly right angles. Branches rooting, their ends ascending. Young shoots dull green, or reddish brown on one side; older bark brown to red brown according to exposure. Young leaves somewhat shining, rather pale green, with minute white dots, veins slightly raised above; below dull, pale green, slightly pubescent, especially about the midrib, margin rather closely glandular-serrate. Old leaves dark green, slightly shining, veins slightly impressed above; below glaucous, especially the upper leaves, with the primary veins raised; margin slightly incurved. Stipules soon withering and deciduous, not longer than half the length of the petiole, oval, externally flat-convex, internally concave, margin incurved glandular-serrate. Catkins on peduncles with two to three petioled leaves, with buds in their axils, and round very convex stipules. Scales oblong, obtuse, pubescent, brown at their tips. Ovary subsessile, densely downy. Style rather long. Stigmas very short, broader than long, notched, erect, spreading, greenish yellow, sometimes tinged with red. Nectary linear, passing the base of the ovary.]

No. 300. Hills near Killin (D. A. Haggart).
[Catkins on peduncles with two to four large leaves with buds in their axils and stipulate; scales pale, pink at the very tip. Ovary shortly pedicelled, the pedicel half as long as the linear nectary. Style mediocre, thick, cleft at the apex, pale. Stigmas short, thick, more than half bifid, spreading, yellowish, tinged externally with reddish brown.]

No. 306. Hills near Killin (D. A. Haggart).
[Branches intricate. Young bark greenish, shining. Leaves with numerous white dots, appearing reticulately rugose from being hollowed between the veins above; below glaucous, with slightly raised reticulate veins. Catkins lax-flowered, on long peduncles with about three leaves, which have buds in their axils and are stipulate. Scales pale, fuscous brown at their tips. Ovary shortly pedicelled, pedicel somewhat shorter than the subquadrate nectary. Style very short and thick, almost obsolete, pale. Stigmas bifid, segments very short, thick, spreading, red externally, then brown.]

No. 307. Hills near Killin (D. A. Haggart).
[Leaves somewhat similar in colour and structure to No. 306, but not so reticulate, and shape somewhat different. Catkins peduncled in the same manner; scales pale, tipped with crimson, especially at the upper part of the catkin. Ovary shortly pedicelled, the pedicel half the length of the long linear nectary. Style short, thick, cleft at the top, pale. Stigmas short, more distinctly bifid than in No. 306, spreading, tinged with red, then brown.]

Nos. 463 and 464. Ben Laoigh.

No. 465. Allt Innis Choarach.
[Small rather erect bush, with the base prostrate and rooting. Catkins peduncled in the usual manner; scales spathulate, not very broad, upper half pale brown. Ovary subsessile. Style very short, thick. Stigmas very short, erect, bifid. Nectary linear, reaching the body of the ovary.]

Not numbered. Larig-an-Lochan and hills near Killin (D. A. Haggart); Allt Innis Choarach and Meall Ghaordie (J. Brebner); Larig-an-Lochan, Cam Creag, Allt Innis Choarach, Ben Laoigh, Craig-na-Caillich, Ben Heasgarnich, Craig Mhor, Ben Lawers, and Ben Chonzie.

Leaf Specimens.

Corrie Dhubh Ghalair (Brebner and Haggart).

× *Salix Dicksoniana* Sm., probably a hybrid between *S. Arbuscula* and *S. phylicifolia*, was found on the Breadalbane Hills long ago, but we have no wild specimens.

26. Salix viminalis L.

Number of Specimens.—Eighteen sheets; forty-two pieces.

Distribution.—Not uncommon on the banks of streams in the Lowlands and in some of the Highland valleys.

Variation.—Not subject to any great variation, which is chiefly in the breadth of the leaves.

Specimens—

MALE.

Nos. 75 and 84. Woody Island.

No. 247. Darry Island.

[Filaments glabrous, free. Nectary linear oblong, often bifid for half or all its length. Rather a late flowerer.]

FEMALE.

No. 6. Tay side at Barnhill.

Nos. 71 and 187. Woody Island.

No. 240. Darry Island.

[Stigmas entire. Style and stigmas yellow.]

No. 244. Darry Island.

[Catkins rather shorter than usual. Stigmas shortly bifid. Style and stigmas yellowish.]

Not numbered. Dalmarnock (C. M'Intosh); Woody Island and Kinloch-Rannoch.

LEAF SPECIMENS.

Woody Island and Barnhill.

27. × SALIX SMITHIANA W.

(*S. viminalis* × the *Capreæ* group).

S. viminalis forms a number of hybrids with *S. Caprea*, *S. cinerea*, and *S. aurita*, but, from the difficulty of ascertaining the exact parentage, it is expedient to consider them in the meantime as varieties of *S. Smithiana.* In Perthshire three chief forms occur, each of which we will take separately.

(*a*) S. STIPULARIS Sm.

Number of Specimens.—Twenty-one sheets; forty-two pieces.

Distribution.—Rare or local. Chiefly on the banks of the Tay below Perth and on the lower part of the Earn.

Variation.—The range of variation is from near *S. viminalis* to near the next variety, *S. sericans.*

Specimens—

MALE.

No. 475. Tay side near Balhepburn.

[Catkins often in pairs, on short peduncles with small leaves. Scales crimson at the tips, more especially at the apex of the catkins before the latter open; afterwards pale at the base, with upper half pale brown or blackish, ligulate, acute, clothed with long hairs. Filaments slightly hairy at the base. Anthers at first tinged with reddish orange, then yellow. Nectary quadrate, yellow. Vernation of leaves revolute.]

I fear that the bush is destroyed, which is unfortunate, as the male of *S. stipularis* seems to be almost unknown.

FEMALE.

No. 7. Tay side at Barnhill.
[Style shorter than the rather short linear entire erect-spreading stigmas. Nectary linear, twice as long as the pedicel of the ovary.]

Nos. 8 and 10. Barnhill.

Nos. 102, 105, 106, 107, 112, and 118. Near Longforgan Station.

No. 243. Darry Island.
[Style and stigmas pale greenish yellow. Style medium, shorter than the linear entire erect-spreading stigmas. Nectary long linear, twice as long as the short pedicel of the ovary.]

No. 278. Darry Island.
[Style medium, slender, shorter than the linear entire stigmas. Nectary linear, twice as long as the short pedicel of the ovary. Young leaves not tinged with red.]

No. 289. Pepper Knowes Mill-Dam.
[Bark densely black-pubescent. Leaves not very shining above. Style shorter than the linear entire stigmas. Nectary linear, twice as long as the pedicel of the ovary.]

No. 427. Balhepburn Island.
[Leaves dark green, veins strongly impressed above; below primary veins raised.]

Not numbered. Dead Waters of the Earn (R. H. Meldrum)! Barnhill.

(*b*) S. SERICANS Tausch.

Number of Specimens.—Thirty-one sheets; sixty-six pieces.

Distribution.—Widely spread, but not very common. Like *S. stipularis*, it is often planted, but self-sown plants occur.

Variation.—Subject to a considerable range of variation. In its most typical form—*S. Smithiana* proper—it is certainly a hybrid between *S. viminalis* and *S. Caprea*, but some conditions suggest a recrossing of the hybrid with one of its parents, and others may contain a strain of *S. cinerea*.

Specimens—

MALE.

Not numbered. Tay side at Kinnaird House (C. M'Intosh); Barnhill; Annat Lodge (cultivated).

FEMALE.

No. 236. Tay side at Kinfauns. A tall tree.
[Style and stigmas greenish yellow. Style nearly as long as the rather short linear entire erect-spreading stigmas. Nectary linear oblong, about as long as the pedicel of the ovary. Young leaves tinged with red towards the base.]

No. 237. Tay side at Kinfauns. A bush.
[Style and stigmas pale greenish yellow-white, stigmas becoming brown. Style a little shorter than the rather short, linear, half bifid, erect-spreading stigmas. Nectary yellow, short, linear, subemarginate, about the same length as the pedicel of the ovary. Young leaves veined and tinged with red, especially towards the base.]

No. 327. Pepper Knowes Mill-Dam.

No. 392. Coulshill near Auchterarder Station.
[Twigs tomentose. Catkins subsessile, with a few green bracts at the base; scales small, narrow, spathulate, fuscous brown on the apical three-quarters. Ovary subulate from an ovate base, adpressedly tomentose, pedicel about twice as long as the narrow oblong nectary. Style medium, slender, yellow. Stigmas about as long as the style, entire, spreading.] An aberrant form. *S. Caprea*, *S. cinerea*, and *S. aurita*, as well as *S. viminalis*, grow near it.

Not numbered. Tay side at Kinnaird House and at Glenalbert (C. M'Intosh).

Leaf Specimens.

No. 121. Near Longforgan Station.

Not numbered. Killin (D. A. Haggart); Dupplin, Fowlis-Wester, Pond of Drummond, and Meikleour.

(*c*) S. ferruginea G. And.

Number of Specimens.—Thirteen sheets; thirty-one pieces.

Distribution.—Very local. I have found it in the Woody Island only.

Variation.—Not very variable so far as our specimens are concerned.

Specimens (all from Woody Island)—

Male.

No. 128.
[Shoots green to brown, at first pubescent, finally glabrous. Twigs brown, dull. Leaves slightly shining, veins impressed above; below pale green, dull, veins strongly raised, margin incurved. Young leaves yellowish. Catkin scales long, spathulate, brownish black at the tips. Filaments variably hairy at the base. Anthers globose, rather dark yellow. Nectary green, irregular in length, quadrate to long.]

Female.

No. 181.
[Branches straight. Young leaves yellowish green. Catkins peduncled. Pedicel of ovary more than twice as long as the oblong nectary. Style yellow, short, about as long as the erect, rather narrow, emarginate, yellow then brown stigmas.]

No. 184.

No. 192.
[Branches slender, straight. Shoots green to brown and red, shining, at the very first slightly pubescent. Twigs slender, dull brown. Leaves shining, subrugose, veins impressed above; below paler green, dull, veins raised, margin incurved, the scant pubescence silky. Young leaves yellowish green.]

Salix daphnoides Vill. (of which we have one sheet and three pieces from Perthshire) occurs here, as elsewhere in Britain, as an introduction only.

28. Salix lanata L.

Number of Specimens.—Five sheets; eleven pieces.

Distribution.—Very local and rare. Glen Lochay and its neighbourhood.

Variation.—Rather variable in the shape of the leaves and amount of pubescence.

Specimens—

Female.

No. 319. Corrie Dhubh Ghalair (J. Brebner). One much twisted and complicated bush, about twelve to eighteen inches high, extending for four or five feet along the edge of a rock at 2525 feet altitude.

[Bark brownish green, somewhat shining. Buds yellowish brown, finally darker, soon glabrous. Leaves becoming almost glabrous, shining dark green above; below glaucous and dull. Catkins on short peduncles, which have one or two small leaves. Scales less than half the length of the capsule, base white, apical two-thirds blackish, clothed within and without with many long, straight, white hairs. Capsule yellow, glabrous, on a short pedicel which is shorter than the narrow nectary. Style long. Stigmas rather short, linear, entire or bifid.]

No. 468. Allt Innis Choarach.

Not numbered. Cam Creag.

29. × Salix Stephania B.W.

(*S. lanata* × *S. herbacea*).

Number of Specimens.—Two sheets; four pieces.

Distribution.—Allt Innis Choarach, where it was first observed by Mr. Haggart, to whom I am much indebted for this and many other willows from Killin. Very few plants have as yet been found.

Specimens—

No. 466. Allt Innis Choarach.

Not numbered. Same locality (Haggart and Brebner).

For particulars of this hybrid see "Revision."

30. × Salix superata B. W.

(*S. lanata* × *S. reticulata*).

Number of Specimens.—Two sheets; five pieces.

Distribution.—Allt Innis Choarach—very rare.

Specimens—

Nos. 467 and 469. For particulars see "Revision."

31. Salix lapponum L.

Number of Specimens.—Twenty-eight sheets; one hundred and three pieces.

Distribution.—Widely spread throughout the higher hills of the Highland district. It also occurs at an altitude of 700 feet in Glendey in the Ochils.

Variation.—Subject to a considerable range of variation in the size, shape, and amount of pubescence of the leaves, and, in a less degree, in the structure of the catkins.

Specimens—

Male.

No. 303. Hills near Killin (D. A. Haggart).

[Filaments glabrous, not stouter than is usual in the genus, apparently connate at the very base. Anthers oval, dull yellow tinged with violet red, finally yellowish brown. Nectary linear oblong. The flowers had no perceptible odour, but possibly they had lost it since they were gathered.]

Female.

No. 296. Hills near Killin (D. A. Haggart).

[Catkins on a peduncle with one or two small leaves. Capsule subsessile. Style short or obsolete, cleft at apex. Stigmas rather long, linear, half bifid. Nectary linear, long, reaching to widest part of capsule.]

No. 297. Same locality.

[Characters the same as No. 296. The style is hairy at the base, and thus looks like part of the capsule. Style and stigmas yellowish, then brownish.]

No. 298. Same locality.

[Characters similar to No. 296 and 297. The young leaves have an obscure minute gland-like stipule.]

No. 302. Same locality.

[Characters similar to No. 296.]

No. 301. Same locality.

[Catkins more woolly and denser-flowered. Capsule sessile. Style longer and more slender. Stigmas filiform, entire. Nectary linear oblong, comparatively shorter.]

No. 391. Glendey, Ochils (W. Martin)! Five or six bushes about five feet high, growing, along with *S. pentandra*, at an altitude of about 700 feet above sea-level.

[Twigs rather straight, glabrous, shining greenish brown. Buds yellow-brown, very slightly pubescent. Catkins dense flowered, subsessile, with a very few scale-like bracts, erect, but somewhat curved. Scales thin, spathulate, rather obtuse, whitish at the base, otherwise brownish black, with many straight white hairs longer than the scale. Capsule sessile, ovate-conical, subobtuse, woolly. Style long, slender, woolly at the base, but hairy throughout, yellowish brown. Stigmas shorter than the style, hairy, entire. Nectary rather thin, narrow, oblong, somewhat triquetrous in section, yellow.

Young leaves woolly on both sides, but mostly below, with very minute gland-like stipules.]

Not numbered. Meall Dhuin Croisg, Meall Ghaordie, and Corrie Dhubh Ghalair (J. Brebner); Craig-na-Caillich, Ben Lawers, Glen Lyon, Garb Meall, and Ben-na-Chuallaich (in Rannoch), Craig-ma-Grianich, and Dalna-spidal.]

LEAF SPECIMENS.

No. 314. Hills near Killin (D. A. Haggart).

Not numbered. Corrie Ardran (E. S. Marshall)!; Meall-nan-Ptarmachan, Corrie Dhubh Ghalair, Allt Innis Choarach! and Meall Ghaordie (J. Brebner); Meall Dhuin Croisg (R. H. Meldrum); Larig-an-Lochan (D. A. Haggart); Cam Creag and Ben Oss.

32. × SALIX SPURIA Willd.

(*S. lapponum* × *S. arbuscula*).

Number of Specimens.—Seven sheets; twenty-three pieces.

Distribution.—In several places on the Breadalbane Hills.

Variation—The range of variation is the usual one in hybrids—*i.e.*, from one parent to the other.

Specimens—

MALE.

No. 304. Hills near Killin (D. A. Haggart).
[Catkins small, on a peduncle with two or three leaves without buds in their axils or stipules. Anthers violet red when unopened, finally fuscous brown. Filaments glabrous. Nectary linear, oblong. Bark fuscous chestnut, somewhat shining. Leaves reticulate, with impressed veins above and raised veins below.]

Not numbered. Cam Creag (R. H. Meldrum).

FEMALE.

Not numbered. Meall Dhuin Croisg (R. H. Meldrum); Allt Innis Choarach (E. S. Marshall).

LEAF SPECIMENS.

Not numbered. Meall Ghaordie, Ben Lawers, Larig-an-Lochan, and near Craig-na-Caillich.

33. SALIX MYRSINITES L.

Number of Specimens.—Four sheets; sixteen pieces.

Distribution.—Widely spread in the Breadalbane district, but not common.

Variation.—Moderately variable so far as our specimens are concerned.

Specimens (none numbered)—

MALE.
Schiehallion.

FEMALE AND LEAF SPECIMENS.
Ben Lawers, Ben Heasgarnich, Craig Mhor, and Schiehallion.
Allt Innis Choarach (J. Brebner); Larig-an-Lochan (D. A. Haggart).

34. × SALIX WAHLENBERGII And.
(*S. Myrsinites* × *S. nigricans*).

Number of Specimens.—Four sheets; nine pieces.

Distribution.—Rare, but widely distributed.

Variation.—The range usual in hybrids.

Specimens (none numbered)—

MALE.
Ben Heasgarnich.

FEMALE AND LEAVES.
Craig Mhor; Meall Ghaordie (J. Brebner).

35. × SALIX SAXETANA B.W.
(*S. Myrsinites* × *S. aurita ?*).

Number of Specimens.—Five sheets; fifteen pieces.

Distribution.—A few bushes on Ben Laoigh. (Nos. 460, 461, and 462.)

For particulars see "Revision."

Of × *S. serta* B.W., a hybrid apparently between *S. Myrsinites* and *S. Arbuscula*, which has been found on Ben Lawers, we have as yet no examples.

36. SALIX HERBACEA L.

Number of Specimens.—Eight sheets; sixty-eight pieces.

Distribution.—Common on most of the higher hills of the Highland district, and on one or two of the Ochil Hills.

Variation.—Not exceedingly variable, though both plants and leaves vary in size, and in shape and habit.

Specimens (none numbered)—

Cultivated, from Breadalbane.

[Female catkins terminal, but with a leaf opposite and a bud between; scales suberose or emarginate at the apex, green margined with red, with many (sometimes few or none) marginal apical rather long hairs. Style rather short, thick, entire or deeply cleft, greenish or purplish according to the colour of the ovary. Stigmas linear, deeply bifid spreading, yellowish or tinged externally with purple. Nectary yellow, of the ordinary thickness and texture (Wimmer says of it "*papyraceum*"); variable in shape, sometimes in one piece with two linear segments next the rachis, sometimes more laciniate, sometimes in one piece next the rachis, and in another next the scale, the two united at the base to form a kind of cup. In the latter case the ovary is stalked, in the former it is sessile. Stipules usually absent, occasionally present and entire and concave, or lanceolate and glandular-toothed, veined.]

Ben Lawers, Craig-na-Caillich, Am Binnein, Ben Laoigh, Farragon, Sow of Athole, Ben Vrackie, Ben Ghlo, The Byres, Glen Tilt, and Glen Beg; Ben Dhu Chraigie (E. S. Marshall); Ben Heasgarnich and Glen Lyon (J. Brebner); Glen Lochay (D. A. Haggart).

37. × Salix Margarita B.W.

(S. herbacea × S. aurita).

Number of Specimens.—Three sheets; twelve pieces.

Distribution.—Neighbourhood of Ben Challum, on the north side of Glen Dochart, where it was found by the late Professor Dickson and the late Mr. Sadler, and more recently by Messrs. Groves. Our specimens are derived from plants cultivated in Edinburgh Botanic Garden. The female only has been found.

Nos. 368 and 369. For particulars see the "Revision."

Note.—× *Salix Moorei* "Watson L.C.," a hybrid of *S. herbacea* with probably *S. nigricans*, has been reported from the Sow of Athole, but we have no specimens.

38. × Salix simulatrix B.W.

(S. herbacea × S. arbuscula).

Number of Specimens.—Two sheets; five pieces.

Distribution.—Several places on the Breadalbane Hills, but either rare or overlooked.

Variation.—From the few specimens I have seen, the range of variation appears to be great.

Our specimens are from Corrie Dhubh Ghalair (J. Brebner) and Meall Dhuin Croisg (W. Barclay and R. H. Meldrum). It has also been found on Craig-na-Caillich, &c. For particulars see the "Revision."

39. × Salix sobrina B.W.

(S. herbacea × S. lapponum).

Number of Specimens.—One sheet; one piece.

Distribution.—In Perthshire this has been found on Ben Chat, in Athole, only.

Variation.—Judging from specimens found in Forfarshire, this hybrid is rather variable.

For particulars of this hybrid see the "Revision."

40. Salix reticulata L.

Number of Specimens.—Six sheets; thirty-four pieces.

Distribution.—Not uncommon on the richer hills to the west of Loch Tay, but apparently not elsewhere in Perthshire.

Variation.—Very little.

Specimens—

Male.

Cultivated, from Ben Lawers.

[Catkins terminal, subtended by a leaf with a bud between. Scales concave, pale greenish, often spotted with red near the red-margined apex—the colour most marked on the side of the catkin which is exposed to the light. Scales with hairs on the back, base, and margin, those at the apex long. Filaments rather long, whitish, hairy from the base to near the middle. Unopened anthers red, then (when burst) yellow and black, finally black, small. Nectary composed of several unequal linear dark green segments, which surround the base of the stamens. Young leaves with very small glandular stipules.]

No. 313. Hills near Killin (D. A. Haggart).

[Scales unicolorous, reddish, hairy at the base or throughout. Filaments hairy for half their length. Nectary forming a laciniate torus, segments linear. Young leaves with gland-like stipules.]

Female.

Cultivated, from Ben Lawers.

[Scales greenish at the base, otherwise more or less reddish. Pubescence of the ovary very white. Style very short, apparently cleft at the apex, dark red. Stigmas short, thick, bifid, erect-spreading, externally red, internally paler. Nectary dark green, surrounding the base of the ovary by four linear segments. Scales thick in texture and stiff.]

Note.—Some of the particulars here given, regarding both male and female, differ from the descriptions of some authors, so that apparently there is some variation in these points.

Our other specimens come from Craig-na-Caillich, Ben Lawers, Ben Heasgarnich, and Craig Mhor; Ben Oss (Drummond Hay); Corrie Dhubh Ghalair and Larig-an-Lochan (Haggart).

41. × Salix semireticulata B.W.

(S. reticulata × S. nigricans).

Number of Specimens.—Three sheets; eleven pieces.

Distribution.—Two plants (Nos. 402 and 403) found on Meall Ghaordie by Mr. J. Brebner.

Variation.—Our specimens show a little variation.

For particulars of this hybrid see the "Revision."

NOTE.—A willow found on Ben Lawers by R. Brown in 1793 appears to be another hybrid of *S. reticulata.* I have called it provisionally *S. sejuncta,* and its rediscovery is much to be desired.

42. SALIX PURPUREA L.

Number of Specimens.—Thirty-three sheets; eighty pieces.

Distribution.—Abundant on the banks of the Tay in some places, and occurs also on the banks of other streams.

Variation.—Rather variable in the size and shape of the leaves, and in the size of the catkins.

Specimens—

MALE.

No. 4. Barnhill.
[Leaves not very glaucous below. Shoots more or less purplish brown. f. *Lambertiana.*]

No. 13. Almond above Bridge of Almond.

No. 41. Almond mouth.

Nos. 82 and 190. Woody Island.

No. 208. Almond above Bridge of Almond.
[Bush prostrate, then ascending, about four feet high. Flowering twigs greenish yellow-brown. Young leaves tinged with reddish brown. Leaves sometimes in a whorl of three, not very glaucous below. f. *Lambertiana.*]

Not numbered. Dead Waters of the Earn (R. H. Meldrum)!; Ruthven Burn (W. Martin); Tay side at Glenalbert and Birnam (C. M'Intosh).

FEMALE.

No. 14. Almond above Bridge of Almond.

No. 53. Almond mouth.

Nos. 61 and 80. Woody Island.

No. 130. Woody Island.
[Young shoots yellowish green. Leaves green below. f. *Woolgariana.*]

No. 242. Darry Island.
[Young shoots yellow in autumn. Flowering twigs greenish yellow-brown, red brown on one side and towards the top. Leaves glaucous below. Stigmas bifid, spreading. f. *Woolgariana.*]

Nos. 456 and 457. Moncreiffe Island (R. Dow).

Not numbered. Almond above Bridge and Woody Island. Tay side at Birnam and Glenalbert (C. M'Intosh).

LEAF SPECIMENS.

No. 323. Darry Island.
[Young shoots furrowed, purple. Leaves pale green below. f. *Woolgariana.*]

Not numbered. Tay side at Cairnie Pier, Kinfauns, Woody Island, and Balnaguard. Earn side at Dupplin and Crieff. Glen Dochart and Finlarig Haugh (D. A. Haggart).

43. × Salix rubra Huds.

(*S. purpurea* × *S. viminalis*).

Number of Specimens.—Twenty-one sheets; fifty-eight pieces.

Distribution.—Local, but occurs in several places where the parent species grow commonly together.

Variation.—Our specimens are mostly on the *S. viminalis* side of the hybrid, and these vary somewhat in the amount of pubescence of the leaves. A few specimens are nearer (but not very near) *S. purpurea.*

Specimens—

I.—Nearer *S. viminalis*, but fairly intermediate.

Male.

Nos. 79 and 83. Woody Island.

No. 189. Woody Island.

[Catkins very handsome. Anthers bright orange-red when unopened, then yellow, finally fuscous. Filaments connate at the base or to the middle, and some almost free.]

No. 230. Woody Island.

[Bark and buds yellow. Anthers orange-red, then yellow, finally fuscous brownish black. Filaments glabrous, connate half-way or between that and the top, or altogether. Nectary narrow, oblong.]

No. 331. Earn side at Dupplin.

[Bark glabrous olive green, scarcely shining. Anthers orange, then yellow, finally fuscous. Filaments variously connate.]

Female.

No. 76. Woody Island.

No. 250. Woody Island.

[Twigs shining, clay-coloured. Ovary sessile. Style short, greenish yellow. Stigmas twice as long as the style, linear oblong, entire, erect-spreading, yellow, then brown. Nectary linear, rather long.]

Leaf Specimens.

Not numbered. Earn side near Forgandenny and Dupplin.

II.—Nearer *S. purpurea.*

Male.

No. 204. Woody Island.

[Branches long, erect, slender. Filaments almost or quite glabrous, connate half-way or to near top, often with four unequal branches at the top, sometimes with three, but more usually with two more equal branches. Anthers crimson, then yellow, finally black. Nectary subquadrate, yellowish.]

No. 419. Woody Island.

[Twigs slender, brownish green to brown, at first pubescent, then glabrous and shining. Buds red. Leaves dark green, dull, nearly flat, slightly pubescent above; below paler green, dull, primary veins raised, margin slightly incurved, surface slightly silky pubescent. Catkin structure similar to No. 204.]

FEMALE.

No. 263. Near Cairnie Mill.

[Twigs pale olive green. Ovary sessile. Style distinct. Stigmas linear, a little longer than the style, apparently entire, spreading. Nectary linear, oblong.]

44. × SALIX SORDIDA Kern.

(*S. purpurea* × *S. cinerea*).

Number of Specimens.—Seventy sheets; one hundred and ninety-two pieces.

Distribution.—In a few places on the banks of the Tay, and chiefly in the Woody Island.

Variation.—Very variable. A few of our bushes have a greater resemblance to *S. purpurea* than *S. cinerea*, but the majority are much nearer *S. cinerea*, some of them so near that if they did not form part of a series they would undoubtedly be called *S. cinerea.* In the case of these specimens it is not improbable that the hybrid has crossed with *S. cinerea.*

Specimens—

MALE.

No. 231. Woody Island.

[Anthers pale yellow. Filaments slightly pilose at the very base, nearly free or connate to near the top. Nectary small quadrate.]

No. 437. Sleepless Island.

[Catkins on a short leafy peduncle, centripetal; scales brownish black at apex. Anthers globose, yellow, finally slightly fuscous. Filaments pilose at the base, free or variously connate between base and summit. Nectary quadrate. Twigs greenish brown, glabrous or black-puberulent. Buds large, ovate, red, or yellow tinged with red. Leaves dark green, slightly shining, veins impressed above; below dull, very glaucous, with raised veins, Catkins and young leaves appearing nearly at the same time. Though in 1889 connate filaments were frequent in this plant, in 1890 the filaments appeared to be all free. At the same time, there seems to be no doubt as to the hybridity.]

The following eight plants incline more or less to *S. cinerea*:—

No. 194. Woody Island.

[Filaments pilose at the base, and more or less connate. Nectary quadrate, yellowish green. Leaves shining, veins impressed above; below pale green, veins strongly raised, undulate margins slightly incurved.]

No. 195. Woody Island.

[Filaments pilose at the base and more or less connate there. Nectary quadrate yellowish.]

No. 196. Woody Island.

[Anthers bright yellow. Filaments pilose at the base and mostly connate, often for one-fifth of their length. Nectary small, greenish yellow. Twigs brown, dull, glabrous. Shoots brownish green pubescent. Leaves dark green, slightly shining, subrugose, veins impressed above; below glaucous green, veins raised, margin slightly incurved.]

No. 197. Woody Island.
[Catkins large, ovate-lanceolate, rather acute. Anthers pale yellow. Filaments pilose at the base, nearly free or connate to a little above the base. Nectary quadrate, yellowish green. Branches long and straight.]

No. 198. Woody Island.
[Catkins large. Anthers pale yellow. Filaments more or less connate at the base and pilose there. Nectary quadrate, green.] Very similar to No. 197.

No. 201. Woody Island.
[Anthers yellow. Filaments pilose at the base, more or less connate at the base, sometimes for a little above the base, sometimes quite free. Nectary dark green, quadrate, entire.]

No. 57. Woody Island.

Not numbered. Tay side at Dalmarnock (C. M'Intosh).

The following three belong to a curious form (f. *rubella*), which is possibly a hybrid of *S. rubra* with *S. cinerea*, and requires further study:—

No. 232. Woody Island.
Anthers bright orange-red when unopened, then yellow, finally fuscous brown. Filaments pilose at the base, and not distinctly connate. Nectary dark green, narrow oblong, variable in size. Twigs dull brown. Shoots long and slender, greenish brown to purple, pubescent but finally glabrous. Leaves more or less erect, dark green, shining, veins slightly impressed above; below glaucous, primary veins raised, margin nearly flat. Young leaves reddish brown.] A very beautiful willow.

No. 81 is probably the same bush as No. 232.

No. 180. Woody Island.
[Characters the same as No. 232.]

FEMALE.

No. 126. Woody Island.
[A well-marked form. Twigs greenish brown, dull. Shoots green, slightly shining, slightly pubescent, then glabrous. Leaves dark green, shining, rugose, veins impressed above; below glaucous, veins raised, margin slightly incurved. Petioles often reddish. Catkin characters the same as No. 397 *infra*.]

No. 182. Woody Island.
[Catkins shortly peduncled. Scales pale at the base, above that frequently reddish, apex black. Ovary pedicel about twice as long as the quadrate nectary. Style very short, thick, crimson, then sometimes yellow. Stigmas subsessile, very short, thick, notched, crimson, then yellow. Branches long and slender. Leaves dark green, shining, veins impressed above; below glaucous, veins raised, margin slightly incurved.]

No. 397. Woody Island.
[Catkins nearly erect, rather dense-flowered; scales narrow, oblong, half black, with white hairs. Ovaries suberect, ovate-conic, on a pedicel about two and a half times the length of the nectary. Style very short, red.

Stigmas very short, erect, bifid. Twigs slender, dull greenish brown. Shoots green, finely pubescent. Leaves dark green, slightly shining, subrugose, veins impressed above; below glaucous green, veins raised, margin slightly incurved.] This and Nos. 126 and 182 have much similiarity.

No. 438. Sleepless Island.

[Catkins large, erect-spreading, on a short peduncle with small leaves; scales half brownish black. Ovary white pubescent, on a pedicel three times the length of the quadrate nectary. Style very short, thick, yellow. Stigmas short, bifid, erect, resembling those of *S. purpurea.* Twigs straight, slender, greenish brown, mostly glabrous. Leaves dark green, shining, veins impressed above; below glaucous, veins raised, margin incurved.]

No. 439. Sleepless Island.

[Style of the male plant No. 437 from this locality. Catkins spreading, on a short peduncle with small leaves; scales half black. Ovary with rather shaggy white pubescence, on a pedicel three times the length of the small quadrate nectary. Style almost none. Stigmas short, as broad as long, wide at the base and narrow upwards, emarginate, spreading. Twigs and buds rather like those of No. 437. Leaves dark green, shining, veins impressed above; below dull glaucous, veins strongly raised.]

The following five plants incline to *S. cinerea*:—

No. 191. Woody Island.

[Catkins suberect, sometimes in threes. Ovary pedicel twice as long as the quadrate green nectary. Style none or very short. Stigmas short, notched, crimson, then pale. Twigs greenish brown, slightly pubescent. Shoots brownish green to reddish brown, finely pubescent. Leaves shining, rugose, veins impressed above; below glaucous green, veins raised, undulate margin incurved. Petioles and buds more or less red.]

No. 202. Woody Island.

[Catkius erect. Ovary pedicel twice as long as the quadrate yellowish nectary. Style none. Stigmas short, notched, externally reddish, then pale.]

No. 443. Almond mouth.

[Catkins erect, on a short peduncle; scales rather short, half black, not very pubescent. Ovary pedicel about twice as long as the triangular oblong yellow nectary. Style at first none, then very short. Stigmas short, as broad as long, emarginate, spreading, more or less crimson. Twigs rather straight and stout, brownish green, somewhat brown pubescent. Leaves dark green, rather dull, veins raised above; below glaucous, veins raised. Sometimes three catkins come from one point.]

No. 444. Almond mouth.

[Similar to 443. Leaves slightly shining above.]

No. 445. Almond mouth.

[Characters much the same as those of No. 443. Catkins subsessile or shortly peduncled; older catkins larger and laxer flowered. Ovaries larger. Twigs brown, rather straight, slightly pubescent. Leaves dull, veins impressed above; below glaucous, veins raised.] These three—Nos. 443, 444, and 445—are very near *S. cinerea.*

The following three plants—from the Woody Island—are very doubtful *S. sordida* :—

Nos. 55 and 203.

No. 200.

[Catkins erect. Style very short. Stigmas short, suberect, yellowish. Ovary pedicel three times the length of the short nectary.

A willow, of which several bushes occur on the banks of the Almond, may be × *S. dichroa* Döll *(S. purpurea* × *S. aurita)*, but at present must remain doubtful.

45. × Salix Doniana Sm.
(S. purpurea × *S. repens)*.

Number of Specimens.—One sheet; four pieces.

Distribution.—One or two very small bushes on the banks of the Tummel. It should be looked for wherever the parents grow in proximity, which does not often happen in Perthshire.

For particulars see the "Revision."

CORRIGENDA.

Page 169—*top line*—for No. 333 read 233. Page 169—*bottom line*—del. No. 54.

INDEX TO THE NUMBERED SPECIMENS.

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XXIV.—*On Spiders, with a List of Perthshire Species.*

By Professor JAMES W. H. TRAIL, M.A., M.D., F.L.S.

(Read 18th December, 1890.)

When, in response to a circular from Mr. Ellison, I began to consider on what subject a short paper might be prepared to be read before the Perthshire Society of Natural Science, it occurred to me that Spiders might well form the theme; in part because I did a little among the Spiders of Perthshire some years ago, but chiefly because (so far as Dr. Buchanan White is aware) these creatures have not had their merits recognised by the Society, to the extent, at least, of their species being distinguished and their (often most interesting) habits studied by any resident in the Shire.

It may seem unduly bold to hope that I may succeed in arousing interest in a class of creatures too often regarded as endowed with few save evil qualities, and condemned, accordingly, to death and destruction by the great majority of the human race. It must be confessed that to the housewife spiders do not commend themselves, and that their webs in the corners of rooms or in the windows are undoubtedly matter in the wrong place, and should scarcely be allowed to remain even under the plea of a desire to study their habits and customs. But even in houses the spiders are working for our advantage, and, in providing food for themselves, are preventing insects from becoming annoyances to us. Where cleanliness and tidiness are duly attended to in houses spiders will not prove troublesome. From Scotsmen they have a claim to favour because of the traditional influence of a spider's perseverance on the history of our country when its independence seemed doomed to pass away. But a wider claim to our goodwill can be justly advanced on behalf, not merely of one, but of all our British spiders. No British species can be accused with justice of being hurtful to mankind, directly or indirectly; while all are beneficial in so far as they aid in lessening the myriads of insects that, if unchecked, would soon prove a devastating scourge. None of our native species are so large that their bites injure human beings; and though in warm climates some reach a great size, so that their bite is much dreaded, yet accidents seldom occur from this cause, owing to the timidity of the spiders, which usually causes them to seek refuge in flight. The retired habits of spiders render it difficult to form any conception of their numbers and variety in modes of life and habits, and of the elegance and beauty of colouring possessed by many of the British species. It is only after the search for these creatures has been carried on for some time that the great interest of the pursuit unfolds itself, and that what at first may have appeared a very limited field for investigation is found to reach constantly on into new developments at first unthought of. Those of my readers who are already familiar with the structure of spiders will, I trust, excuse my assumption that all may not be equally familiar with certain organs to which I shall have occasion to refer below, and will permit a brief description of these structures.

Spiders are grouped with Insects, Crabs, and a good many other forms of animals under the Division ARTHROPODA, characterised by possessing a *hard outer skeleton* (usually in the form of complete or partial rings, joined together by soft skin) on the body and jointed limbs. In all the classes into which the *Arthropoda* are divided the mouth is furnished with feet modified to serve as jaws, though the extent to which the feet are employed in this way differs considerably in the various groups. The classses of Arthropoda differ from one another in important points as regards their structure and mode of life. The spiders are grouped along with the mites and scorpions into the Class ARACHNIDA, which is most closely related to the *Myriopoda* and to the *Insecta*, but is very easily distinguished from both. The *Myriopoda* have the head alone distinguished from the body. The latter is made up of many rings or segments, all practically alike, and each provided with a pair of small legs. In the millipedes the rings each seem to bear *two* pairs of legs, two rings being closely united. The thorax cannot be distinguished from the abdomen in them either by its form or by its limbs. The *Insecta* have three well-marked regions,—viz., 1, the *head*, of four closely united segments, bearing the organs of the special senses and the jaws; 2, the *thorax*, composed of three closely united segments, each of which bears a pair of true legs for walking, while the two hinder segments usually bear wings or their representatives; and 3, the *abdomen*, of ten segments, bearing the organs of reproduction, but usually without a trace of limbs for locomotion. As regards the sense-organs the *Insecta* possess one pair of true antennæ, and very generally have two compound and three simple eyes. They all breathe by taking in air through a series of openings, called spiracles, into tubes (tracheæ) branching all through the body and limbs, the tube being prevented from collapsing by a spiral fibre rolled up closely in the inner layers of its wall. Thus the air is brought in all parts to the blood, instead of the blood to special organs. Insects pass through a more or less well marked metamorphosis. Turning now to the ARACHNIDA, we find them characterised by possessing (as in *Insecta*) only a limited number of segments, which are divided, however, into only *two* well-defined regions. This is due to the head and thorax being so closely united as to form one mass, which bears the jaws, the sense-organs, and *four* pairs of legs for locomotion. The abdomen resembles that of the Insecta in the absence of limbs. There are no antennæ, their work as organs of touch being discharged by palpi, attached to the jaws. The eyes are never compound. Aëration of the blood is effected in the lower forms through the skin; in the higher by tracheæ, aided by a special lung-sac, in which are thin plates into which the blood flows to be purified. Among some of the mites there is a metamorphosis; but in the higher groups of ARACHNIDA the young, on emerging from the egg, differ from the adults little, if at all, in form.

The true spiders (ARANEINA) are readily distinguished from the other orders of *Arachnida* by the abdomen being joined to the cephalothorax by a slender pedicel, instead of by its full breadth, as in the mites and scorpions. In the latter group the segments of the abdomen are very evident, while in spiders and mites they are so completely fused together as to be indistinguishable from one another. The spiders and the true scorpions alike breathe chiefly by their lung-sacs. In structure the spiders show remarkably little diversity among themselves,—far less than is met with commonly in any order of Insecta; and their food, also, is little varied, all subsisting upon living animals of small size. But in size spiders vary considerably, from the giants of the order, the *Mygales*, some of which reach 10 inches in length of span of the legs, and $2\frac{1}{2}$ inches of body, down to the almost microscopic gossamer-spiders, many of which are too small to be clearly seen without the help of a good lens. In all the general aspect is very uniform. The mandibles (chief jaws) are perforated by a tube for the conveyance of poison from the poison-gland into the wound made by the mandibles in biting. The simple eyes are arranged on the front of the cephalothorax. The abdomen is furnished with three pairs of spinnerets, from which the silk, on which their safety and wellbeing so often depends, is exuded as a fluid that, when exposed to the air, hardens almost instantly into the well-known threads. The more important points to be borne in mind in the systematic study of spiders, with a view to determining the species, are comparatively few. Among the most important distinctive characters of the genera are those derived from the number (usually eight, but in some fewer) and arrangement of the simple eyes on the anterior part of the cephalothorax. The modes of life, in some active, in others sedentary, are correlated with important structural characters, such as to permit of the one being inferred from the other. For example, the general form of the body and the development of the limbs and of the spinnerets will often reveal to the expert the habits of a species. These all afford important characters, as do also the webs of the snare-making species.

The specific characters depend greatly upon colour and markings in most cases, but in certain genera *(e.g. Walckenaëra)* the colouring is very sombre and uniform, so that it is exceedingly difficult to distinguish the species by this. Reliance in such genera must be placed on the very much more reliable characters of differences in form of the body, in the eyes, and, above all, in the males, on the structure of the last joint of the palpi, which is, in them, peculiarly modified to be employed in the union of the sexes, and is usually highly characteristic of each species.

As regards their mode of capturing prey spiders may be divided into (1) those that weave snares, more or less elaborate in form and construction; and (2) those that do not make a snare, but either hunt their prey by speed of foot, or lurk in some crevice or other convenient retreat until an insect comes sufficiently near to be seized by a leap.

The old genus *Lycosa*, now broken up into numerous genera for convenience, includes the best examples of the "hunting spiders."

Several of the species are very common; and one can scarcely watch a square foot of moorland or of waste ground on a bright summer day for even a minute without seeing one or more brown spiders, from $\frac{1}{4}$ to $\frac{1}{2}$ inch in length of body, running actively among the herbage. Many of the larger examples carry under the hinder extremity of the body a doubly convex bag of brown or white silk. This is the egg-cocoon, carried by the female, and protected by her with the utmost devotion, even at the risk of destruction to herself. Yet it has been found that when the cocoon was taken from a female, and the eggs replaced in it by anything of about equal weight, on placing the cocoon beside her it was seized eagerly and carried off without recognition of the change in its contents. Not unfrequently one observes that the spider seems larger than usual, and looks as if covered with a rather hazy outer coat. On capturing the spider this coat seems to melt away, and inspection proves that it consists of numerous minute spiders, carried chiefly on the female's back. These are the young, which, so soon as they crawl out between the sides of the egg-cocoon, climb on to their mother's back, and continue under her protection for a time.

Certain of the hunting spiders, now grouped chiefly in the restricted genus *Pirata*, frequent marshy spots; and it is a very common occurrence to see them run as easily over water as among the herbage, but they do not seem to descend below the surface.

Another of the group, *Trochosa picta*, differs much from its relatives in forming a silk-lined tube in the sand. In this it lives, making only short excursions over the sand close to its burrows.

The Leaping Spiders *(Salticides)* are more showy in colours than the *Lycosides*, but are less common. They surprise their prey by leaping on it; and they usually protect themselves from falling by fixing a silk thread at the point from which the leap is made, while the other end of it is attached to the spider's spinnerets. They conceal their white egg-bags in crevices of or between stones.

The Crab Spiders (*Thomisides*) are usually marked out by their rather broad form and their peculiar movements, sideward or retrograde, as well as forward. They usually lurk in crevices, but some have the habit of lying in wait for flies in the centre of flowers, which they often imitate in colour. Some of them make web-floats, by means of which they can be carried through the air.

The *Drassides* include, for the most part, rather large but dull-coloured species, which live between two leaves spun together or in variously formed silken tubes, in which usually the females place the egg-bags. A very curious modification of habit is met with in *Argyroneta aquatica*, the "Water Spider" *par excellence*, which is probably not uncommon in Scotland, though as yet recorded from few Scotch localities. This species is readily overlooked, as it makes its abode among the weeds under water. It spins a kind of diving-bell, to fill which it carries down air attached to its body, releasing the air when it enters its home, and returning to the surface for more and yet more till it has procured enough. This spider is an interesting inmate of an aquarium, and is not difficult to keep in health there.

Two other small families, characterised by having *six* instead of eight eyes, also make little use of a snare in catching prey, for which they hunt in the vicinity of their silken tubes, made in crevices of or among stones.

But all the other families of British spiders possessed of *eight* eyes may be said to use more or less elaborate snares. Of these some (*e.g.*, *Theridion*) make rough structures, often among herbage. Others make very strong dense webs—*e.g.*, certain house-spiders; and others spin webs beautifully perfect in form and regularity.

Few objects could be more lovely than the dewspangled web of many of the *Epeirides*, a group which embraces some of the largest of the spiders found in Britain, as well as of the most showy in colour and markings.

The smaller species that belong to the *Theridiides* (*Neriene* and *Walckenaëra*) are among the chief makers of the *gossamer* that is so noticeable a feature on almost every fine day in autumn; and that at times becomes a pest to the sportsman among stubble or turnips by blinding his dogs. The tiny makers of the silken threads or masses swarm everywhere, and objects that might seem beyond their reach are as thickly peopled as the herbage. Every one must have experienced the annoyance of feeling them crawling over the face and hands; and many doubtless have observed the little creatures sailing through the air, each on its silken float, or shooting off from any suitable vantage-point on a new aerial voyage.

All female spiders make careful provision for the safety of their eggs, which are usually enclosed in a bag or cocoon of characteristic appearance and form. This may be carried about by the mother, or be concealed in some crevice, or placed in a rolled-up leaf, or kept in the retreat on or near the web in which the female spider herself lives. Frequently the mother guards her brood for some time after they emerge from the egg-bag.

But while the female is thus tender to her young ones, she is credited with very different conduct towards the male, at least in some species, in which the difference in size and strength is much in her favour. In these species the male is most cautious during his advances to guard himself from being seized by the female till she shows a favourable response. He may well be prudent, as the penalty of being seized has been observed to be death at the jaws of his charmer, who scruples not to suck the life-blood of the too rash admirer.

We have not in Scotland any of the Trap-door Spiders, such as Moggridge describes so well in his "Harvesting Ants and Trap-door Spiders," from his personal observations near Mentone. But though we cannot study this curious and interesting group in Scotland, there is ample room for much interest in observing the ways of our native species; and much remains to be done, and may be done successfully anywhere, by any person able and disposed to give time to the careful observation and record of the habits and acuteness (or the reverse) of the senses and of the faculties of even the most common species. The nature and mode of capture of their prey, their adaptation to their environment, their means of defence, both active and passive, their length of life, and many other questions, can scarcely be described as sufficiently answered with regard to any but a few species. Among the most interesting of the works that treat of such problems the Rev. H. M'Cook's works are entitled to a high rank; but unfortunately for us they relate only to the spiders of the United States of America. Despite this fact they will richly repay careful study.

Another valuable series of recent observations on the habits of American spiders has appeared in the "Occasional Papers of the Natural History of Milwaukee." They are memoirs by Mr. and Mrs. Peckham on the mental powers, protective mimicry, sexual selection, and similar problems regarding these animals. In "Nature" recently various notes of interest will be found that treat of the mental powers of spiders and their mode of recognising their prey. The conclusion come to in respect to their mental faculties is not very favourable, being that they are easily deceived, and that every sense save that of touch is dull.

All our native spiders may be described as unsocial, and popular tradition represents the spiders as cruel and treacherous, but of this there is as little real ground to accuse them as there appears to be to attribute to them great cunning. They kill their prey, and, if driven to it by hunger, they will eat each other; but the same accusations may be made with truth against man himself.

But if we turn to equatorial America, we find that social habits are met with even among spiders, perhaps from the greater plenty of insect food. I have seen not only large webs spun in common and occupied by numerous spiders, but seen small spiders of another species permitted to live on the web, and to pick up the small insects that seemed to be beneath the notice of their hosts. Indeed this to us apparently strange partnership is even extended to certain hemipterous insects, which I have observed living on the webs in harmony with the spiders, and are of service to the latter apparently by acting as scavengers in clearing the webs of debris.

While referring to the spiders of Brazil, I may mention that, besides the giants already referred to, others are scarce less noteworthy owing to the very strange spines and protuberances that project from the abdomen, their bright colours, and the hardness of their skin. But extraordinary and conspicuous as they appear when removed from their natural environments, these odd-looking spiders are often rendered less conspicuous even by the oddness of their appearance when looked for where they live.

I had also the opportunity of observing some remarkable cases of mimicry, both passive by resembling inanimate objects, and active in the case of species that mimicked certain insects. Among the more striking of the latter were species that mimicked ants so closely in form and habits that it required a close inspection to detect the difference. In these spiders the front pair of legs were held and moved like the antennæ of the ants, while the other three pairs of legs alone were used for locomotion.

Very little need be said of the direct uses of spiders to mankind. A few peculiar people have developed a taste for them as food; but fortunately the taste has not become general. They have been made use of as medicine, as has also been the web, for internal use; but they do not now appear in the list of fashionable remedies. The webs, however, possess undoubted styptic properties, checking the loss of blood from wounds.

The threads are employed in certain optical instruments, for which purpose their fineness renders them suitable. Efforts have more than once been made to employ the silk in the manufacture of cloth; but though the silk of some species can be woven into cloth, the difficulties of procuring it in such amount as to repay the labour, owing to the spiders' food and habits, have proved insurmountable.

Turning now for a little to the methods of *collection* and of *preservation*, it may be of service to any one thinking of pursuing the study in Perthshire to have a few hints given as to the methods most likely to be useful in practice.

Collection.—The requirements for a successful hunt are not many. Pill-boxes (especially glass-topped) are the most convenient for systematic observations of the habits of spiders, as one can enclose with the spider the snare and egg-bag, where these can be procured and are capable of being preserved, while the spider escapes injury from being knocked against others, and can be properly set out and preserved at home. Moreover, notes on the habits can be entered in a notebook in the field, referring to the spider by a number which is written on the box and in the book. Glass tubes may be used instead of boxes, but are more liable to break and are less easily carried.

It is also convenient to be provided with one or two phials (two drachm size is about the most convenient), nearly or quite filled with spirits of wine, or other moderately strong spirit. Such phials are especially convenient when space is limited, as the captures from any special locality can be placed in a phial; and this, when furnished with a gummed label bearing place and date of capture, may be put aside for careful examination at a more convenient season. In this way a very considerable collection may be stored in small bulk and usually in condition to permit of the determination of the species in it.

The disadvantages in the use of phials as store-bottles are considerable, however. The specimens are much more liable to injury in them than when isolated alive in boxes; especially if the bottle is not quite full of spirit. It is, besides, much less easy to prepare the specimens satisfactorily for permanent preservation after they have been in spirit long enough for all parts to become rigid.

In lifting the spiders we may do so by means of slender forceps, or by a wetted finger-tip; but even the most careful handling is apt to injure many species considerably. There is thus another advantage in using the pill-box, since the spider can usually be boxed without actually touching it.

Localities most likely to be productive in spiders vary according to the group or family, so that, to be able to judge of the probable results of work in any given locality, it is necessary to be familiar with the habits and favourite haunts of the various families. For example, the *Lycosides* prefer waste ground and swamps, on which they run actively about, except *Trochosa picta*, which makes its silk-lined burrows among loose sand on the seashore, and sometimes beside rivers, as at Stanley.

Many species may be found on palings, wall-tops, or other heights, running actively from place to place, or waiting to leap on their prey when it approaches them. Among the families more often to be found in such situations are the Gossamer-spiders and the *Salticides*.

The webs of the Orb-weavers (*Epeirides*) are conspicuous objects in autumn, especially when studded with dew in the morning; and a little care in tracing the threads by which the spider keeps in touch with its snare will soon disclose its retreat, however carefully that may be concealed in some adjoining crevice. Other species, also, are most readily detected by their webs,—less carefully made, but scarcely less conspicuous than those of the *Epeirides*,—or by the retreat formed to protect the eggs, either of silken threads alone or of leaves spun together with more or less care.

But while many spiders can thus be readily discovered by even the most careless observer, the majority of the species require to be sought for. A good many conceal themselves under stones (*Textrix denticulata*, *Amaurobius fenestralis*, *Segestria senoculata*, &c.) To obtain these, and others of like habits, loose stones should be turned over, especially on the tops of old earthen walls, and among natural debris on cliffs.

The true Water-spider (*Argyroneta aquatica*) must be sought for in pools, among pond weeds, *Myriophyllum*, and similar herbage. Owing to its peculiar habits it may readily escape detection, even where not uncommon.

Some species, especially the *Thomisides*, have the habit of lurking in flowers in wait for insect visitors, their tints and markings facilitating concealment in the flowers. Others lie stretched out on stems or branches of herbs and bushes, and in such positions are not easily detected. For all spiders with such habits the most successful method is to shake the bushes and herbage over a waterproof, or over a large umbrella. A piece of strong brown paper will be found not a bad substitute in the absence of a waterproof or umbrella. When the herbage is too short for this method it may be swept with an insect net; but of course the soft-bodied spiders are liable to be injured in the net.

Bundles or small heaps of cut herbage—weeds, rushes, &c.—especially if they have lain undisturbed for some time, are often tenanted by numerous spiders, and I have taken more than twenty species by shaking a single bundle carefully over a waterproof. This method proves most successful in autumn, less so at other seasons, as the plants in the bundles become less attractive retreats when sodden with moisture and decaying.

Preservation.—It is of course desirable to preserve permanently the results of time and labour spent in collecting spiders. The difficulties are greater than with insects, but they are by no means insurmountable, and care expended in the method described below is well repaid by the formation of a collection retaining form and colours—all the specimens in which are readily accessible should any one of them require to be minutely examined at any time.

The specimens to be permanently mounted should be carefully selected, to show the adults of both sexes, a series of the variations in colour and markings that exist in the adults, and also a series to exhibit the development from the egg to full maturity. All spiders should be preserved in fluid, as their bodies are too soft to permit of being dried with success by any method that has yet been attempted, except in the case of a few of the hard-bodied tropical species, and of the larger species, in which the abdomen can be eviscerated, and stuffed or inflated with air and dried. The smallest species may be treated as microscopic preparations and mounted, without pressure, in Canada balsam ; and preparations of the most important organs (*e.g.*, the eyes, feet, and spinnerets) of the larger species mounted in the same method form valuable adjuncts to the general collection. But the fluid that has been found most generally useful is spirits of wine, usually diluted with about an equal bulk of water. In this the form, markings, and colours are usually well preserved so long as the spirit is prevented from evaporating, or replaced as it evaporates. The most convenient mode of keeping the spiders is in tubes—in each of which there should be only a single species—though as many examples may be placed in the tube as can be properly displayed in it.

In the case of the larger species, in which the characters can be readily distinguished without minute examination, the tubes may be closed with advantage, either with a cork covered with a cement that will resist the action of spirits, or, still more effectually, by hermetically closing the tube. This latter operation is not a very difficult one after a little practice ; and of course, when properly done, preserves the specimens almost indefinitely so long as the tube is unbroken. But it is desirable to be able readily to remove unique or small specimens from the tube for more close inspection sometimes, and this precludes the closure of the tube in either of the above methods. The Rev. O. P. Cambridge—the leading authority on spiders in Britain—recommends putting the specimens into tubes along with a piece of paper on which the name is written in pencil. The tube is then filled with the preservative fluid ; the mouth is closed with a plug of cotton, and the tubes are inverted and placed side by side in a glass jar or bottle, such as those used in shops for holding sweets. Some fluid is kept in the bottle, and so long as this is prevented from drying up the fluid remains in the tubes. In this way access is easily obtained to any individual specimen. Still another detail in the formation of a successful collection remains to be mentioned, and deserves special attention on account of its influence on the beauty and value of the collection. One early discovers that spiders dropped into spirit tend to become rigid and brittle, and that the legs are drawn inwards, and often become entangled in such a way as to spoil the whole value of the specimen. Nor can subsequent efforts remedy this if the spiders are allowed to lie in the tube unfixed to any support. It is indeed prevented if the spiders are killed in an ordinary "killing bottle" by the fumes of Potassic Cyanide, and then set out on cork before being put into spirit to harden. After this treatment the limbs will remain outstretched, but they are liable to be broken off when so spread if the specimens remain unfixed, as they become rigid and brittle.

The difficulty is overcome by the use of thin plates of solid paraffin, which are easily prepared by pouring melted paraffin on a perfectly level smooth surface slightly heated and allowed to cool. The sheets of paraffin must be of such thickness as to afford the necessary strength to avoid breaking in the tube; they must therefore be thicker in the larger tubes. They are very easily cut to any desired width and length, so as to fit any size of tube. They are not affected injuriously by spirits, and they make excellent supports for the spiders. To get the best results it is best to kill and set the specimens as described above before fixing them on the plate; but newly killed spiders may be set out and fixed on the paraffin before putting them at all into spirit. The method of fixing them on the paraffin is very simple. The number that the tube will hold without crowding is ascertained, and their places are marked on the slip of paraffin by dots. A spider with the limbs duly placed, whether before or after immersion in spirit, is laid on the dot marked for it. A needle is heated; one of the feet is lifted up a little way with a cool needle, and the hot needle is pushed into the paraffin where it is desired that the foot shall be placed. While the paraffin is still soft the foot is pushed into it just far enough to allow of the paraffin holding it firmly when cold and solid. The process is repeated with each of the other feet, and the specimen is then permanently secured from displacement and injury. The other specimens are affixed to the slip in same manner, and it is then stored with them on it in spirit in a tube, which may be closed by any of the methods already described. An incidental, but considerable, advantage in the use of paraffin is that the specimens can be arranged on the slip in the order best suited to show development, variation, or other points of special interest. A disadvantage, of course, is that the structure of the claws is concealed, but one or more specimens may be fixed on their backs. The webs may be shown between pieces of glass, and the tents for the protection of the spiders and eggs, and also the egg cocoons, should form a dry collection in boxes placed beside the tubes containing the spider.

Works of Reference.—In the study of British spiders the works of two men stand prominently forward. John Blackwall, F.L.S., by his "History of the Spiders of Great Britain and Ireland," published by the Ray Society (Vol. I. in 1859, and Vol. II. in 1862), placed a reliable guide in the hands of students of the group in our Islands; and by the descriptions and the excellent figures of each species facilitated very greatly the task of identifying the species, especially among the more difficult groups.

But since the completion of Blackwall's work many forms have been discovered in Britain, and much progress has been made in working out the synonymy of European spiders by Thorell and others. For bringing within the reach of British students the information contained in the works of the Continental and American experts in its application to British spiders, as well as for much original work in Arachnology, thanks are due to the Rev. O. Pickard Cambridge, F.L.S. In the "Transactions of the Linnean Society," and in other scientific journals, are various papers upon the spiders of Britain, based on collections forwarded to him from all parts of the country.

The most important work by Mr. Cambridge is "The Spiders of Dorsetshire." In this are described all the spiders known to the author as British, those not found in Dorsetshire being included in an Appendix.

Another work, though less original, deserves mention as having done good service in bringing the results of Mr. Blackwall's work within reach of some to whom the more expensive book was inaccessible. This work is E. F. Staveley's "British Spiders," which is, in fact, a condensation of Blackwall's "History" in its descriptive part, with excellent figures of selected species. The nomenclature in it is that used by Blackwall.

In the subjoined list are enumerated all the spiders known to me as identified from the basin of the Tay and its tributaries. Those not yet found within the limits of Perthshire are placed within brackets, and the localities in Perthshire from which I have obtained each species are given after the name. Some of the species noted from Dunkeld were forwarded to me by Dr. Buchanan White; others were captured there by myself. The list must be regarded as a mere commencement of the subject. The number of species recorded in it does not reach one-sixth of that for Great Britain—a proportion which a resident in Perthshire could very soon alter greatly. The mountains of Perthshire should add largely to the number.

LIST OF SPIDERS OF TAY.

Fam. *Dysderides.*

Oonops pulcher, Templeton .... Dunkeld.
Harpactes Hombergii, Scop. .... Dunkeld.
Segestria senoculata, Linn .... Common.

Fam. *Drassides.*

Micaria pulicaria, Sund .... Dunkeld.
Clubiona compta, C. Koch .... Dunkeld; scarce.
C. pallens, C. Koch (= *C. diversa*, Cambr.) .... Dunkeld.
Cheiracanthium carnifex, C. Koch .... Dunkeld; scarce.
Anyphæna accentuata, Walck .... Dunkeld; scarce.

Fam. *Dictynides.*

Dictyna arundinacea, Linn (= *Ergatis benigna*, Bl.) Among heather, &c.; common.

Fam. *Agelenides.*

Amaurobius fenestralis, Ström. (= *Ciniflo atrox*, Bl.) Among stones; common.
Tegenaria Derhamii, Scop. (= *T. civilis*, Bl.) .... In houses; common.
Textrix denticulata, Oliv. (= *T. lycosina*, Bl.) .... Among stones; common.
Cryphœca sylvicola, C. Koch .... Dunkeld; (Lintrathen).
Hahnia montana, Bl .... Dunkeld.

Fam. *Theridiides.*

Theridion Sisyphium, Clerck (= *Th. nervosum*, Bl.) Common among heather, &c.
Th. denticulatum, Walck .... Dunkeld.
Th. varians, Hahn .... Beside the Loch of the Lows.
Th. pallens, Bl .... Dunkeld.
Th. pictum .... Dunkeld.

Phyllonethis lineata, Clerck............................Very common in twisted leaves.
Neriene atra, Bl..Stanley.
N. promiscua, Cambr.....................................Dunkeld.
N. pascalis, Cambr.......................................Dunkeld; scarce.
N. rubens, Bl...Common.
(N. livida, Bl...Lintrathen).
N. fuscipalpis, C. Koch.................................Dunkeld.
Walckenaëra cristata, Bl.................... ....Dunkeld.
W. scabricula, Westr....................................Dunkeld.
W. Beckii, Cambr.................... ....Dunkeld.
W. nemoralis, Bl..Dunkeld.
W. frontata, Bl..Dunkeld.
Pachygnatha Clerckii, Sund...........................Dunkeld.
P. Degeerii, Sund..Common.
Linyphia thoracica, Reuss-Wid. (= *L. cauta*, Bl.)..Dunkeld.
L. minuta, Bl...Dunkeld.
L. tenebricola, Reuss-Wid. (= *L. tenuis*, Bl.).......Dunkeld.
L. variegata, Clerck (= *Neriene variegata*, Bl.).......Dunkeld.
L. lepida, Cambr...Dunkeld.
(L. alacris, Bl..Lintrathen).
L. bicolor, Bl. (= *Neriene bicolor*, Bl.)..............Dunkeld.
L. insignis, Bl..Dunkeld.
L. bucculenta, Clerck (= *Neriene trilineata*, Bl.)...Stanley.
L. triangularis, Clerck (= *L. montana*, Bl.).........Abundant.
L. pusilla, Sund. (= *L. fuliginea*, Bl.)...............Dunkeld.
L. hortensis, Sund. (= *L. pratensis*, Bl.)............Dunkeld.
(L. socialis, Bl...Lintrathen).
Ero thoracica, Reuss-Wid. (= *Theridion variegatum*, Bl.)..Dunkeld.

Fam. *Epeirides.*

Meta segmentata, Clerck (= *Epeira inclinata*, Bl.)Very common and variable.
M. Merianae, Scop. (= *E. antriada*, Bl.)...........Common in holes and below banks.
Tetragnatha extensa, Linn...............................Common among herbage.
Singa pygmæa, Sund. (= *E. anthracina*, Bl.).......Dunkeld; scarce.
Zilla atrica, C. Koch (= *E. calophylla*, Bl.).........Abundant.
Epeira cucurbitina, Clerck..............................Dunkeld.
E. diademata, Clerck......................................Abundant.
E. scalaris, Walck..Dunkeld; scarce.
E. cornuta, Clerck (= *E. apoclisa*, Bl.)..............Abundant.

E. quadrata, Clerck..Abundant.
E. umbratica, Clerck..Dunkeld; rare.

Fam. *Thomisides.*

Xysticus cristatus, Clerck.......................................Abundant everywhere.
X. lanio, C. Koch...Dunkeld.
X. trux, Bl...Dunkeld.
Philodromus, cespiticollis, Walck............................Dunkeld.
P. elegans, Bl..Dunkeld; (Lintrathen.)

Fam. *Lycosides.*

Ocyale mirablis, Clerck...Blairgowrie.
Trochosa cinerea, Fabr. (= *L. allodroma*, Bl.)......Dunkeld & Stanley.
T. picta, Hahn..Common in burrows amid loose sand; Stanley.
T. ruricola, De Geer (= *L. campestris*, Bl.)..........Perth.
T. terricola, Thor. (= *L. agretyca*, Bl.)..............Dunkeld.
Lycosa monticola, Clerck...Dunkeld; (Lintrathen).
Tarentula andrenivora, Walck.................................Perth.

Fam. *Salticides.*

Epiblemum scenicum, Clerck...................................Dunkeld.
Heliophanus cupreus, Walck....................................Dunkeld.
Altus falcatus, Clerck (= *Salticus coronatus*, Bl.)...Dunkeld; common.

XXV.—*The Rocks of Highland Perthshire; their Origin, Plication, and Denudation.*

By H. Coates and P. Macnair.

(Read 8th January, 1891.)

The rocks of the Highlands of Perthshire are metamorphic—that is, they were, in the majority of instances at least, originally laid down as sedimentary deposits, but have subsequently been altered, probably by the heat generated in the plication and disturbance of the originally horizontal strata.

The metamorphic rocks of Perthshire show many different stages in the process of alteration. In some of the siliceous members, the rounded granules of quartz are still recognisable, though often transfused into a siliceous cement or matrix. Some of the grits and conglomerates bear still more conclusive evidence as to their clastic origin. The greatest amount of alteration is seen in the schists.

Beginning with the least altered members of the series, the grits and conglomerates are well developed along the southern boundary of the Highlands, where they lie immediately above the clay slates, which, in turn, abut against the lower members of the old red sandstone system. This band of conglomerates and grits, mingled with greywacke and quartzite, may be traced from the shores of Loch Katrine eastwards by Loch Earn. Another band of similar rocks runs parallel with this one, but farther to the north, through Glen Lochy, Tyndrum, Glen Lyon, Glen Tilt, and Ben-y-Gloe. Schiehallion also forms part of this band. Patches of similar arenaceous rocks also occur amongst some of the higher peaks of the Breadalbane hills.

Below the arenaceous rocks just described occurs a well-marked horizon of argillaceous rocks, consisting chiefly of Phyllites and clay slates. These run in a band across the entire country from Stonehaven to Bute and Arran, and they represent the lowest members of the altered rocks of the Highlands found in Perthshire. They are easily traced, owing to their distinct lithological features. They are particularly well seen in the neighbourhood of Dunkeld, where they are worked for roofing slates. They are also well seen at the Loch of the Lowes, near the Bridge of Cally, at Craiglea (north of Crieff), Comrie, Callander, and, indeed, all along the southern margin of the Highlands.

We come next to the foliated series of the metamorphic rocks, comprising the different varieties of schist, such as talc-schist, hydromica schist, calcareous mica-schist, quartz-schist, &c., and also gneiss. These differ in the proportions in which the mica and quartz, &c., are present, but they have all a more or less foliated structure. A pretty complete series of specimens will be found in the Museum, where the peculiarities of each may be studied. As regards geographical distribution, these rocks occupy the area lying between the two bands of arenaceous rocks already described. This area includes such great mountain masses as Ben-Lawers, Craig-na-Challeich, and Ben-More. Mica-schists are also well developed along the shores of Loch Tay, and in the valley of the Tay from where it leaves the loch to where it is joined by the Tummel.

The only metamorphic Rocks of Highland Perthshire remaining to be mentioned are the comparatively small group of the crystalline limestones. These are chiefly developed along the central division of the district, outcropping in the valley of the Dochart, along the shores of Loch Tay, and in the upper Tay valley. They also come to the surface in Glen Lyon.

The igneous or eruptive rocks of Highland Perthshire consist of bosses and sheets of granite, quartz-felsite, quartz-porphyry, and other allied rocks. Granite is not very common, occurring in detached masses on the Moor of Rannoch and near Ben-Chonzie. These igneous rocks have been intruded into the sedimentary rocks subsequent to their metamorphism, as is proved by the latter being still further altered at their junctions with the former.

We have next to enquire as to the origin of the metamorphic rocks of the Highlands. They all point more or less strongly to an aqueous origin. The quartzites, grits, and greywacke have evidently been at one time sandstones, varying in the comparative coarseness of their particles, while the conglomerates have been laid down as deposits of gravel.

Commencing with the lowest member of the series, the clay slates along the southern boundary of the area seem to indicate a period during which only this margin of land was submerged, but with a gradually subsiding movement. Next, the arenaceous bands (*i.e.* the quartzites, grits, conglomerate, &c.) point to more distinctly marine conditions, with deeper water, but still in the vicinity of dry land. Next come the mica-schists, with bands of calcareous mica-schist and pure limestone. These were doubtless laid down in still deeper water, when the land had sunk to a lower level, and oceanic conditions prevailed, suitable for the deposition of fine micaceous and calcareous mud and the accumulation of calcareous organic remains. Lastly, the land began to rise again, resulting in a shallower sea, in which arenaceous deposits were again laid down. The sequence, placing the lowest or oldest rocks at the bottom of the table, is as follows :—

6. Quartzites, grits, greywacke, and other arenaceous rocks.
5. Mica-schists and quartz-schists.
4. Calcareous mica-schist and pure limestone.
3. Mica-schist and quartz-schist in varying proportions.
2. Quartzite, grit, greywacke, and conglomerate.
1. Clay slates, phyllites, and other argillaceous rocks.

The most casual examination of the metamorphic rocks we have been examining will serve to show that they do not now occupy the horizontal position in which they were laid down. Along the southern boundary of the area they dip towards the north-west, generally at a moderate angle. This dip, which may be traced across the whole country, indicates the southern limit of a great synclinal trough. In Perthshire it is best seen at Blairgowrie, Dunkeld, Comrie, Crieff, and Callander. Passing northward, towards the centre of the district, the dip gradually changes to south-east, indicating that we have reached the northern limit of the trough. This is well seen in such transverse valleys as Glen Ogle, Glen Lednock, &c. Passing still further northward, we come upon the great anticlinal axis, or upward curving of the rocks. This axis may be said to coincide roughly with the trend of the Dochart valley, the basin of Loch Tay, and the upper valley of the Tay as far as Ballinluig. Going still further northward, we come upon a succession of synclines and anticlines, one after the other, until we reach the extreme north-west of the county.

We thus see that these synclinal and anticlinal axes run, in general, from north-east to south-west. The rocks have doubtless been folded into these curves owing to the shrinkage of the earth's crust in the gradual process of cooling. This crumpling has, of course, taken place subsequent to the formation of the rocks as sedimentary deposits.

When the structure of the Highland rocks is compared with the structure of the rocks in such a typical mountain chain as the Appalachians in North America, it becomes evident that the former must form the foundation of what was once a true mountain chain also—that is, a mountain chain having its origin in the crumpling of the earth's crust. The features which specially indicate this are the greater intensity of the folding towards the centre of the mass and the greater horizontality towards its outer boundaries. In the core of a true mountain chain the strata are sometimes so crowded together that they become ruptured, and get thrust over the top of each other, in an inverted position, for long distances. The investigations of the Geological Survey have shown that precisely similar conditions are displayed by the rocks of the Highlands of Scotland. This is particularly the case in the north-west of Sutherlandshire, where the plication reaches its greatest intensity, and where the strata have been fractured, inverted, and thrust over each other for a distance of eight miles. This, therefore, would appear to represent the core of the original mountain chain. Passing from that point towards the south-east, the foldings become gradually less intense until we reach the comparatively gentle curves of the synclines and anticlines already described as characteristic of the rocks of Highland Perthshire. These, therefore, appear to mark the flank of the mountain chain.

The plication of the rocks has had a direct influence on the configuration of the country in determining the trend of the valleys. It has also had an indirect influence in determining the direction of the principal fault systems. Some of these faults have remained lines of weakness from Silurian times down to the present day, as, for example, at Comrie, on the line of the great fault which runs right across the country, at the junction of the Highland rocks with those of the midland valley. The earthquakes which still frequently occur in that district seem to be the outcome of the same weakness in the crust which caused the original fracture and faulting.

Numerous other faults are to be found in the Highlands of Perthshire. One runs through the valley of Loch Tay, while another stretches from Tyndrum eastwards towards Ben-y-Gloe, in a direction parallel to Glen Lyon. All these faults, generally speaking, run parallel with each other and with the axes of the synclines and anticlines, thus indicating the unity of the forces which have been at work in disturbing the strata. The same forces have also been the cause of the alteration of the rocks from sandstones, shales, &c., into quartzites, clay slates, schists, &c. Recent investigations have proved that the enormous pressure to which a rock-mass is subjected in the process of plication has the power of entirely re-arranging its component particles, and of producing partial or complete crystallisation.

We have said that the rocks of Highland Perthshire were once the foundation of a great mountain chain. If that is the case, it may be asked, what has become of the superstructure? The answer, of course, is that it has all been removed by denudation. The fact of this enormous amount of denudation is, of itself, evidence of the great antiquity of these rocks. Indeed, it has been laid down as an axiom that all large mountains are of comparatively recent origin.

The question next arises—When and in what manner has this denudation taken place? It is probable that it began contemporaneously with the plication of the rocks, as the fractures then produced would expose surfaces particularly liable to abrasion. It is probable, also, that both the sea and the sub-aerial forces have, at different times, had their share in the work of levelling down this great mass. Sir Archibald Geikie points out, in his "Scenery and Geology of Scotland," that the comparatively uniform height to which the hills of the Scottish Highlands rise seems to indicate that at one stage in the history of the denudation there was a great tableland of this altitude. This tableland would represent the base-level of erosion to which the mass had been reduced by submarine action. Afterwards upheaval took place, sub-aerial forces came into play, and the present hills and valleys of the Highlands have been carved out of the old tableland by the action of frost, rain, wind, running water, and ice. Sir Archibald further supposes that when this sub-aerial denudation began the direction of the longitudinal valleys would at first be determined by the direction of the strike of the rocks; while such transverse valleys as Glen Lednock, Glen Ogle, and the transverse portions of the valley of the Tay would have their courses determined by the structure of the synclines and anticlines, as the streams would naturally tend to run off from the anticlinal axes.

XXVI.—*Tertiary Dykes of the Lower Tay Valley and District around Perth.* By ROBERT DOW.

(Read 9th April, 1891.)

In the concluding chapter of the "Fair Maid of Perth," Sir Walter Scott has immortalised the Linn of Campsie as the spot which closed the career of Connacher the Highland cateran. "The ruins of Campsie arise on the summit of a precipitous rock which descends on the princely river, there rendered remarkable by the cataract called Campsie Linn, where its waters rush tumultuously over a range of basaltic rock which intercepts the current like a dyke erected by human hands." The dyke thus described by the great wizard is truly a romantic and beautiful spot. The Tay, after being augmented by the Isla, flows in a south-westerly channel. About a quarter of a mile above the Linn, the river takes a sudden bend nearly due west at the point where it infringes on the dyke. It is then compelled to run parallel with it for a considerable distance just opposite Taymount House, where the dyke forms a perpendicular wall of basaltic masonry. The old channel of the river was clearly much nearer the Taymount lands, and, to prevent the river from making further encroachments, a passage was made by blasting on the Stobhall side, where the river now rushes through the narrow gorge known as the Linn. No better spot could be found for examining a "dyke" than just here. The impetuous rush of the river has denuded to an extraordinary degree the much softer strata of red sandstone. This has been all the more easily effected from its soft crumbling nature, which has in all probability been caused at the time of the eruption. The molten lava flow has first baked and then cracked the sandstone for a long distance on each side of the dyke. This peculiar commutated sandstone may be observed for over three miles below the Linn. The deep red shingle beds formed along the river side add a charm to the steep green slopes on both banks above.

The dyke is fifty feet wide, and is quite uniform throughout. It appears to have been blasted by artificial means at various points to make a passage for the stream. The peculiar jointing of the mass, so characteristic of all basaltic rocks, is exposed in a remarkable degree. The dyke is divided up into huge semi-rectangular blocks piled one above another, so that the whole mass has all the appearance of some cyclopean masonry. These joints or structural planes were caused when the dyke was in a semi-molten condition, by the contraction of the basalt in cooling. This process of division has been carried out in some basalts with mathematical exactness, and the whole mass is cut up into long prismatic columns neatly fitted into one another. The Giant's Causeway, Fingal's Cave in Staffa, and, in a less degree, the cubical blocks of the dykes of our own district, are well-known examples.

At the Linn dyke we have what appears to be a somewhat rare occurrence, at least in Perthshire—namely, the intersection of two dykes. The point of contact is on the Stobhall side of the river just at the water edge. The one dyke forms the retaining wall already described; it then trends to the north-east, forming the ridge on which Stobhall Castle is built. After being traceable for over a mile, it becomes lost under the superincumbent soil. The second dyke, which forms the Linn, can be traced for a very much longer distance. For some distance from the river bank it forms a veritable wall twenty feet in height in some portions, especially on the river side, where the denudation appears to have been excessive. And here, on the wall sides, we can examine the spheroidal weathering so often met in decaying basalts or lavas. This is the result of decomposition penetrating from without inwards in blocks which, in course of time, become spheroidal. A very fine example of this spheroidal weathering is to be seen in Corsie Hill quarry at its eastern end, where the whinstone has been long exposed to the weather.

From the summit of the river bank the dyke disappears, but its path can be easily traced by the knolls and hummocks which mark its course and by the clumps of whin which grow upon them. The dyke now crosses the main road leading to the Bridge of Isla, and just at the road-side, where the ground suddenly rises, it is quarried for road metal. No finer section of eruptive basalt through bedded sandstone could be found anywhere. The basalt wall is quite perpendicular, and the face of the sandstone is quite smooth and baked by contact with the once molten mass. The fresh cleavage faces of the whinstone blocks show unmistakable evidence that they were once a molten mass. They are covered by what might be termed, for want of a better name, a prismatic frost-work, from the crystallization when slowly cooling.

We once more ascend the ridge, and find that the dyke again assumes its mural character, and on the very summit of the rising ground it forms a wall thirty feet in height in some parts. This has arisen, no doubt, from the excessive sub-aerial denudation which must have been going on for ages on so exposed an upland. The dyke then crosses a great band of conglomerate which stretches from the vicinity of Coupar-Angus to the Tay at Luncarty. It can be traced for a distance of nearly four miles from the Linn of Campsie.

Having described, in some detail, the dyke at the Linn of Campsie, it will be quite unnecessary to describe with the same fullness the other dykes which are found in the bed of the river. About a mile below the village of Stanley and two miles below the Linn, another remarkable dyke falls to be noted. This is known as the Thistlebridge Dyke. It crosses the river at right angles to the current, and bears marks of having been blown up by artificial means for the passage of salmon. Its mural character is quite conspicuous on either bank. It is of the same width as the Linn dyke. On the east side of the river it can be traced for a distance of three miles. After emerging from the river, it passes the ancient site of the Abbey of Cambusmichael. It crosses the Blairgowrie Road to the north of the village of Guildtown, whence it can be traced for a mile farther eastwards.

On the western side of the river it can be traced for a short distance only. Emerging from the river, the dyke has had to be tunnelled to allow the lade, which supplies water power to the Luncarty Bleachfields, to flow through. The dyke above this has been quarried for road metal in three different places. The Thistlebridge stone, being extremely hard, was quite celebrated before the days of railways. The excavations caused by quarrying expose the smooth, vertical, and baked sandstones through which the eruptive whinstone has been ejected. In the old quarry just on the road-side, where the basalt has been long exposed, may be seen a fine section of the spheroidal weathering already described. A small trap dyke is exposed to view in the Shochie, near its source, which seems to be part of the same dyke as the one just described at Thistlebridge. They are in the same line as laid down on the geological chart. In all probability the dyke is continuous, but has been buried by the superincumbent sub-soil.

Two small dykes now fall to be noted. They are not marked on the geological survey map, but are quite evidently dykes, though small and insignificant. They are exposed by the denuding action of the river, but are not traceable on either side. The one is situated 200 yards below the Thistlebridge dyke, and is 6 feet wide; the second is situated 50 yards farther down, and is 8 feet wide. About two miles above the Linn another of these small dykes occurs. It can be traced for a short distance on either bank. This one, after being hidden on its western side for about six miles, again comes to the surface just below the village of Bankfoot. Here it may be traced for miles westwards, passing the spot marked by the monument erected to the memory of the poet Nicol at Tulliebelton. It then crosses the Great Fault line, when it is found erupted through the Highland slate rocks. This exhausts, so far as I have been able to examine, the trap dykes which cross the Tay in the Stanley district. Reckoning the Linn dyke as two, this gives a total of six.

No more dykes are observable till the Luncarty district is reached. The river between these two points is bordered by broad haughlands with a deep alluvial soil which would cover effectually any insignificant dykes. At the Stormontfield ponds, where the ground rises from the low alluvial haughland, another trap dyke appears. It can be traced for two miles eastwards until it crosses the Blairgowrie Road. On the western side it trends to the south-west, passes quite close to Luncarty Station and Battleby, touches the south bank of the Shochie a little westwards, where the burn bends from a south-east flow to a north-west about a mile east of Moneydie Schoolhouse. Still stretching westwards, it crosses the bed of the Almond at Lynedoch, where the denuding force of the river renders it quite observable.

A second dyke crosses the Tay, about half a mile below the one just mentioned, at the Waulkmill Ferry. A fine hard whinstone is quarried from this dyke at Ardgilzean. It runs almost parallel to the one higher up the river, and can be traced as far west as the Almond valley, where it is exposed at the Brig of Dalcrue. A third dyke, though not exposed at the Tay, occurs about half a mile above the Almond mouth. This one is grandly exposed at Cromwell Park. It can be traced eastwards by Pitcairngreen, Redgorton Church, and still eastwards as far as the railway, where all trace is lost.

In our immediate vicinity the following dykes may be noted :—

(1.) Corsie Hill. This one is finely exposed, as the quarry has been worked for a very long time. The crystalline basalt has been erupted through the bedded porphyrites, and yet here we have the same mural structure, with the smooth faces of the porphyry.

(2.) Windyedge, north of Kinfauns Castle, and a little to the north-west of the Binn. This is not a dyke, but a boss of diabase, similar to those common in south Forfarshire, especially in the Dundee district. Balgay Hill is a huge boss of diabase. Diabase is a name given to some ancient basalt rocks in which, owing to alteration of their augite, a greenish chloritic discoloration has taken place. The lavas of early geological times are to a great extent composed of diabase.

(3.) Pitroddie and Kilspindie. This dyke may be traced west of Kilspindie for over a couple of miles, through the porphyry of the Sidlaws.

(4.) Newhouse and Blackruthven. This dyke seems to be part of the one exposed at Pitroddie.

(5.) Hill of Ruthven. This dyke is exposed in an old quarry to the east of the farm-house.

(6.) Scoonieburn. This dyke extends across the whole country. From Moncreiffe Hill it stretches westward by Tarsappie, Scoonieburn, Kirkton, Dupplin Loch, &c., to Ochtertyre.

(7.) Craigend. This dyke runs parallel to the one just mentioned, with an average distance of half-a-mile between them. It stretches from Craigend westward to Aberdalgie Church, Dupplin Loch (on the south side), and then westward through Perthshire.

This concludes the Tertiary dykes in what may be termed the lower Tay valley and surrounding district of Perth. Those of the lower Almond valley which would be included in the Perth district were described by Dr. Milroy of Moneydie some years ago, and his paper can be read in the *Proceedings* of the Society, Vol. I. *(First Series)*, page 24.

The trap dykes of Perthshire bring us to a comparatively late era in geological history. They show unmistakable evidences of tremendous upheavals, which must have been of an altogether exceptionally severe character. The crust of what was at the time the Lowlands of Perthshire was rent open by long straight fissures, sometimes extending for miles, and in some cases right across the country. These fissures covered a very extensive area. The greater part of Scotland, the northern part of England, the whole of Ulster, and the bed of the northern half of the Irish Sea were included. Up through these yawning rents the molten lava rose from below, and probably in many places reached the surface and poured forth over the land in vast floods.

The terraced hills of Antrim, Skye, Mull, and the adjacent islands are memorials of these prolonged and magnificent eruptions. The lava that solidified within the walls of the vertical fissures now forms what are popularly known as "dykes." The dyke or wall-like form is very apparent, especially when the adjacent strata are soft and the denudation has been extensive. This is generally the case when the dyke crosses the bed of a river, where the denuding force of the current is excessive. No better example of this phase of geological phenomena could be witnessed than the trap dyke forming the Linn of Campsie, a little above the village of Stanley, or the one a mile further down the river, at Thistlebridge.

These trap dykes, as well as the others of Perthshire, are clearly co-related with the latest of all the volcanic outbursts which devastated our country. The volcanic vents stretched in a sinuous line from the Irish Sea northwards to the Faroe Islands and Iceland. The volcanic vents were closed up by the superincumbent masses of solidified lava, but the heaving and expansive forces at work were so prodigious that the land was rent into great fissures for miles, and subsequently filled up with molten lava.

These basaltic dykes occur so abundantly around the centre of upheaval that the whole of the stratified rocks in the immediate vicinity are broken up by a complete network of them. Farther to the east these dykes are found in smaller numbers, but still evidently radiating from the same centre. Nowhere can we find more admirable examples than in the western islands and the adjoining mainland.

When composed of materials which do not so readily undergo decomposition as the surrounding rocks, the dykes stand up like walls, but when they are more readily acted on by chemical and physical agencies than the rocks which enclose them, they give rise to deep trenches, with vertical sides.

In the same dyke, especially when it is of considerable width, we often find every variety of basalt, from a glassy material formed by the rapid cooling of the mass when it came in contact with the colder adjacent rocks, to the perfectly crystalline or granitic variety which forms the centre of the intrusive mass.

One of the most remarkable features of trap dykes is the singular straightness of their sides. As a rule they rise through the other rocks literally as dykes, the two opposite faces of each dyke running as parallel to each other as those of a wall of masonry, and often much smoother. This feature is seen with striking effect when the dyke has risen through soft rocks which have been worn away. While instances do occur in which the dykes have filled very uneven fissures, the prevailing regularity of their thickness and direction tends to show that the igneous rock has not itself been directly the cause of the fissures. These have much more probably been due to the action of a general powerful agency, of which the eruption of the igneous rock is itself only additional evidence. There is reason to believe that in many, if not in most cases, the fissures existed before they came to be widened and filled up with intrusive rock so as to become dykes.

In assigning the geological age of the trap dykes of Scotland to Tertiary times, geologists have been guided by the following considerations. The dykes cut through every formation, from the oldest Primary rocks, up to and including the chalk deposits, the latest of the Secondary formations. They cross faults of every size and direction. We have numerous examples of this in our own neighbourhood. The dyke which stretches from Moncreiffe Hill westwards along the Earn valley crosses a fault about half-a-mile west of the Kirkton Hill. The numerous dykes in the Bankfoot district are crossed again and again by the great boundary fault which runs parallel to the first ridge of the Grampians. And, lastly, they are in all probability connected and co-related with the great volcanic plateau of the west already referred to, and, if so, they are of undoubted

Miocene or Mid Tertiary age. The Basaltic plateaux of Ulster, Mull, and Skye are of Tertiary age, as is proved by the following facts. Between Portrush and the Giant's Causeway the throats of several volcanoes pass through chalk deposits of undoubted Miocene age, as shown by their fossiliferous deposits. The lava beds, wherever sectionally exposed, are seen to be superimposed on the upturned and eroded edges of cretaceous deposits. The chalk in many places has been altered by heat and pressure from its characteristic earthy appearance into a white crystalline marble, hard enough to be polished. In Iceland the lava sheets, 500 feet thick, lie on similar chalk deposits. In the Island of Mull, the Duke of Argyle has described certain Miocene leaf-beds which were subsequently covered up by streams of molten lava that issued from the Mull volcanoes. The Basaltic plateau, wherever exposed, is thus seen to be incumbent upon the last deposits of Secondary age. Its age is therefore clearly assigned. This being so, it follows that the dykes belong to the same period, or one succeeding at no very long interval. With these Tertiary dykes the record of volcanic activity in Britain seems to close.

XXVII.—*Additional Rare Perthshire Mosses.* By R. H. MELDRUM.

(Read 9th April, 1891.)

In the paper which I communicated to the Society last session, I enumerated some mosses which had not previously been recorded from Perthshire, and gave new localities for a few of our rarer species. Since that paper was read, other interesting discoveries have been made, and, on this occasion, I shall give an account of these.

The moss which comes first in point of importance is *Dicranum undulatum*, Ehrh., so called from its undulated leaves. In the British Moss Flora, Dr. Braithwaite, describing the genus *Dicranum*, says of this species, "*D. undulatum* is a species which ought to occur here, being found in alpine woods throughout Europe and North America, but though it has been several times reported from various localities, no genuine specimen has yet come before us;" and again, in a note upon *D. palustre*, he says, "*D. palustre* was confounded by all the early British botanists with the fine *D. undulatum*, Ehrh. which is distributed all over the Continent, but is strangely absent from this country, as is also the still grander *D. elatum*, Lindb. (*D. robustum*, Blytt), though both might reasonably have been expected to occur here."

That was written in 1883. In the summer of 1887, the first British specimen was found by Mr. Bagnall, in Warwickshire, and a description of the plant was inserted in the supplement to Vol. I. of the Moss Flora, which was published a few weeks later. The following note appears with the description:—"It is with great pleasure that at the last moment I am able to insert this interesting discovery by my valued friend, Mr. Bagnall, for it seemed strange indeed that a plant common through all Europe and North America should be wanting here, yet its rarity with us is certain, or so conspicuous a plant would before this have rewarded our numerous collectors. I hope to give the figure of it in the supplement to the next volume."

In February, while collecting in Dupplin Woods, I found a moss which I at once set down as this species, and microscopical examination at home confirmed me in my first opinion. On submitting a specimen to the great authority, Dr. Braithwaite, I received the following reply:—"Your *Dicranum* is quite correct and perfectly accords with the Continental form. Bagnall's is the only other station in Britain, and he found his in a similar place among heather and grass, but his plant is less typical. I shall make the drawing for the supplement plate from your specimen."

At first I found only one small patch, a few inches in diameter, but the following week I detected another, some 200 yards from the first. More recently I have been successful in finding a third station, about a mile from the original locality, and not in the same wood. In every case the habitat was the same, and the supply very limited in amount. In all probability it occurs elsewhere in the county in similar situations, but is not easily noticed from growing in such small patches in the midst of heather, *Polytrichum*, and the similar *Dicranum palustre.*

The next moss, *Tortula princeps*, De Not. (*T. Mülleri*, B. and S.), was found by me last summer in Glenfarg. The only other Perthshire locality I can find recorded is Glen Tilt, where it was discovered by Miss M'Inroy of Lude, a lady who detected several rare mosses in that district. In the *Edinburgh Botanical Society's Transactions*, Vol. VII., p. 516, occurs the following extract from a letter of hers concerning it:—"From 1858 to 1861 very fine specimens of *Tortula Mülleri* were to be found on an old wall and low rock beside the stream, but the removal of the wall has, in the meantime at least, led to its disappearance; in time, if the little that remains be spared, it may again gain a footing." Probably the moss has regained its footing in the thirty years that have elapsed since then, at least I hope so. It is fairly abundant in Glenfarg at more than one spot.

The distribution of this moss is rather remarkable. It is a species characteristic of the Mediterranean region, and so we find that in France, beyond the limits of that region, it occurs in only a few localities in the west and north-west, and usually in company with other stragglers from the south. In England it is scarcely found, and yet in Scotland, at a greater distance from its headquarters, it is widely distributed, occurring as far north as Ross-shire.

In my former paper I referred to the large number of species of *Grimmia* growing on the trap-hills about Perth, and I have now to record an addition to their number—viz., *Grimmia conferta*, Funck. This plant I had noticed for the last three or four years on both Callerfountain and Moncreiffe Hills, but I thought it was only a very marked form of *G. apocarpa*, which is a variable moss; and, in fact, many botanists consider *G. conferta* to be nothing more than a variety of *apocarpa*. Aided by the excellent descriptions and plates of the Moss Flora, I recently made a careful examination of the Callerfountain plant, and satisfied myself that it was *G. conferta*, a determination endorsed by Dr. Braithwaite, to whom I sent specimens. He records it only from Arthur's Seat, but a variety, *pruinosa* (Wils.), occurs in several localities, and in Perthshire has been reported by M'Kinlay, from Doune. This variety is distinguished from the type chiefly by the longer hair-points to the leaves.

Camptothecium nitens, Sch. (*Hypnum nitens*, Schreb.) is another moss which has been added to the Perthshire Flora during the past year. I detected it in a small marsh near Cairn Geddes, in the Ochils, on the occasion of the Society's Excursion from Damhead to Invermay. It was found in some quantity, and recognised at once by its tomentose stems and shining leaves of a golden hue. In England it occurs, or has occurred (for drainage has destroyed it in at least some of its stations), in Yorkshire, Cheshire, and Norfolk. In Scotland it is recorded from the Pentlands, Kinross, and Forfarshire, and Howie, in the *Edinburgh Botanical Society's Transactions*, records it from Tent's Muir, but specimens from him in our Society's Herbarium so named and localised are *C. lutescens*. I see that in his recently published Moss Flora of Fife and Kinross Howie makes no mention of it from Tent's Muir, so that this record may be considered an error.

I might extend this paper to a greater length by noticing several other mosses of interest for which new stations have been found, but I prefer to confine my remarks to those species which are rare, not in Perthshire only, but in Scotland as a whole. Our county, owing to its extensive and varied surface, has always been noted for the richness of its Moss Flora, and yet how little of it has been examined carefully, how much of it not at all! The fact that the species I have spoken of to-night have all been found in one small corner of the county augurs well for the extent and interest of the list we hope to be able to show when many districts still unexplored have been carefully examined.

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XXVIII.—*The Old Red Sandstone of Perthshire.*

By H. Coates, F.R.S.E., and P. Macnair.

(Read 7th April, 1892.)

In a paper read before the Society last year we gave an account of the rocks of Highland Perthshire, describing their structure, origin, plication, and denudation. In the present paper we propose to treat of the rocks of Lowland Perthshire in a similar way. In doing so we shall endeavour to present another chapter in the geological and geographical evolution of Perthshire.

In order to make the relationship of these rocks clear, we shall first give a brief outline of the Old Red system as developed in Scotland; then, passing to the Perthshire series, we shall describe, first, their general development; second, their plication and fault systems; and third, their denudation.

I.—General Aspect of the Old Red Sandstone of Scotland.

Between the formation of the Silurian rocks of the Highlands and Southern Uplands, and the deposition of the Old Red Sandstone, a long interval of time elapsed, and great geographical changes were induced. The whole of the Scottish area was raised above the sea level, and the upturned edges of the plicated strata were denuded to an enormous extent. In this area were four main depressions, which were occupied by the lakes in which the Old Red Sandstone formations of Scotland were laid down. For convenience of reference, Sir Archibald Geikie has given these basins names. The most northerly, which occupies nearly the whole of Caithness, and runs in a fringe along both shores of the Moray Firth, he has named Lake Orcadie; another, which coincides with the midland valley, is Lake Caledonia; while the remaining two, which are of comparatively small extent, are situated, the one in Argyleshire and the other in Berwickshire, and are known as Lake Lorne and Lake Cheviot respectively.

For an immense period of time the sea must have been excluded from these basins, as the strata reach a great depth, and are almost entirely composed of lacustrine deposits. In Lanarkshire, however, about 5000 feet above the base of the system, there occurs a band of shale containing a *graptolite*, *Spirorbis Lewisii*, and *Orthoceras dimidiatum*, all of which are characteristic of the Upper Silurian, and point to the fact that the Silurian Sea must have invaded the lake for some time. There are evidences that these great inland lakes must have occupied a large part of west and north-west Europe, while to the south-west the old sea basin still preserved its position, being tenanted by the fauna typical of the Devonian system.

That these basins were isolated in our Scottish area is a fact now placed beyond dispute, both by the lithological diversity of the rocks and by differences in their fossil contents. The great palæontological differences between Lake Orcadie and Lake Caledonia led Sir Roderick Murchison to place the former series in a middle group, altogether different from the lower and upper. Sir Archibald Geikie, however, maintains that the admitted palæontological differences are not greater than the striking lithological differences between the strata of the two regions would account for, and that as great a contrast may sometimes be seen between the ichthyc faunas of contiguous water-basins at the present time. The isolation of these basins was first pointed out by Godwin-Austen, and more recently by the late Sir A. C. Ramsay. Undoubtedly the whole evidence points to the fact that there could have been no means of communication between them.

Sir R. Murchison divided the Old Red Sandstone system into three groups—the lower, the middle, and the upper; but it was afterwards demonstrated that nowhere could these three divisions be found together, and that such a classification was not based upon ascertained stratigraphical facts. Sir Archibald Geikie pointed out that the Old Red Sandstone was only to be found with one distinct physical and palæontological break, and therefore divided it into the upper and the lower. This twofold division is well seen in our own district at Clashbennie and Dura Den.

Between the two divisions there is both a distinct unconformability and a distinct difference of organic contents. The lower series consists of conglomerates, sandstones, and associated igneous rocks, the characteristic fossils being *Dipterus*, *Coccosteus*, *Cephalaspis*, *Pterygotus*, &c. The upper series consists of yellow and red sandstones, conglomerates, marls, &c., which pass up conformably into the base of the Carboniferous system, and contain the remains of *Holoptychius*, *Bothriolepis*, &c.

As already mentioned, marked differences are found among the fossil contents of the different Lake Basins. Lake Orcadie has by far the largest number of species, there being nearly 60 species of fish to be found in that basin alone, including the following genera:—*Mesacanthus*, *Homosteus*, *Cheiracanthus*, *Cheirolepis*, *Coccosteus*, *Diplacanthus*, *Diplopterus*, *Dipterus*, *Glyptolepis*, and *Pterichthys*. From the lower member of the system in Lake Caledonia only 17 species of fish have been found, belonging principally to the sub-divisions *Acantho-*

didæ and *Ostracostei.* The most plentiful forms are *Diplacanthus gracilis* and *Acanthodes Mitchelli*, and the following species also occur:—*Climatius scutiger*, *Parexus incurvus*, *Cephalaspis Lyelli*, and *Pteraspis Mitchelli.*

Out of 18 genera, with 60 species, from Caithness, and 10 genera, with 17 species, from the Arbroath flagstones, only four genera and one or two species are common to the two areas.

Upon the whole, the upper series is singularly unfossiliferous, although the beds at Dura Den are a notable exception. Some remains also have lately been found at Clashbennie, including scales and plates of *Phyllolepis* and of *Holoptychius nobilissimus.*

There is probably no place where the Old Red Sandstone can be so well studied as in Scotland. Not only is the isolation of the different areas complete, but the lithological features of both the sedimentary and the igneous rocks are strongly marked, and the fossil remains are abundant and varied.

II.—The Rocks of the Old Red Sandstone of Perthshire: their Origin, Structure, Distribution, and Succession.

The lowest, and at the same time the most characteristic, member of the Lower Old Red Sandstone of the midland valley is the great conglomerate. It stretches right across Scotland, from Stonehaven on the north-east to the Firth of Clyde on the south-west, flanking the base of the Grampian Mountains. The rock itself is composed of fragments of the crystalline rocks of the Highlands, such as mica-schist, quartz-schist, &c., while parts of it are composed of pebbles of porphyrite derived from the lava beds of the active volcanoes of lower Old Red Sandstone times. The character of the rock and its position both point to the fact that it must rest at the base of the system, for in Glen Turret and Glen Islay it is seen to rest unconformably and almost immediately upon the upturned edges of the grits and flagstones of the Highlands.

The manner in which this conglomerate was formed may be explained as follows, the references being to the map and section on Plate I. After the production of the comparatively level tableland, referred to in our paper on the Highland area, the land began to sink between the two principal faults, marked MN and OP in Fig. I. and also shown on the map by the dotted lines. This sinking would direct the drainage towards the centre of the depression AB. Along the bottom of the small lake thus formed, beds of pebbles, brought down by streams from the crystalline rocks of the Highlands, would begin to accumulate. By the continued sinking of the area these deposits would gradually creep backwards, and when the lake stood at the level A^2 B^2 the conglomerate would have crept backwards to A′ and B′, and accumulations of grit and sand would have begun to form farther out in the lake, above the first layer of shingle. In this manner the conglomerate would always preserve its position at the base of the system, and would in its turn get overlaid by the beds of grit and sand carried out towards the centre of the lake. The littoral nature of the conglomerate, as well as its former extensive encroachment upon the Highland area, is well seen in these sections where part of the conglomerate still rests unconformably upon the Highland rocks to the north of the great line of fault; as, for instance, at Craighall, near Blairgowrie. On entering the cañon of the Ericht at this place it will be seen that the conglomerates rest unconformably and almost horizontally upon the Highland rocks. Their horizontal position is at first difficult to make out, as the bedding of conglomerate is rather obscure; but the presence of some small intercalated beds of sandstone places the matter beyond dispute. Here, then, we stand upon the very base of the system, still occupying its normal position, and over the top of which must have been piled thousands of feet of sandstones, grits, conglomerates, and interbedded volcanic rocks.

Plate II., Fig. 4, is a section across the area just described, which will help to make the relative positions of these rocks more easily understood. The Highland rocks come to the surface to the north of the section, and are seen to have a general dip towards the north-west. On these rest the basal conglomerates of the Old Red Sandstone, B. Those to the north of the great line of fault are seen in the section still occupying their normal position upon the Highland rocks. Going south, towards Rattray and Blairgowrie, we pass over the great fault, M N, which exposes the basement beds of conglomerate thrown vertically downwards. Going still farther south, the angle of dip gradually decreases, until the conglomerates pass upwards into the sandstones at Rosemount, south of Blairgowrie. There the rocks are almost horizontal, forming the centre of the synclinal trough. If the effect of this fault, M N, were undone, the whole mass of strata from M to P would be placed in the position indicated by the dotted lines, which will show how widely Lake Caledonia extended.

The conglomerate is well exposed all along the flanks of the Grampians, and may be best studied in those sections produced by the passage of the principal rivers from the Highland valleys to the plain of Strathmore. In the valley of the Ericht at Blairgowrie, and in those of the North and South Esks, the Wast Water, the Tay at Birnam and Murthly, the Turret at Crieff, and also in the hills around Callander, good sections are exposed.

This conglomerate, as pointed out by Professor James Geikie in his presidential address to the Society in 1881, might well engage the attention of local geologists, in reference both to its origin and the materials of which it is composed.

It is evident that at the time of the formation of the conglomerate the sides of the Grampians must have formed the northern shore-line of Lake Caledonia, along which it was laid down as gravel, just as shingle accumulates on the seashore at the present day. It would overlie and run along the ancient border line of the lake, filling in and running up the creeks of the then existent land. The conglomerate shows almost everywhere evidence of torrential origin, and has evidently been laid down by the streams flowing from the Highland hills. It was long ago suspected that at the time of its deposition glaciers may have existed in the Highland hills, but direct evidence has not as yet been obtained on this point.

Passing upwards in the system, we come next to the series of sandstones which occupy almost the whole of the valley of Strathmore. In some of the higher members of this series obscure plant markings have been detected, and it is thought that further research amongst these beds might reveal plant remains which would throw much light on the flora of Old Red Sandstone times.

One of the most interesting and striking features of the Old Red Sandstone of our district is the abundant intercalation of ancient lava beds among the sandstones and conglomerates. They lie, as Sir A. Geikie shows, several thousand feet above the base of the system, and have a total thickness of over 6000 feet. They are chiefly composed of porphyrites, felsites, and tuffs, and form the main mass of the Sidlaw and Ochil hills. They are undoubtedly of volcanic origin, and indicate that the ancient lake must have been dotted over with active volcanic vents, which seem to have arranged themselves in lines conforming to the general trend of the fault systems which produced the great midland valley. From these volcanic vents were poured out great streams of lava which covered the whole, or nearly the whole, floor of the lake.

These volcanic beds are well exposed in the Sidlaw and Ochil hills, where they have been brought to the surface by a large anticlinal fold of the rocks. This fold may be well seen from the top of Moncreiffe Hill. On ascending that hill, which is itself part of the northern limb of the anticlinal arch, we see, on looking down the valley of the Tay, that all the hills belonging to the Sidlaw range have their long slopes dipping towards the north-west and their abrupt mural fronts facing the south-east. Looking towards the south, the Ochil range of hills is seen to present exactly the reverse order. There the long slopes dip away towards the south-east and the escarpments face the north-west.

The volcanic rocks of this great anticlinal arch have, in their turn, been covered by the higher members of the sandstone series of Strathmore, indicating that the volcanic activity must have died out ere the lake itself had disappeared. Another series of volcanic rocks—or, rather, the northern continuation of the same series,—is well exposed amongst the conglomerates along the flanks of the Highlands, as at Blairgowrie, Murthly, Crieff, and Comrie. There, owing to their stratigraphical position, they do not form such striking features of the landscape as in the Ochils and Sidlaws, but they serve to show that, whilst the sandstones of the centre of the lake were being covered by these rocks, the conglomerates forming along its edge were also being overlaid by huge beds of molten volcanic material.

These volcanic rocks are chiefly porphyrites, being composed of a triclinic felspar (plagioclase), with magnetite, hornblende, augite, and mica. When examined under the lens they generally present a fine felsitic base, in which are scattered larger crystals of felspar. They present all the physical features of such rocks, such as jointing, vesicular phenomena, &c. One of the most interesting sections of these rocks is that to be found in the hills of Kinnoull and Moncreiffe. The entire surface of Kinnoull Hill is covered by a series of lava beds, well exhibited in the face of the hill, and having a general north-west dip. At the base of the hill, immediately above the Kinfauns Castle carriage-drive, there occurs a series of ashy conglomerates, tuffs, and other volcanic ejectamenta, which stretch across the valley of the Tay, and overlie the lava beds of Moncreiffe Hill. These latter also dip towards the north-west, and, with the Kinnoull Hill beds, form part of the northern limb of the great anticlinal arch already referred to. (See Plate II., Fig. 3).

We now pass on to the rocks of the Upper Old Red Sandstone of Perthshire. These, as explained in the introductory section, always rest unconformably upon the Lower Old Red Sandstone, and pass up conformably into the calciferous sandstones of the carboniferous system. In Perthshire they are developed only along the Carse of Gowrie, and have been preserved in rather a remarkable way, having been carried down into the heart of the Lower Old Red Sandstone volcanic rocks between two powerful faults, and having thereby escaped the general denudation which has swept away the rest of the Upper Old Red Sandstone. In the trough between these faults has also been preserved a small patch of carboniferous rocks, which are exposed in Dron parish. The relationships of these rocks will be more fully explained in our next section, when we deal with the fault systems of the area. (See Plate II., Fig. 2).

We have been fortunate in recently discovering in the upper Old

Red Sandstone beds at Clashbennie scales and plates of *Holoptychius* and *Phyllolepis*,* which are now becoming very rare.

III.—The Plication of the Rocks and Development of the Fault Systems of the Old Red Sandstone of Perthshire.

Having given a general outline of the various rocks representing the Old Red Sandstone in Perthshire, we now pass on to speak of the manner in which they have been plicated and folded into the positions which they now occupy, as indicated by their lines of dip. All the rocks, whether sedimentary or volcanic, must have been laid down in approximately horizontal positions, and any other position which they may now occupy indicates a subsequent disturbance. In our paper on the Rocks of Highland Perthshire we showed that the anticlines and synclines and the general fault systems had assumed a universal north-east and south-west trend. The principal faults of the Highland rocks,—such as those of the north-west of Sutherlandshire, that of the Great Glen, and that of Glen Lyon in Perthshire,—as well as the smaller faults, all run in this direction. It will, of course, be understood that the continuation of these Highland rocks underlie the Old Red Sandstone of Perthshire, where, in all likelihood, they are folded and faulted in the same manner as those exposed in the Highlands, and we may assume that the direction of these faults has, in turn, been communicated to those of the later Old Red Sandstone formations deposited above them.

After the reduction of the Silurian rocks to a comparatively flat table-land, certain parts of the Scottish area began to be depressed along lines of weakness produced by the fault systems developed in the crystalline rocks, these faults retaining the same trend as originally produced by the plication of the Highland rocks. One of these lines of weakness existed along the southern side of the Great Glen, and undoubtedly extended outwards in a corresponding line into the German Ocean. This fault evidently determined the southern limit of Lake Orcadie.

Passing now to our own basin, or Lake Caledonia, we find the direction of the northern edge of the basin indicated by a powerful fault, which throws down the Old Red Sandstone beds to the south, presenting their broken edges to the surface in an almost perpendicular dip. This fault has been the most important factor both in giving origin to the basin itself and afterwards in plicating the rocks laid down in it. It extends from Stonehaven, on the east, right across the country, by Alyth, Blairgowrie, Murthly, Crieff, Comrie,

* These have kindly been examined for us by Dr. R. H. Traquair, F.R.S., Edinburgh, who has identified them as *Phyllolepis concentrica*, Agassiz.

and Callander, and onwards to the Firth of Clyde. As already shown, it dates back to Silurian times, and must have been produced along with the great plication of the Highland rocks. That it still exists as a line of weakness is evident from the occurrence of earthquakes at Comrie, which is situated almost upon the line of fault.

There is a corresponding downthrow of the Old Red Sandstone series to the south, the fault running from Dunbar across to Girvan.

By the sinking of the area between these two faults a great depression was made in the crystalline Silurian rocks, which, for the earlier part, was occupied by the fresh-water lakes of Old Red Sandstone times, and later on was again and again invaded by the sea, as shown by the carboniferous limestones. The subsidence appears to have been a gradual process, and to have reached its greatest intensity towards the centre of the basin, owing, no doubt, to the pressure of the accumulated sediments. As this depression increased, the lake would gradually extend backwards, until it reached the wide extension of which we have evidence in the conglomerates which flank the Grampians.

After the whole series of conglomerates, sandstones, grits, shales, and associated volcanic rocks, had been laid down in this depression or lake, or perhaps contemporaneously with their actual deposition, the disturbance of the horizontal strata began. The whole series had been gradually and slowly let down along the great fault already mentioned and abutted against it in a synclinal trough. The northern limb of this trough is very steep, indicating that the rocks must have been pushed against it by a powerful force. Towards the south this synclinal trough is succeeded by a large flat anticlinal arch, which, as before stated, has brought the volcanic rocks to the surface, and forms the Sidlaw and Ochil hills. These synclines and anticlines, like those of the Highland rocks, have a north-west and south-east trend, resulting from the thrusting of the rocks against the great line of fault.

One of the most interesting fault phenomena of Perthshire is the occurrence of a trough fault along the Carse of Gowrie and the Firth of Tay. The northern line of fault is seen along the southern front of Moncreiffe Hill, and it crosses the Tay somewhere about the back of Inchyra, running along the foot of the Sidlaw Hills towards Pitroddie and Kinnaird, and thence eastwards towards Dundee. The southern line of fault runs in a parallel direction, extending from Glenearn, along by Dron and Abernethy, and thence to Newburgh. The effect of this fault has been, as before stated, to bring down into the very heart of the Lower Old Red Sandstone rocks the Upper Old Red Sandstone members, and even in some cases, as at

Dron, the basement beds of the carboniferous series. This trough fault has had a most important influence on the topography of the district, for it has carried down the hard volcanic rocks, and presented to the surface the softer overlying sandstones of the Upper Old Red and lower carboniferous series, which, in turn, have been worn away by the processes of denudation, and thus given rise to the present valley of the Tay below Perth.

IV.—The Laws that have governed the Denudation of the Old Red Sandstone of Scotland, and more particularly of Perthshire.

In our former paper, on the Highland area, we briefly noticed Sir Archibald Geikie's theory of the denudation of the Highlands and the origin of the Highland valleys. He divides the Highland valleys into two systems, the longitudinal and the transverse. Of the former, Glen Dochart, and its continuation, the valley of Loch Tay, may be taken as an example; while Glen Lednock and Glen Islay are examples of the latter. He proceeds to show that the longitudinal valleys owe their origin chiefly to geological structure, the trend of the anticlines and synclines being the principal factor in determining their direction.

The origin of the transverse valleys is likewise referred to the anticlines and synclines, though their direct relationship to these is very obscure. He speaks of them as follows:—"In the other, or transverse class of valleys, the line of direction is independent of geological structure, and crosses irregularly the strike of the rocks, according to the readiest route the water could at first find down the slopes of the ridges." * He admits, however, over and over again, that there are difficulties connected with this theory, and that there are many anomalous valleys whose origin it will not account for. He refers, for instance, to those valleys which lie between the great glen and the eastern seaboard of the country, and which are neither longitudinal nor transverse, and consequently cannot be explained by his theory. It is not our intention here to enter into a detailed criticism of his method of explaining the origin of these valleys and its evident inadequacy to do so, but we shall have occasion to revert to our own views as to the origin of the Scottish valley systems, which, we consider, explain many of the phenomena connected with the physical evolution of Scotland and the growth and direction of its watershed.

It seems to us that a consideration of the configuration of the

* "Scenery of Scotland." 2nd Ed., p. 168.

country as it was in Old Red Sandstone times should throw some light on this problem. During Old Red Sandstone times, as we have seen, several depressions were formed in the Silurian rocks, and were occupied by great fresh-water lakes. These lakes must have been fed by streams flowing in on all sides from the surrounding Highlands. The formation of the deposits which now represent these lakes was gradual, and proceeded from the centres of the respective areas. With the gradual extension of the lakes the rivers which flowed into them would recede, and would trench out of the crystalline rocks of the Highlands a series of valleys, all opening towards the depressed areas.

If we study the course of the Highland watershed, we shall find that the present configuration of the country has, in great measure, resulted from the action of these rivers, whose courses were at first determined in the manner just described. It commences in the north at Cape Wrath, and runs southward towards the line of the Great Glen, after which it bends sharply towards the east. An examination of the map of Scotland, as shown on Plate I., will make this clear. The shaded areas represent the former extent of the Old Red Sandstone lakes, while the watershed is indicated by a line running along the high ground which separated the lakes from each other. All the north-eastern rivers—such as the Helmsdale, Oykell, Carron, Findhorn, and Spey—would drain their waters into Lake Orcadie; while the Dee, the Don, the Esk, the Islay, the Ericht, and the Tay would flow into Lake Caledonia from the north. In this way these rivers would gradually eat out their valleys, and throw down the debris in the basins of their respective lakes. From the position of the Old Red Sandstone rocks, and the manner in which they run up the Great Glen, it is evident that that glen is as old as Lower Old Red Sandstone times. The position of the conglomerates along the margin of the Highlands of Perthshire also warrants the same conclusion as regards the age of all the rivers debouching upon the plain of Strathmore from the Highlands.

The evidence of the rivers of Highland Perthshire, with regard to the origin of their valleys, is particularly striking. If we take our stand, say, on one of the low conglomerate hills which flank the Grampians, and look towards the crystalline hills to the north of us, we can at once realise how the initial direction of the valleys opening up before us was determined, long ages ago, by the streams flowing down from the Highlands into the great fresh-water lake which occupied the strath below us.

PLATE I.

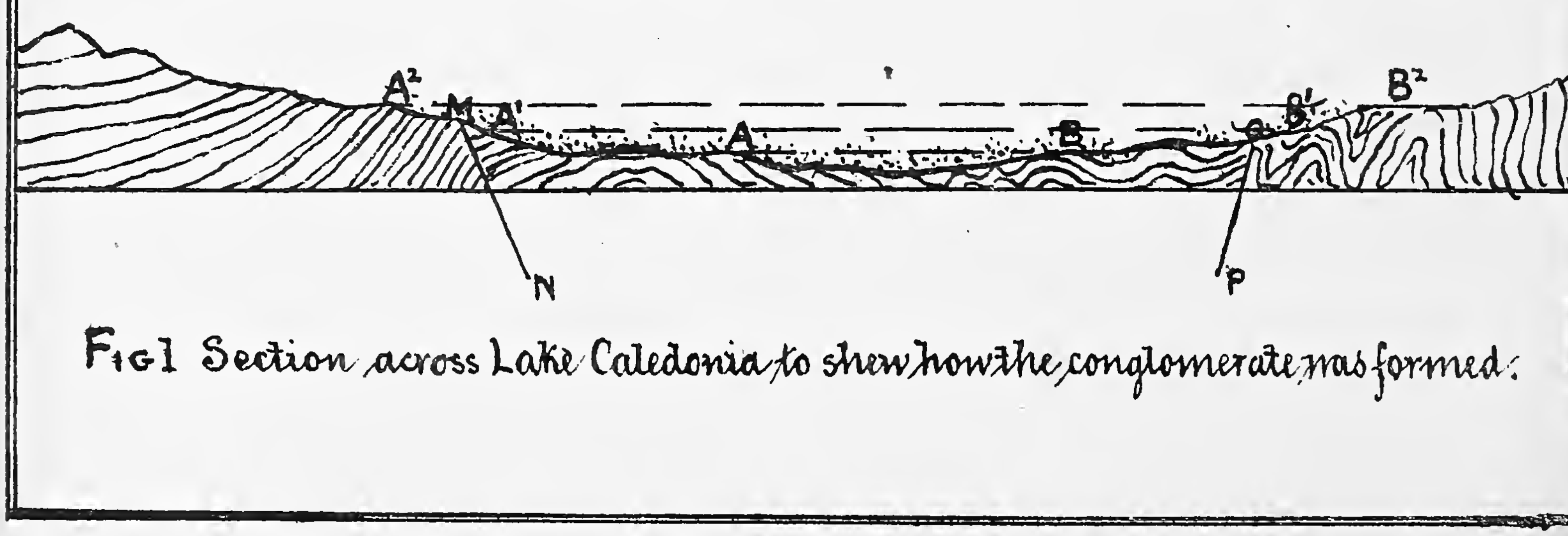


Fig 1 Section across Lake Caledonia to shew how the conglomerate was formed.

PLATE 2

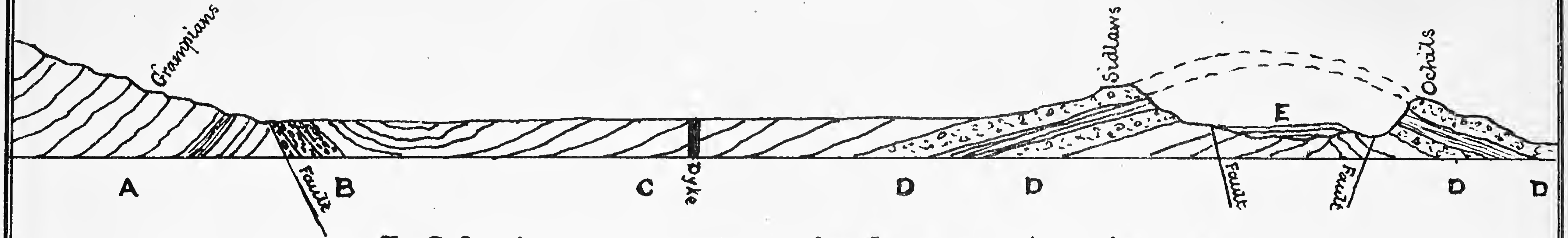
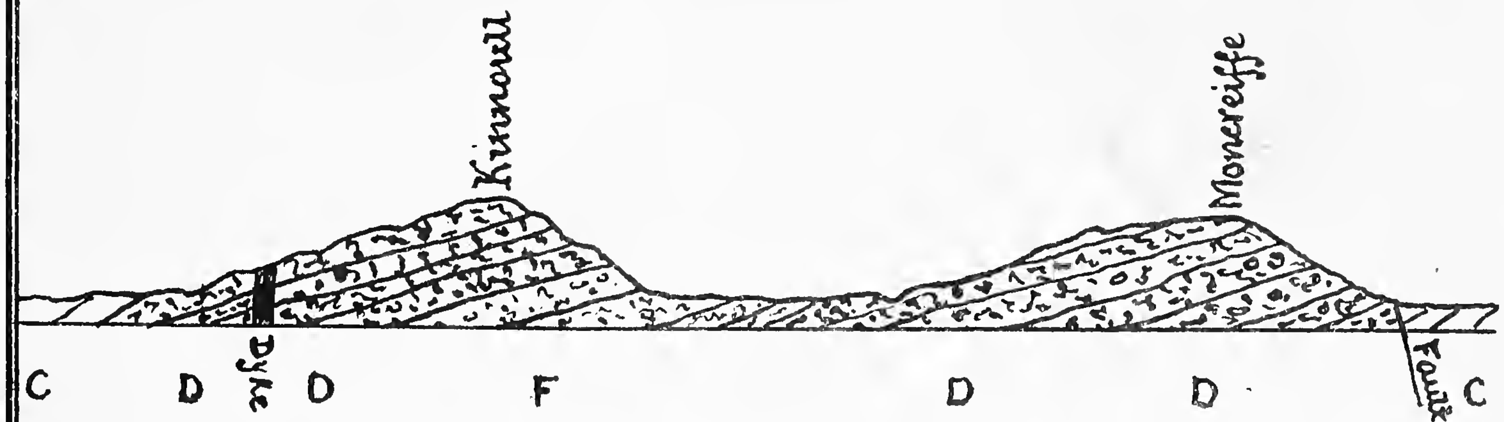


FIG 2 Section across the Valley of Strathmore and the TAY below Perth



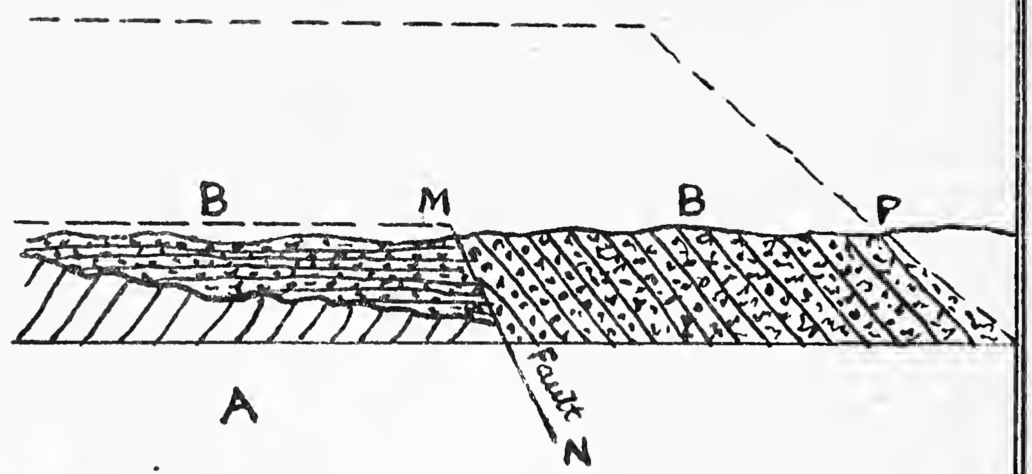


FIG 3 Section across Kinnoull + Moncreiffe Hills

FIG 4. Section across the Ericht near Blairgowrie

A Crystaline rocks of the Highlands

B Great basal conglomerate

C Sandstone Series

D Interbedded Porphyrites

E Upper old red Sandstone

F Local Conglomerates

XXIX.—*Flora of the Left Bank of the Tay between Perth and Glencarse.*

By W. Barclay.

(Read 12th February, 1891).

In a paper which appeared in a former part of the *Transactions* (Vol. I., p. 123) I gave some account of the flora of the right bank of the Tay between Perth and the mouth of the Earn. I now purpose to deal very briefly with that part of the river-bank which lies exactly opposite, beginning at Kinnoull Churchyard and ending at Cairnie Pier.

The plants occurring in the quarry at the end of the railway bridge and those in the little patch of wood at Kinfauns Station are included in the list. The latter is evidently a portion of the back-water of the river which has been cut off by the railway, and therefore comes properly within my limit. In all other cases the list includes only plants growing along the river-bank or on the low ground between that and the river.

Making a general comparison between the opposite banks, it will be found that on the left bank the ground is for a considerable part of the way drier and steeper, and much of it is wooded more or less closely. The marshy tracts lying between the bank proper and the river are much less extensive, so that it is easier to make a thorough search. In wading amongst the rank vegetation of the Elcho marshes you never feel sure that you may not have overlooked something, but in examining the opposite bank you have more confidence in the completeness of your investigation; you do not to the same extent get lost, so to speak, amidst tall and matted grasses and sedges. One part must be excepted. There is a sort of muddy gulf, or backwater, between Derry Island and Kinfauns Station, which is filled with water at every tide, and which is at all times too soft in most parts to be travelled over. So far, however, as can be judged from such an examination as it is possible to make, the flora seems to consist chiefly of the commoner water plants, and I do not think that even a more thorough search would add many names to the list.

On the whole, there is a very great similarity in the vegetation of the two opposite banks. The great majority of the species on both sides of the river are identical, though in many cases a plant may occur in greater abundance on one side than on the other. But there are also some noteworthy differences. The left bank, for example, is much richer in willows. Of these, a great many species occur, about Barnhill and Kinfauns, which are not found on the opposite side. *Pyrola minor* occurs at one place, about half-way between the railway bridge and Kinfauns, but is not found on the opposite bank. The melancholy thistle, *Cnicus heterophyllus*, is found in abundance in a marsh at Barnhill, whilst as yet only one or two plants have been got on the other side. Moreover, on the left bank, but not on the right, we find *Geranium sanguineum* and *G. pyrenaicum*, *Hypericum pulchrum* and *H. quadrangulum*, *Oxalis Acetosella*, and *Circæa lutetiana*. On the other hand, the flowering rush, *Butomus umbellatus*, one of the rarities of the Elcho marsh, has not been got above Cairnie Pier, though there is a bed of it farther down. *Rumex Hydrolapathum*, *Typha latifolia*, and *Carex acuta*, all rare plants, occurring at Elcho, are wanting on the other side of the river.

Beginning at Perth, and going down the river, I shall now notice the more noteworthy plants in the order of their occurrence.

On the outside of the wall at Kinnoull Churchyard, the creeping toad-flax, *Linaria repens*, has been established for a great many years. A little farther down *Petasites albus* shoots up in early spring, whilst immediately below the railway bridge, *Petasites fragrans* has long been known to keep its ground. In the quarry at this place we find *Geranium pyrenaicum*, *Trifolium arvense*, and *Trifolium striatum*, and on the railway, beside it, *Linaria minor*, a plant which seems to have suddenly made its appearance last year in great abundance at railway stations all over the country. Farther down, an alien, *Senecio Doria*, was found till within a year or two ago, but it has now, I am afraid, become extinct. From this point, and all the rest of the way down, we find abundance of *Aster Novi-Belgii* and *Allium carinatum*, the latter in some places displacing all other plants. At Barnhill also occur *Solidago lanceolata*, *Astrantia major*, and *Polygonum Bistorta*, all of course naturalised plants. Proceeding downwards, we find at Limehaugh scattered plants of *Sanguisorba canadensis*, and here also a small clump of *Arum maculatum* has maintained its position for several years. From the close proximity of the gardens at Barnhill to the bank of the river escaped plants are occasionally found there or farther down. I have seen Tulips, Sweet William, and other garden plants growing here and there, but of course these do not fix themselves permanently, and I have therefore not included them in the list. *Aquilegia vulgaris* would seem to belong to this category; but as it occurs farther up at several places, and as it seems to have become to some extent naturalised, I have given it a place in the list.

Between Walnut Grove and Derry Island there is nothing specially noteworthy, except perhaps, on a dry bank, scattered plants of *Pyrola* *minor;* at another place a clump of *Geranium pyrenaicum*, and near it a patch of *Scrophularia vernalis*. Derry Island, which is now not an island, but a peninsula, presents us with a number of interesting species. Several of these have only lately found a lodgment, showing that the river is a most efficient agent for carrying seeds from one part to another. Occasionally, also, plants which occur only in small quantity may be extirpated by floods, so that the flora of any part of the river-bank varies to some extent from year to year. This spring, for example, I found on Derry Island a fine patch of *Astragalus glycyphyllos*, which was certainly not there in previous years. This plant occurs up the Tay at Delvine and Thistle Brig, as well as on the Almond at Huntingtower. There can be very little doubt but that from one of these stations seeds have been carried down by the river, and have found a lodgment on Derry Island.

The Lupine (*Lupinus perennis*) also, which was first known to occur as a naturalised plant as far up as Aberfeldy, has gradually extended its range down the river. At various places it occurs abundantly, as at Birnam, Delvine, the island at Perth Bridge, and, indeed, all along the river wherever it finds a gravelly bank to suit it. It also is now within a very few years thoroughly established on Derry Island. Here also occur *Geranium sanguineum*, *Hypericum dubium*, *Veronica montana*, *Campanula latifolia*, *Campanula rapunculoides*, *Epipactis latifolia*. There is also in abundance a large *Symphytum*, but I have not been able to determine the species.

Returning to the beginning of the peninsula and crossing the railway, we enter the little wood previously mentioned. Here may be found *Aremonia Agriminoides*, an American plant belonging to the *Rosaceæ*, which has been known to grow at many places in the Carse of Gowrie for nearly half-a-century, and is therefore thoroughly naturalised. In the marsh which occupies the greater part of the wood there is a bed of *Carex vesicaria*, and at the foot of a tree a single plant of *Stachys Betonica* has kept its place for several years. Recrossing the railway at Kinfauns Station, we proceed again down the river-bank towards Seggieden, noting as we go scattered plants of *Epipactis latifolia* and numerous specimens of *Rudbeckia laciniata*. At Seggieden we meet with the rather rare *Rubus Leesii* (now a variety of *Rubus Idæus*). At this place Colonel Drummond Hay has known it for about forty years, and it has not been found elsewhere in Perthshire. Between Seggieden and Cairnie Pier there is a long stretch of marshy ground not particularly interesting. More than half-way towards Inchyra we met with *Eleocharis uniglumis*, *Œnanthe fistulosa*, and *Scirpus maritimus*. The latter two occur much higher up on the opposite side, both being found abundantly at Sleepless. A little above Inchyra, and also below it, there may be found *Allium Scorodoprasum*, which was also got on the opposite side, above the mouth of the Earn, by Mr. Meldrum and myself. Farther down Dr. Buchanan White detected in small quantity, this summer, *Festuca loliacea*, Huds., and *Glyceria maritima*, both rare grasses on the banks of the Tay.

It was mentioned previously that the tract included in this paper is rich in willows. Dr. Buchanan White has furnished me with the following information regarding these. Willows of various species occur all along the river, but the marshes at Barnhill and at Derry Island are the richest stations. *Salix pentandra*, which is very rare in Perthshire, is found at Barnhill, but has probably been planted. *S. aurita*, a very common willow in most places, is rare along this part of the river-bank. In the wood at Kinfauns Station there are curious dwarf forms of *S. Caprea*, with long leafy peduncles to the catkins. At Barnhill good *S. phylicifolia* occurs, whilst *S. nigricans* is found here and there, but is not abundant. At Kinfauns Station are several plants of x *S. strepida (nigricans* x *cinerea).* There is also very fine x *S. stipularis* at Barnhill, but probably planted. The hybrids *S. lutescens*, A. Kern., and *S. Reichardti*, A. Kern., probably occur near Kinfauns, but cannot with certainty be included in the list.

Of another difficult genus—the roses—four species only have been met with, but there are numerous varieties. The commonest forms are *Rosa mollis* and some of the early ripening varieties of *R. canina*, especially *R. glauca*, Vill.; *R. subcristata*, Baker; and *R. Watsoni*, Baker. I have included only those of whose occurrence I am certain, but there are probably several others which have not yet been detected.

In the subjoined list there are contained 383 species of Phanerogams, belonging to 56 orders, and 6 species of Cryptogams, belonging to the two orders of *Filices* and *Equisetaceæ*. Of these about 50 species cannot be considered as native plants, and there are a few others which have been found only in small quantity as casuals, so that the number of plants which can be justly considered as both native and thoroughly established will probably not reach beyond 330 species. But this is a very considerable number to be found in such a limited area, and proves that, on the whole, the left bank in this part of the river's course is richer than the right. This, no doubt, arises from the differences in the nature of the banks which have been pointed out in the introduction.

In conclusion, I have to thank Dr. Buchanan White for much assistance in perfecting the list, and also Col. Drummond Hay for the valuable information which I received from him.

List of Flowering Plants and Ferns growing on the Left Bank of the Tay beween Kinnoull Churchyard and Cairnie Pier.

Ranunculaceæ.

Anemone nemorosa, L.
Ranunculus hederaceus, L.
Flammula, L.
auricomus, L.
5 acris, L.
repens, L.
bulbosus, L.
Ficaria, L.
Caltha palustris, L.
10 Trollius europæus, L.
Aquilegia vulgaris, L.

Papaveraceæ.

Papaver somniferum, L.
Rhœas, L.
dubium, L.
15 Argemone, L.

Fumariaceæ.

Fumaria pallidiflora, Jord.,
b. Boræi, Jord.
densiflora, D.C.
officinalis, L.

Cruciferæ.

Nasturtium officinale, R.Br.
20 sylvestre, R.Br.
palustre, D.C.
Barbarea vulgaris, R.Br.
Cardamine amara, L.
pratensis, L.
25 hirsuta, L.
flexuosa, With.
Erophila vulgaris, D.C.
Hesperis matronalis, L.
(Escape).
Sisymbrium Thaliana, Hook.
30 officinale, Scop.
Alliaria, Scop.
Brassica Sinapis, Visiani.
alba, Boiss.
Capsella Bursa-pastoris, [Mœnch.
35 Lepidium Smithii, Hook.
Raphanus Raphanistrum, L.

Resedaceæ.

Reseda Luteola, L.

Violarieæ.

Viola sylvatica, Fr.
tricolor, L.
40 arvensis, Murr.

Polygaleæ.

Polygala vulgaris, L.

Caryophylleæ.

Dianthus barbatus, L.
(Escape).
Silene Cucubalus, Wibel.
maritima, With.
45 Lychnis alba, Mill.
diurna, Sibth.
Flos-cuculi, L.
Cerastium glomeratum, [Thuill.
triviale, Link.
b. holosteoides, Fr.
50 Stellaria media, Cyr.
Holostea, L.
graminea, L.
uliginosa, Murr.

Arenaria trinervia, L.
55 serpyllifolia, L.
Sagina procumbens, L.
Spergula arvensis, L.
Lepigonum rubrum, Fr.

Portulaceæ.

Montia fontana, L.

Hypericineæ.

60 Hypericum perforatum, L.
quadrangulum, L. (ex p.), Fr.
a. dubium, Leers.
quadratum, Stokes.
pulchrum, L.
hirsutum, L.

Malvaceæ.

65 Malva moschata, L.
borealis, L.
(Casual, on railway bank at Barnhill).

Geraniaceæ.

Geranium sanguineum, L.
sylvaticum, L.
pratense, L.
70 pyrenaicum, Burm. f.
molle, L.
dissectum, L.
Robertianum, L.
Oxalis Acetosella, L.

Ilicineæ.

75 Ilex Aquifolium, L.

Sapindaceæ.

Acer Pseudo-platanus, L.

Leguminosæ.

Ulex europæus, L.
Cytisus scoparius, Link.
ramentaceus, Sieb.
(One bush on Derry Island).
80 Lupinus perennis,
Ononis repens, L.
Medicago lupulina, L.
Trifolium pratense, L.
medium, L.
85 arvense, L.
striatum, L.
hybridum, L.
repens, L.
procumbens, L.
90 dubium, Sibth.
Anthyllis Vulneraria, L.
Lotus corniculatus, L.
pilosus, Beeke.
Astragalus glycyphyllos, L.
95 Vicia hirsuta, Koch.
Cracca, L.
sepium, L.
angustifolia, Roth.
Lathyrus pratensis, L.
100 macrorrhizus, Wimm.

Rosaceæ.

Prunus communis, Huds.
Padus, L.
Spiræa Ulmaria, L.
Rubus Idæus, L.
b. Leesii, Bab.
105 rosaceus W. & N., *b.* Hystrix, Weihe.
Radula, Weihe.
Koehleri, Weihe, *b.* infestus, Weihe.
corylifolius, Sm., *a.* sublustris, Lees.
b. conjungens, Bab.
c. fasciculatus, P. J. [Müll.
cæsius, L.

(The *Rubi* were collected by Dr. Buchanan White and named by Prof. Babington. Probably several other forms occur).

110 Geum urbanum, L.
x intermedium, Ehrh.
rivale, L.
Fragaria vesca, L.
Potentilla Fragariastrum, [Ehrh.
Tormentilla, Neck.
115 reptans, L.
Anserina, L.
Alchemilla vulgaris, L.
Sanguisorba canadensis, L.
Rosa mollis, Sm.
b. cærulea, Woods.
120 tomentosa, Sm.
b. subglobosa, Sm.
rubiginosa, L.
canina, L.
a. lutetiana, Leman.
c. sphærica, Woods.
e. dumalis (Bechst.)
g. urbica (Leman).
i. arvatica, Baker.
v. glauca (Vill.)
w. subcristata, Baker.
z. coriifolia, Fr.
*a**. Watsoni, Baker.
Pyrus Aucuparia, Gært.
Malus, L.,
b. mitis, Wallr.
125 Cratægus Oxyacantha, L.

Saxifrageæ.

Saxifraga granulata, L.
Chrysosplenium oppositifo- [lium, L.
Ribes Grossularia, L.
rubrum, L.
130 nigrum, L.

Crassulaceæ.

Sedum Telephium, L.

Halorageæ.

Callitriche vernalis, Koch.

Lythrarieæ.

Lythrum Salicaria, L.
(Casual).

Onagrarieæ.

Epilobium hirsutum, L.
135 montanum, L.
obscurum, Schreb.
palustre, L.
Circæa lutetiana, L., *b.* intermedia.

Umbelliferæ.

Astrantia major, L.
140 Carum Carui, L.
Ægopodium Podragraria, L.
Pimpinella Saxifraga, L.
Conopodium denudatum, [Koch.
Myrrhis Odorata, Scop.
145 Chærophyllum temulum, L.
Scandix Pecten-Veneris, L.
(Casual, on railway bank at end of Railway Bridge).

Anthriscus sylvestris, Hoffm.
Œnanthe fistulosa, L.
crocata, L.
150 Angelica sylvestris, L.
Heracleum Sphondylium, L.
Caucalis Anthriscus, Huds.

Araliaceæ.

Hedera Helix, L.

Caprifoliaceæ.

Sambucus nigra, L.
155 Lonicera Periclymenum, L.
Symphoricarpus racemosus, [L.

Rubiaceæ.

Galium boreale, L.
Cruciata, Scop.

Galium verum, L.
160 palustre, L.
Aparine, L.

Valerianeæ.

Valeriana officinalis, L.
Valerianella olitoria, Mœnch.

Dipsaceæ.

Scabiosa succisa, L.
165 arvensis, L.

Compositæ.

Solidago Virgaurea, L.
lanceolata, L.
Bellis perennis, L.
Aster Novi-Belgii, L.
170 Rudbeckia laciniata, D.
Helianthus tuberosus, L. (Casual).
Achillea Millefolium, L.
Ptarmica, L.
Chrysanthemum Leucan- [themum, L.
175 Matricaria inodora, L.
Tanacetum vulgare, L.
Artemisia vulgaris, L.
Tussilago Farfara, L.
Petasites fragrans, Presl.
180 vulgaris, Desf.
albus, Gaert.
Senecio vulgaris, L.
sylvaticus, L.
Jacobæa, L.
185 aquaticus, Huds.
Doria, L.
(I have not seen this for two years, so that it may be extinct).
Arctium minus, Schk.
Cnicus lanceolatus, Hoffm.
palustris, Hoffm.
190 heterophyllus, Willd.
arvensis, Hoffm.
Centaurea nigra, L.
Lapsana communis, L.
Crepis virens, L.
195 paludosa, Mœnch.
Hieracium Pilosella, L.
prenanthoides, Vill.
crocatum, Fr.
Eupatorium, Griseb.
200 Hypochæris radicata, L.
Leontodon autumnalis, L.
Taraxacum officinale, Web.
Sonchus oleraceus, L.
asper, Hoffm.
205 arvensis, L.
Tragopogon pratensis, L.

Campanulaceæ.

Campanula latifolia, L.
rapunculoides, L.
rotundifolia, L.

Ericaceæ.

210 Calluna Erica, D. C. (In small quantity).
Pyrola minor, Sw..

Primulaceæ.

Primula vulgaris, Huds.
veris, L.
Lysimachia nemorum, L.
215 Nummularia, L.

Oleaceæ.

Fraxinus excelsior, L.
Ligustrum vulgare, L.
Syringa vulgaris, L.

Apocynaceæ.

Vinca minor, L.

Boragineæ.

220 Symphytum tuberosum, L.
sp.

Lycopsis arvensis, L.
Myosotis cæspitosa, Schultz.
palustris, With.
225 arvensis, Hoffm.

Convolvulaceæ.

Calystegia Sepium, R. Br.

Scrophularineæ.

Verbascum Thapsus, L.
Linaria repens, Mill.
vulgaris, Mill.
230 minor, Desf.
Scrophularia nodosa, L.
vernalis, L.
Mimulus lutens, L.
Digitalis purpurea, L.
235 Veronica hederæfolia, L.
agrestis, L.
persica, Poir.
arvensis, L.
serpyllifolia, L.
240 officinalis, L.
Chamædrys, L.
montana, L.
scutellata, L.
Anagallis, L.
245 Beccabunga, L.
Euphrasia officinalis, L.
Bartsia Odontites, Huds.
Pedicularis palustris, L.
sylvatica, L.
250 Rhinanthus Crista-galli, L.

Labiatæ.

Mentha hirsuta, L.
arvensis, L.
Origanum vulgare, L.
Thymus Serpyllum, Fr.
255 Calamintha Clinopodium, [Benth.
Nepeta Glechoma, Benth.
Prunella vulgaris, L.
Stachys Betonica, Benth. (One plant).
palustris, L.
260 sylvatica, L.
Galeopsis Tetrahit, L.
Lamium purpureum, L.
album, L.
Teucrium Scorodonia, L.
265 Ajuga reptans, L.

Plantagineæ.

Plantago major, L.
lanceolata, L.

Illecebraceæ.

Scleranthus annuus, L.

Chenopodiaceæ.

Chenopodium album, L.
270 Bonus-Henricus, L.
Atriplex patula, L.

Polygonaceæ.

Polygonum Convolvulus, L.
aviculare, L.
Hydropiper, L.
275 Persicaria, L.
lapathifolium, L.
amphibium, L.
Bistorta, L.
Rumex conglomeratus, Murr.
280 sanguineus, L., *b.* viridis, Sibth.
obtusifolius, L.
crispus, L.
alpinus, L.
Acetosa, L.
285 Acetosella, L.

Euphorbiaceæ.

Mercurialis perennis, L.

Urticaceæ.

Ulmus campestris, Sm.
Urtica dioica, L.

Cupuliferæ.

Betula alba, L.
290 Alnus glutinosa, L.
Corylus Avellana, L.
Quercus Robur, L.
Fagus sylvatica, L.

Salicineæ.

Salix triandra, L.
(Derry Island).
295 x decipiens, Hoffm.
(Derry Island and Barnhill).
pentandra, L.
(Barnhill; probably planted).
fragilis, L.,
b. britannica, Buchanan White.
alba, L.
aurita, L.
(Barnhill).
300 cinerea, L.
Caprea, L.
(With curious forms near Kinfauns Station).
phylicifolia, L.
nigricans, Sm.
(Below Barnhill and at Derry Island).
x strepida, Forbes.
(Kinfauns Station).
305 viminalis, L.
x Smithiana, Willd.
a. stipularis, Sm.
(Barnhill and Derry Island).
b. sericans, Tausch.
(Barnhill; Kinfauns).
purpurea, L.
(With forms Lambertiana and Woolgariana).

Coniferæ.

Pinus sylvestris, L.

Hydrocharideæ.

Elodea canadensis, Mich.

Orchideæ.

310 Epipactis latifolia, All.
Orchis latifolia, L.
maculata, L.

Irideæ.

Iris Pseudacorus, L.

Liliaceæ.

Allium Scorodoprasum, L.
315 carinatum, L.
ursinum, L.
Scilla nutans, L.

Juncaceæ.

Juncus bufonius, L.
glaucus, Ehrh.
320 effusus, L.
conglomeratus, L.
supinus, Mœnch.
lamprocarpus, Ehrh.
acutiflorus, Ehrh.
325 Luzula maxima, D.C.
campestris, D.C.
multiflora, Lej.

Aroideæ.

Arum maculatum, L.

Lemnaceæ.

Lemna minor, L.

Alismaceæ.

330 Alisma Plantago, L.

Cyperaceæ.

Eleocharis palustris, R.Br.
  uniglumis, Link.
Scirpus setaceus, L.
  Tabernæmontani, Gml.
335 maritimus, L.
  sylvaticus, L.
Eriophorum angustifolium, [Roth.
Carex dioica, L.
  echinata, Murr.
340 remota, L.
  curta, Good.
  ovalis, Good.
  Goodenowii, J. Gay.
  glauca, Murr.
345 præcox, Jacq.
  panicea, L.
  sylvatica, Huds.
  flava, L.
  hirta, L.
350 rostrata, Stokes.
  vesicaria, L.

Gramineæ.

Phalaris arundinacea, L.
Anthoxanthum odoratum, L.
Alopecurus geniculatus, L.
355 pratensis, L.
Phleum pratense, L.
Agrostis alba, L.
  vulgaris, With.
Aira caryophyllea, L.
360 Deschampsia cæspitosa, [Beauv.
Holcus mollis, L.
  lanatus, L.
Trisetum flavescens, Beauv.
Arrhenatherum avenaceum, [Beauv.
365 Phragmites communis, Trin.
Cynosurus cristatus, L.
Dactylis glomerata, L.
Poa annua, L.
  pratensis, L.
370 trivialis, L.
Glyceria fluitans, R.Br.
  aquatica, Sm.
  maritima, Wahl.
Festuca ovina, L.
375 elatior, L.
  c. loliacea, Huds.
  arundinacea, Schreb.
Bromus giganteus, L.
  asper, Murr.
  sterilis, L.
380 commutatus, Schrad.
  mollis, L.
Lolium perenne, L.
Agropyron repens, Beauv.

Filices.

Athyrium Filix-fœmina, [Roth.
385 Lastrea Filix-mas, Presl.
  dilatata, Presl.

Equisetaceæ.

Equisetum arvense, L.
  palustre, L.
  limosum, Sm.

XXX.—*Hypnum procerrimum, Molendo: a new British Moss.*

By R. H. Meldrum.

(Read 7th April, 1892).

I was fortunate enough to find this species last July on Ben Lawers. This locality is well known to every botanist, whether he devotes his attention to Phanerogams or Cryptogams, for in both these divisions of the vegetable kingdom Ben Lawers is excelled by no area of equal extent in Britain. It may be said to be the Mecca of British botanists—a place to be visited by every one at least once in his lifetime,—and, as a matter of fact, few, if any, botanists of note in this country have failed to make the pilgrimage thither, or to revisit it again and again.

Every summer witnesses numbers of enthusiastic individuals toiling up its slopes. Beginners in the study of plants are there, eager to obtain specimens of the rarities known to occur in its corries and on the ledges of its precipices. There, also, are the past-masters in the science, searching every nook and cranny in the hope of discovering some novelty overlooked on previous visits, noting with interest what plants still keep their ground in spite of frequent ravages, or with regret observing that some of the rarest are year by year becoming still more rare.

The Ben is a sacred spot to the moss-hunter, even in a greater degree than it is to his brother of the spud. A great many rare mosses have been found here for the first time in Britain, and, though many of these have of late years been obtained in other parts of the country, a fair number still remain recorded from it alone. So many eminent muscologists have explored it over and over again that it might be thought that the knowledge of its Moss Flora was complete; but if it be borne in mind that to detect many of the minuter species a close and searching scrutiny of the ground must be made, that this has to be done on hands and knees, and that there are many ledges and slopes very difficult to get at, then it will not appear astonishing that new discoveries should still continue to be made on this much-visited mountain.

It is strange how often, on an excursion, the best find of the day is made by what seems the merest chance. It is a frequent subject of comment on such occasions how narrowly the plant escaped being passed over, and the moss at present under notice was no exception to this general rule. The particulars of its discovery are as follows:—I noticed some moss on the sloping face of a cliff almost out of reach. By dint of a little exertion I managed to obtain a small quantity, and the first look at it did not elate me in any degree, as I set it down as a very common species. Luckily I did not throw it away, as I was on the point of doing, but bagged it for home examination, on the principle that everything from Ben Lawers was worth careful inspection. So home it came, was dried, and laid aside with some other plants requiring careful study. About two months ago, on looking over my Herbarium, the appearance of a specimen of *Hypnum procerrimum* from Norway reminded me so forcibly of my

Ben Lawers plant that I at once got out my microscope and compared the two under it, and, to my great delight, found they corresponded exactly.

That there might be no mistake in the determination I despatched a specimen to Dr. Braithwaite, who replied, "Your *Hyp. procerrimum* quite agrees with a specimen I have from the Tyrol." *Hypnum procerrimum* has a considerable resemblance to a very common moss, *Hyp. molluscum*, for which it has probably been mistaken on Ben Lawers. It is distinguished from this species by its more robust habit and greater rigidity, by its stem being more denuded of leaves in the lower part, and especially by the margin of the leaves being quite entire. Only female flowers have been found, and it has nowhere been obtained in fruit.

On the Continent this moss has been found in many localities—on the Alps, in France, Switzerland, and Austria, on the Jura Mountains, and in at least one locality in the Pyrenees. It also occurs on the Dovrefelds in Norway. It is distinctly an alpine plant, and is confined to limestone, on which rock it was found on Ben Lawers. It will be noticed that its occurrence here is quite in keeping with its continental distribution, and, now that attention has been called to it, it may possibly turn up in suitable localities elsewhere.

I may here mention another moss, also a dweller on limestone, which I found the same day on Ben Lawers, and which I have not seen recorded from there, though I cannot imagine how it could have been overlooked, as it is quite within reach, and at a spot frequently visited by botanists. This is the rare *Pottia latifolia*, C.M., a minute species, but one very easily identified. If this has been found here before, it must have been very recently, and no record made of it.

XXXI.—*Report on the Geology of the Cuttings of the Crieff and Comrie Railway.**

By Henry Coates, F.R.S.E.

The total length of the Crieff and Comrie Railway line, now in course of construction, is a fraction under six miles, and its general direction is almost due east and west. Its eastern half, namely, that commencing at Crieff, is situated in the Lowland or Old Red Sandstone division of Perthshire; while its western half, or that terminating at Comrie, is situated in the Highland division. It

* Examined by the Society on 30th April, 1892, and on subsequent occasions.

therefore passes over the line of the "great fault" which runs between these two formations, and which forms, approximately, the northern boundary of the Midland Valley of Scotland.

All the cuttings occur on the eastern section of the line, as the western section runs over a comparatively flat stretch of meadow land. The only rocks exposed, therefore, are those of the Lower Old Red Sandstone Series. In addition to these, however, a number of interesting glacial and post-glacial deposits are seen.

There are altogether seven separate cuttings on the line, all of which are comprised within the first three miles from Crieff. In four of these the rock is exposed, while the other three are entirely, or almost entirely, through boulder clay and alluvial deposits.

The first cutting commences almost at Crieff Station, and has a total length of 1850 feet. This is the most complicated of the cuttings in its geological features. A few yards to the west of King Street the succession is as follows:—At the base is a bed of fine yellow silt, 8 feet in thickness. Resting on this is a layer of boulder clay, 1½ feet thick, in which the boulders are very large and very numerous. Next comes a bed of peat, 8½ feet thick, in which some thin layers of sand and grit occur. On the top of all is about a foot of surface soil. This bed of peat is quite local, and occupies a shallow basin in the boulder clay. In all the other cuttings the boulder clay is surmounted by river deposits; but this particular area must have been occupied in post-glacial times by a marsh, undisturbed by river action. The bed of yellow silt underlying the thin band of boulder clay I am at a loss to account for.

About a hundred yards to the west, in the same cutting, the Old Red Conglomerate rises up in a buttress-like mass, and forms at that point the base of the series. This was well seen where the line passes under Burrell Street. The Conglomerate there dips towards the south-east at an angle of 30 degrees. Its upper surface is very much disintegrated, apparently by ice action. Resting on this disintegrated surface is a bed of boulder clay, which, to the west of Burrell Street, rapidly thickens, until it reaches a total height of 24 feet. The line at this point, however, is now being arched over and covered in, so that the opportunity for examining this section will not occur again. The stones in this mass of boulder clay were neither very large nor very numerous, and were all more or less rolled and rounded. It seems probable that it was this high bank of boulder clay which protected the marshy area, already described, from the action of the River Turret, and thus allowed the bed of peat to accumulate.

At the western extremity of this cutting, resting within a denuded trough of the boulder clay, is a deposit of river material, about 15 feet in thickness, consisting of coarse bedded gravel.

The next two cuttings I take together because of their obvious geological connections. These are the cuttings through the highest terraces on either side of the Turret valley, which the line here crosses. The cutting on the east or left side of the valley is 530 feet long, and that on the west or right side 1250 feet. The average depth of each is about 15 feet. The boulder clay appears at the base of each, varying in thickness from 2 to 6 feet. Some very large boulders are exposed, some of which are finely grooved and polished. Large numbers of the smaller stones were being broken up to provide ballast for the line, and thus a good opportunity was afforded for studying the contents of the boulder clay of this region. They consisted chiefly of rounded fragments of the crystalline rocks of the Highlands, such as felstone, granite, diorite, mica schist, quartzite, amorphous quartz, &c. A series of these has been preserved for the Museum, in which will also be exhibited some photographs of the sections, taken when they were freshly exposed.

The river deposits of these two cuttings consist of coarse and fine gravel, grit, sand, and silt. These are all more or less distinctly bedded, and the finer material frequently exhibits false bedding, indicating the action of running water. The pebbles in the gravel beds are all distinctly water-worn. These two high terraces of river material represent the action of the River Turret when working at a former higher level.

These beds of river gravel present a striking analogy to the Old Red Conglomerate which underlies them. In both the pebbles consist of rounded fragments of crystalline rocks, brought down from the Highland glens, and in both there are thin layers of sand and grit intercallated among the beds of coarser material. Judging from the configuration of the country, it seems probable that in Old Red Sandstone times the valley of the Turret had already begun to be formed, and that the river was then, along with the other streams of this region which flow in a south-easterly direction, bringing down vast quantities of pebbles from the crystalline rocks of the Highlands, and depositing them along the margin of the great fresh-water lake which occupied the Midland Valley of Scotland.

The fourth cutting occurs a mile and a half from Crieff, at the western extremity of Lady Mary's Walk. It is 1700 feet in length and 18 feet deep. The greater part of this cutting consists of boulder clay. Resting on the boulder clay, at the east end of the cutting, is a series of river deposits, which gradually thin out towards the west. These consist of bedded silts and coarse river gravel in alternate layers.

Half-a-mile farther along the line we come to the fifth cutting, which is perhaps the most interesting of the series. Here the beds of Old Red Sandstone proper appear for the first time. At the base of the cutting they rise up at an angle of 80 degrees, from which they curve round to the vertical, and then to a reverse angle of 78 degrees. (See Plate III.) The explanation of this up-tilting is, of course, that we are here almost upon the line of the "great fault" already referred to. In some places, where the surfaces of the beds are exposed, distinct ripple-marks can be seen, which seem to make the incongruity of the vertical position of the strata all the more apparent.

These sandstones are exposed in the cutting for a height of about 12 feet. Resting on the top of them—that is, on the truncated edges of the upturned strata—is a deposit of boulder clay, which reaches a height of 30 feet, and contains some very finely-glaciated boulders. (See Plate IV.) On the top of the boulder clay is a bed of fine sand, 4 or 5 feet in thickness, apparently of river origin.

The total length of this cutting is 725 feet, and its maximum depth is 45 feet.

I may here remark, in passing, that the denuded edges of the up-tilted sandstone are exposed in a very interesting manner in the bed of the River Earn, not far from this spot.

The sixth cutting is through another small outcrop of sandstone, scarcely a hundred yards from the last. It is 330 feet long and 5 feet deep.

The seventh and last cutting occurs just half-way between Crieff and Comrie, where the line is carried in a tunnel through the hill on which the Baird Monument stands. This hill is one of a series of small wooded hills which rise abruptly along the flank of the Grampians in this district, and consist almost entirely of Old Red Conglomerate. The tunnel is 270 feet long, and the Conglomerate through which it is bored is particularly hard and coarse. A bed of contemporaneous porphyrite is exposed in some parts of the hill, but not, so far as I could make out, in the tunnel.

In conclusion, I have to express my indebtedness to Mr. John Young, C.E., Perth, the chief engineer, and to Mr. Moncur, the resident engineer, who kindly gave me facilities for inspecting the cuttings, and also placed at my disposal the plans and sections of the line.

PLATE III.—CRIEFF AND COMRIE RAILWAY.

VERTICAL SANDSTONES IN FIFTH CUTTING.

PLATE IV.—CRIEFF AND COMRIE RAILWAY.

GLACIATED BOULDER IN FIFTH CUTTING (4 FT. x 2 FT. 3 INS. x 1 FT. 9 INS.)

IMPORTANT NOTICE.

As has been already intimated by Circular, a scheme has been adopted for the Extension of the Museum at an estimated cost of *not less* than £2500.

The Subscriptions promised up to date (15th Oct.) amount to upwards of £2200.

Members who intend to subscribe, and have not yet done so, will much oblige by intimating, as soon as possible, the amount of their Subscriptions to the Hon. Treasurer, JAMES MORISON, Esq., Blackfriars Street.

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1893.

WINTER SESSION, 1892-93.

10th November, 1893.

MR. HENRY COATES, F.R.S.E., President, in the Chair.

The following donations were intimated :—

Museum—Perthshire Collection.—Two Pike—from Mr. Foote, Stanley. Gadwell Duck—from Mr. J. A. Harvie Brown of Dunipace. Two Eggs of Stock Dove—from Viscount Stormont. Nest and Eggs of Capercailzie—from Mr. A. M'Gregor, Eastwood, Dunkeld. Two Water Voles—from Lieutenant-Colonel Duthie, Doune. Hoopoe—from Mr. H. Wedderburn, Yr. of Birkhill, per Colonel Drummond Hay. Nest and Eggs of Missel Thrush—from Miss Grace Morrison, Crieff. Lepidoptera—from Master Clement White, Annat Lodge. Geological Specimens—from Mr. Gray, Rev. F. Smith, Mr. Scott Moncrieff Penney, Mr. R. Dow, Mr. H. Coates, and Dr. Buchanan White. *Index Collection.*—Geological Specimens—from Rev. F. Smith. Cast Skin of Green Grass Snake—from Mr. E. Weston Bell of Rossie.

Library.—"The Scientific Evidences of Evolution"—from Mr. W. Barclay. Hugh Miller's "Tales and Sketches," "Sketch Book of Popular Geology," "Leading Articles," "First Impressions of England," "Scenes and Legends," and "Cruise of the Betsy;" Grant Allen's "Colin Clout's Calendar;" Plates from the Intellectual Observer—from Miss Wakeham. Photograph of the Rocking Stone on Craigie Barns—from Mr. W. Ellison, and Frame from Mr. H. Coates.

Colonel Drummond Hay of Seggieden sent for exhibition a specimen of the Hoopoe, with the following note on the

OCCURRENCE OF THE HOOPOE IN THE TAY DISTRICT.

It is with much pleasure that, as your Curator, I am enabled to exhibit this evening for your inspection a specimen of so rare a bird to the district (indeed to Scotland generally) as the Hoopoe. It was shot on the south bank of the Tay at Birkhill, by H. Wedderburn, jun., Esq., on the 8th of last month (October, 1892), and, having been at once consigned to me with the option of its disposal, I have now the further pleasure of placing it in the Society's Museum. As some members may not be fully acquainted with its habits, it may be fitting to mention a few particulars regarding them.

The Hoopoe is a veritable bird of passage, and in several parts of England it may be considered a pretty regular summer migrant, breeding and rearing its young where allowed to do so. In Scotland it is a much rarer bird, but has been noticed more or less in every county from Berwickshire to both the Orkney and Shetland Islands. In the county of Perth and Tay District, though other specimens may have occurred, there are only three known to me previous to the present one, the first being as far back as the year 1828, at Megginch, and the last, a specimen shot on the Moncreiffe estate, in Craigie Wood near Perth, about the year 1853, now in the possession of Sir Robert Moncreiffe. Of later years there are two notices of its occurrence, immediately to the south and north of the Tay Basin, namely, in those of the Forth and North Esk, at Elie, in Fife, in 1875, and at Dunninald, near Montrose, in 1882, both occurring in spring.

But it is on the Mediterranean seaboard where it is to be studied to perfection, for there it abounds, especially in the spring passage from Northern Africa in March and April; and at Malta, so common were they at that season, that I have seen them (with shame be it spoken) hanging up in scores in the Valetta market, and I have known them sent up to table, but under disguise—the bill straightened, the bird trussed, and the feet carefully cut off, and entered on the bill of fare as "Sicilian Snipe;" the ornithologist, however, was not to be taken in. After thus paying heavy toll, the Hoopoe spreads through all the southern and central parts of Europe, where they breed, generally returning south in August; but the young birds may, possibly, like those of the Cuckoo, its near ally, follow later on, which may account for their often appearing in this country in autumn, when the plumage, as is the case in the present subject, is by no means so bright or pure as it is in spring.

It is from the call-note that the Hoopoe takes its name, sounding like the words hoop hoop two or three times repeated in a low, soft, though somewhat guttural tone, which, the first time I heard it in the olive groves in Corfu, somewhat startled me, though I soon became accustomed to it, for they were very common, remaining all summer.

In habit, though frequenting woods, it prefers places where they are open, with moist fields adjoining where it can with ease plunge its bill into the soil, its food being small worms. It also feeds on ants and their eggs and small coleoptera gathered about old and rotten timber. The bird now under consideration, when first seen by Mr. Wedderburn, was flying pretty high up in the air over a potato field (it may be remarked there is a deal of old timber in the vicinity), and on watching it, it was seen to settle on an adjoining fence and then disappear, but on walking up to the spot where last seen, it rose out of the potatoes some little distance off, where no doubt it had been feeding, from the muddy state of both bill and feet.

Mr. Henry Coates, Delegate of the Society to the British Association, and Mr. R. Brown, Delegate to the East of Scotland Union of Naturalists' Societies, gave their Reports.

The President delivered the following Opening Address:—

Gentlemen,—It has been the custom in this Society, as it is in other Societies, for the President to open the winter session with a few remarks on the work of the preceding summer session. The custom has this advantage, that it helps to keep up the continuity of the Society's labours and to bridge over the rather long interval between the April and November meetings. In the present instance, the task of describing the principal feature of the summer session, namely the series of official excursions, has kindly been undertaken by Dr. Buchanan White. With regard to these, therefore, I shall merely state that they were supplemented by several unofficial excursions of a geological nature, in which I had the pleasure of taking part. These have resulted in some new light being thrown on certain questions relating to the Geology of the district, and also in the addition of a considerable number of specimens to the Society's collection of Rocks and Minerals.

Referring to Geology leads me to remark that the past summer has been one of special interest for Scottish Geologists—first, because the British Association has met in our Metropolis, and has been presided over by one who has done more than anyone else to popularise the study of Scottish Geology; and second, because that same geologist, Sir Archibald Geikie, has issued a new Geological Map of Scotland, with descriptive notes.

With regard to the first of these events, the meeting of the British Association in Edinburgh, the proceedings in the Geological Section were of particular interest to Scottish Geologists, both on account of the number of eminent Foreign and English Geologists who were present, and the part which these took in the discussion of Scottish problems. The value of these discussions also was much enhanced by the readiness with which the members of the Geological Survey were always willing to give the benefit of their practical experience.

With regard to the publication of the new Geological Map of Scotland, the value of such a map, corrected up to date, is evident, when we remember that only a limited number of the Geological Survey sheets are, as yet, available for the general public. My chief reason for referring to it, however, is the bearing which the descriptive notes have on the Geology of our own district, more especially with regard to the rocks of Highland Perthshire. These, I need hardly remind you, consist of a series of sedimentary rocks, all more or less altered, and highly diversified, together with intrusive masses of associated igneous rocks. All of these bear evidence of enormous antiquity, both in the textural alteration which they exhibit, and in the denudation which they have suffered. Anyone who has studied these rocks in Perthshire in conjunction with the Old Red Sandstone Rocks, which immediately overlie them, must have been convinced that the latter are but as the production of yesterday when compared with the antiquity of the former. Before the Old Red Sandstone was laid down, the crystalline and metamorphic rocks of the Highlands had been in existence for countless ages, during which they had been bent, crumpled and sheared, and had been wasted and worn until there remained only the ruined fragment of a former vast plateau of sedimentary rocks. Taking these facts into consideration, we are not surprised to find that geologists have gradually been relegating these rocks farther and farther back in the geological scale of time, until now Sir Archibald Geikie, in the notes referred to, has declared them to be, not only Pre-Silurian and Pre-Cambrian, but even Pre-Torridonian. In fact, the only rocks in Britain which he admits to be of prior origin are those of the Archæan or Fundamental Gneiss of the outer Hebrides.

So much, then, for what these rocks are *not*. If, in turn, we ask what they *are*, it does not seem possible to get a very definite answer. It is true they have got a new name, having been christened the "Dalradian" series, a name derived from the old Celtic kingdom of Dalriada, but this, as Sir Archibald confesses, is only "for the sake of convenient reference."

At first sight, it would seem almost incredible that the exact position in the geological scale of so important a series of sedimentary rocks, and their corelation to similar rocks in other parts of the world, should still remain undetermined. But we must bear in mind that the means whereby the relative age and horizon of other sedimentary rocks are recognised, are, in the case of the rocks under consideration, almost or altogether wanting. I refer, of course, to fossil remains. There are two obvious causes to account for this barrenness of organic remains, namely, the antiquity of the rocks, and the alterations which they have undergone. It may be, as Sir Archibald admits, that further research will yet reveal the "missing link" which shall connect these rocks with the great World-series of sedimentary strata; but in the meantime it would seem as if we must be content to study them as a group *per se*, and to treat them with the local isolation which is symbolised in their new name of "Dalradian."

I now return, however, to the more immediate concerns of our own Society. I have said that Dr. Buchanan White will give an account of the field work of the past summer, but that is not the only work which has engaged the attention of the Society since our last public meeting. Shortly after the close of the winter session, your Council met to consider the subject of Museum Extension. Before resolving to proceed with a scheme, there were two questions which had to be answered:—first, was the extension required; and, second, was it possible to raise the necessary funds. The first question they had no difficulty in answering in the affirmative; the second they resolved to put to the practical test by issuing an appeal to the members and general public. The wonderfully generous response with which that appeal has been met has amply justified the Council in their decision on the first question, for, of the large sum asked, namely £2,500, nine-tenths were subscribed within a few weeks. Such being the case, it is impossible to doubt that the remaining tenth will soon be made up. Where all have responded so liberally, it is perhaps invidious to single out individual donors, but I cannot help referring to one donation which gave the Council particular encouragement, namely, that voted by the City of Perth Co-operative Society. They believe that the Directors of that Society, in giving this donation, expressed their confidence in the benefits which the Museum will confer, especially on the industrial classes in Perth. The same remarks also apply to the very generous grant which was voted by the Duncan Trustees. Another gratifying feature has been the hearty support which the scheme has received from all parts of the County. One gentleman, on receiving a copy of the circular, came to Perth for the purpose of satisfying himself that more space was really required, and, as the result of his visit of inspection, sent a handsome donation.

Having received such substantial encouragement, it will be the endeavour of the Council, and of the members in charge of the different departments, to make the building and the collections as perfect as possible. In this connection I may be pardoned quoting two sentences from a letter I have received from our esteemed Curator, Colonel Drummond Hay. Speaking of the liberal response with which the appeal was met, he says, "It has given me a great stimulus in my particular department. I hope to make the Bird Collection quite worthy of it, and am working hard in that direction now." Colonel Drummond Hay has also sent me a letter which he received from Sir William Flower, Director of the Natural History Department of the British Museum, in which he refers to the proposed scheme as follows: "I was very glad to hear of the proposed extension of your Museum, which, ever since you showed it to me, I have looked upon as a model of what a provincial museum ought to be; and I am particularly glad to find that you are extending it upon the same lines, and keeping the Index, or general educational collection, quite distinct from the local collections. The addition of the new room will enable you to carry out this principle still more thoroughly." Such remarks, coming from so eminent an authority, need no comment from me to emphasise their importance.

In conclusion, allow me to glance at the programme of work before us for the winter session on which we have just entered. You will have observed that in the Syllabus which the Council have arranged, a prominent place is given to a series of papers on the Natural History of the Banks of the Tay. They have arranged these in the belief that systematic and combined research is likely to give more valuable results than are to be expected from isolated and individual study. It must not be supposed, however, that these papers will be at all final or exhaustive in their nature. It is not possible, and perhaps not desirable, that they should be. In several of the departments they will be merely preliminary reports, laying down the lines upon which future investigation may proceed. It is intended to confine the scope of these papers to the Tay proper, exclusive of its tributaries, from where it leaves Loch Tay, at Kenmore, to Invergowrie, where it leaves the boundaries of Perthshire. Laterally the area will embrace the immediate banks, as well as the lowest or most recent river terrace, including, of course, the river itself and its bed.

At first sight it might seem that the Natural History of this limited area is a subject that might soon be exhausted, but I think those who have undertaken its elucidation will have a different account to give of it. The valley of a great river must always be a scene of constant change and great variety. New forms of animal and plant life are constantly appearing and disappearing, gravel beds and sandbanks are never at rest, even the contour of the valley itself is the result of forces which are ever at work.

It is appropriate that the Physiography should head the series, for I am more than ever convinced that the study of geography is of paramount importance to the naturalist. No matter what his particular study may be, his first care should be to make himself thoroughly master of the topography of the district in which he is working, of the precise direction of its main systems of hill and valley, of the comparative altitudes of its different areas, &c. For the geologist this knowledge is simply indispensible, unless he is to degenerate into a mere collector of meaningless specimens, instead of a student of the past conditions of the earth's surface. To the botanist it is not less useful, if he wishes to work out the complicated problems of distribution and adaptation, while the same applies with equal force to the zoologist. By the study of geography I mean, of course, not the acquirement of a string of names, but the training which will enable us to realise, in a series of mental pictures, the contour of any given part of our country, and the relations of its several physical features. One of the most important aids in this study is the series of Orographical maps which have been brought to such perfection in recent years. When the Tay Valley papers are published in the Transactions, the Council hope to be able to illustrate them with a set of physical maps which Mr. Bartholemew, of the Geographical Institute, Edinburgh, has kindly undertaken to prepare.

It now only remains for me to say that I trust the session on which we have entered will be a very pleasant and profitable one, and that our meetings will not be lacking either in interest or attendance.

Dr. Buchanan White read the following account of the Excursions made during the summer of 1892 :—

As is our usual custom, the first official excursion was fixed for the Queen's Birthday (26th May), and although the date is too early for much to be obtained in the way of botanical or zoological specimens, yet the excursion is usually well attended. On this occasion a most enjoyable day was spent on, or in the neighbourhood of, Craigie Barns, near Dunkeld. The first spot to be visited was Cally Loch, a picturesque pond, of more or less artificial origin, lying at the base of the hill. The surface of the water was in many places white with the flowers of a plant which has, I think, been called from its scent the "Water Hawthorn." This is *Aponogeton distachyum*, a native of the Cape of Good Hope, but (as was pointed out in the account of one of last year's excursions) apparently perfectly hardy in this country, as it has grown in Cally Loch for many years. That its scent has been appropriately compared with that of the hawthorn we found from the whiffs of fragrance that the breezes wafted to us as we lay on the shores of the pond, lazily watching the bees visiting the curiously formed flowers. From Cally Pond we sauntered up the hill, lingering a while in the Duchess Charlotte's Cave—half natural, half artificial,—till finally we got to the edge of the precipice known as the Lover's Leap, where we halted to admire the grand view, new to most of the party. A slight haziness obscured the more distant hills, but Dunkeld, Birnam Hill, the valley of the Tay, and several of the Stormont Lochs—including the Loch of the Lows, "where the devil drowned his mother,"—made up a lovely scene. Near the top of the hill a fine plant of *Verbascum Thapsus* was noticed—a higher altitude for this plant than we had previously observed. (Happening to be on the hill in July, I looked for this plant, and found that some miserable wretch had pulled it up by the roots and broken it in two.) We next proceeded to the "Rocking Stone" (so called because it does not rock!), a great block of stone balanced upon three smaller ones, which in their turn rest upon an ice-polished and striated rock surface, the whole affording a grand example of glacial action. I am indebted to Mr. Barker for the following measurements taken during our visit:—Length of the "Rocking Stone," 13 feet; extreme breadth, 7 feet; extreme height, 5 feet; supposed contents, 17 cubic yards. The boulders on which it is balanced are each about 2 feet in length. The striations on the rock below the stone point between N.W. and N.N.W., but the long axis of the stone is rather more to the W. The material of the stone is the same as that of the neighbouring rocks, but it may have been brought from some distance, since these Highland schists occupy a wide area. After photographs had been taken by Mr. W. Ellison (one is now amongst the Lecture-Room series), a symposium was held on the hillside, and an interesting discussion took place, which, commencing with the glacial theory and the formation of the mountains surrounding the party, passed on to questions of much wider scope. The symposium ended, we went down into the valley of the Tay, noticing on our way some plants and insects of interest. Amongst the former was a single plant of the hybrid between *Primula vulgaris* and *P. veris*, whose occurrence was rather curious, as none of the latter species were observed in the vicinity, although not rare in the district; *Sagina subulata*, a plant which is rare in Perthshire, except on the trap hills and the conglomerates of the "Great Fault;" and lastly, a pink-flowered form of *Nepeta Glechoma*. Amongst the insects were *Argynnis Euphrosyne* and *Venilia maculata*, both of rather local distribution. A large nest of the Wood Ant (*Formica rufa*) was also found and examined with interest. The distribution of this species is rather curious. Though common in many parts of England, it does not occur, so far as I am aware, in lowland Scotland, but is abundant in woods, especially of fir, throughout a great part of highland Scotland to the north of the "Great Fault." Its nests, composed of fir needles or other vegetable debris, are sometimes 3 or 4 feet high and 12 or 15 feet in circumference. In addition to the rightful owners, the nests often contain a number of guests, mostly beetles, but also including one moth, one hemipteron, and a curious little crustacean, which either live in the older and unfrequented parts of the formicary, or are protected by various contrivances from any too familiar attention on the part of the ants. We had not time on this occasion to make a search for any of these creatures, since we had to ascend King's Seat, a small hill which lies between Craigie Barns and the Tay. On the top of this hill we found another beautifully glaciated rock surface, with well-marked striations, and resting on it another perched block, one end of which is supported by a smaller stone. The larger block has since it was deposited split into three. From King's Seat we made our way by the riverside, through the lovely grounds of Dunkeld Cottage, to Dunkeld, and thence to Birnam.

The second excursion was to Redmyre, a small woodland lake near Longforgan, and took place on 4th June. No plants of very special interest were observed on this occasion.

Our third excursion came off on 25th June. From Forteviot Station we went through the woods to Dupplin Loch. Soon after we had started it began to rain, and continued to do so the whole day. Near the bridge across the Earn *Echium vulgare* is common on the roadside. In the woods little of interest was seen, the best plant being *Apium inundatum*, which occurred in a small pool. Dupplin Loch and its neighbourhood used to be celebrated for a large colony of Black-headed Gulls. A number of years ago this colony is said to have migrated to Methven, but some of them returned to Dupplin some years ago, and we were glad to see that two large colonies now exist there. From the state of the marshes on the margins of the loch we were unable to search them properly, so passed on to another wood near the farm of Westmuir. Here the only plant worth noting was *Listera cordata*, which was abundant. Passing Westmuir, we examined the rough moorland pastures which extend between that place and Greenhill Farm. While not productive of anything very remarkable, this moorland may be said to be rather above the average of similar places, its surface being decked with the flowers of *Genista anglica*, *Trollius europæus*, *Polygonum viviparum*, and various orchids, such as *Gymnadenia Conopsea*, *Orchis latifolia*, and *O. maculata*, *Habenaria bifolia*, and, best of all, *H. albida*. In a mill-dam near Greenhill *Eleocharis acicularis* and *Nasturtium terrestre* were observed. On reaching Tibbermore Road we decided not to go on to Methven Moss, as had been the intention, but to walk into Perth, where we arrived about 6 P.M.—*very* wet!

On 4th July we paid a visit to Craighall, near Blairgowrie, a rich and attractive locality, to which in past years more than one excursion has been made by the Society. Before proceeding to Craighall some little time was profitably spent in examining, from a geological point of view, two quarries near the town. The geological features of these and other places visited during the day were pointed out by the President, Mr. Henry Coates, who has kindly furnished me with a report. In one of the quarries (of conglomerate) the pubescent form (var. *puberula*, Jord.) of *Sileve Cucubalus* was observed, as well as naturalized plants of *Aquilegia vulgaris* and *Saponaria officinalis*. At Craighall the party was most hospitably entertained by General Clerk-Rattray. (I may here remark that an unwritten rule of the Society forbids us accepting the kind hospitality which is often offered, but that on this occasion we could not avoid doing so.) Craighall House is romantically perched on the ledge of a high rock, at whose base the River Ericht flows, and from the balcony of the drawing-room a magnificent view is obtained of the wooded and precipitous ravine through which that river takes its rapid course. After duly admiring this, we proceeded to botanise up the river. Amongst other plants noticed were *Polygonatum verticillatum*, for which Craighall has long been famous, *Festuca sylvatica*, *Neottia* *nidus-avis*, *Epilobium angustifolium*, *Carex sylvatica*, and *Lychnis Viscaria.* The latter plant is said to have its habitat on trap rocks (which, indeed, it usually has), but here it grows on the conglomerate. In some other parts of Perthshire it finds a congenial home on the Silurian Schists.

The following is our President's report on the geology:—

The ground traversed in this excursion is of particular interest, because it embraces the boundary between the Old Red Sandstone and the crystalline rocks of the Highlands at a point where that boundary does not, as elsewhere in Perthshire, coincide with the line or the Great Fault. The first point visited was Blairgowrie Quarry, about half-a-mile from Blairgowrie, on the Coupar-Angus Road. Here the sandstones of Strathmore are exposed in an approximately horizontal position, showing that this point is in the central portion of the synclinal trough of Strathmore. Some local beds of conglomerate are intercallated with the sandstones, and the whole is capped by a pretty thick bed of boulder clay.

The next halt was made at the Catscraig Quarry, half-way between Blairgowrie and Craighall. This quarry is opened in a volcanic dyke, and presents some very characteristic features. The dyke can be traced across the country for a considerable distance westwards, being marked by a line of trees. It is one of the numerous dykes of Tertiary age which traverse the Old Red Sandstone formations in Perthshire. It consists of a dark close-grained basalt, containing small crystals of plagioclase. It presents very strongly marked columnar structure, the columns running transversely to the direction of the dyke. The conglomerate through which the dyke has been intruded is very much fused and altered at the places of junction with the basalt. Perhaps the most remarkable feature about the dyke is its position. Instead of being, as is usually the case, vertical, it is inclined at an angle of about 20 degrees to the perpendicular. This is probably to be accounted for by the proximity to the "Great Fault." Proceeding along the road towards Craighall, the configuration of the surface of the ground gave strong evidence of the geological structure beneath. The hard beds of conglomerate could be seen cropping out at a high angle of dip, exactly as they do in the lower part of Glen Turret. The precise position of the Great Fault could only be guessed at from this configuration, but it probably crosses Glen Ericht somewhere near the bridge at the entrance to Craighall.

The last point of geological interest which was examined was the cañon of the Ericht, above Craighall House. This natural cutting is instructive both from a stratigraphical and a dynamical point of view. The rock is conglomerate, but the bedding, instead of being, as it is at the mouth of the Glen, nearly perpendicular, is here nearly or quite horizontal. This fact tells us that we have here passed to the north of the line of fault, and are viewing the conglomerates in the undisturbed and normal position in which they were originally laid down. The bedding, which would otherwise be difficult to trace, is made evident by the intercallation of some thin beds of sandstone.

The glen itself is interesting as being the finest example we have in Scotland of the cañon type of valley. This was well seen in the view from the drawing-room window of Craighall House. The sides are in some places quite perpendicular for a height of over 200 feet. The reason for this conformation is, of course, that while the river has been cutting out its channel, the rock has been too hard to admit of the atmospheric agencies levelling off the sides, as they do in valleys which are cut through softer rocks.

Commencing on 27th July, a three days excursion to Ben Lawers was undertaken. I was unfortunately unable to take part in this excursion or to be present at the meeting of the Mountain Club, which was held with due solemnity. Since the botany of Ben Lawers is so well known it is unnecessary to mention the plants which were found.

Mr. Ellison tells me that, amongst other insects, he got a magnificent specimen of the rare and interesting *Pachnobia alpina*.

At the meeting of the Mountain Club the following poem was read:—

A STORY FOR THE TIMES.

There stood a weary man upon a hill,
Bowed with the burden of some four-score years,
"Enough! 'he cried,' I shall my days fulfil
Far from the strife of party hopes and fears;
Far from the clamorous multitudes that dog
The heels of statesmen, who with ready lies
Build—(upon ground that vies with younder bog)—
Utopian mansions fair to heedless eyes."

"Now will I get me from the men who use
Their country's needs as stepping-stones to power;
Who strive for votes, and confidence abuse,
So they may be the puppets of an hour,
And dance a season in the world's keen sight
And win applause awhile. Men who have nursed
Pin-pricks to festering sores, and called day night;
Who place their country last, their party first."

"Yon azure sky shall roof me night and day;
This verdant turf make princely resting place:
No strife shall mar the tenure of my way,
And, should I need the solace of my race,
I'll bid to my free palace those who seek
To study nature more than study men.
Union is strength, and they are strong, not weak,
Who work for Science in the mountain clan!"

He turned him, and before him stood a youth,
Girt round with vasculum and spud—
The garb of science. "Sir, now of a truth,"
The old man cried, "we two are of one blood:
We be as brothers; I your mistress own;
I too would work for her. Bird, Beast and Flower—
I love them all, and each deep-veinèd stone!
Clasp hands, my brother, I too own their power!"

The youth gazed long at him in calm surprise.
"You're daft!" said he. "I am not what you name;
I study plants, not all beneath the skies;
I leave the rest to others, and I blame

Them not: and yet that they should turn their back
  Upon this glorious riddle that I scan,
To study flighty moths, or stones that lack
  E'en life! There 're idiots in the mountain clan!"

He turned away, and fast upon his heels,
  With gauzy net streaming upon the wind,
Glasses on nose, a youth who runs and kneels
  And shouts—a youth to all things deaf and blind
Save to the captives of his net and box.
"Who'd heed those weeds!" he cried. "These feathered wings
Are better than a hundred thousand rocks!
  I scorn the man who thinks on other things!"

"The 'Fault' must lie beneath yon grassy slope,"
  (The old man turned and met the earnest gaze
Of one with hammer armed) "and I have hope
  To trace its outlines here. It must amaze
You, Sir, to see yon senseless fellows there,
  Intent on weed or flea, when they might see
This wondrous 'Fault,' and, with a little care,
  Might trace the cause why such a thing should be."

The old man flung him on the flinty ground,
  Bowed his grey hairs, and raised his voice and wept,
And the whole Club came running at the sound,
  And, looking each on each, their silence kept,
Not knowing what to say. One placed a flower
  Within his trembling hand, and one a stone,
And one a box of moths, but naught had power
  To stay the falling tear and check his moan.

Then starting wildly from his rocky bed,
  The old man up and faced them one and all,
"I from election lies and strifes have fled,
  But into other lies and strifes to fall!
Go! mar no longer with your hateful pride
  This peaceful nature! Man is always man,
He must exalt himself, must have a side
  Ranged against side. I scorn the mountain clan!"

The members laughed—and laughed—and laughed again;
  "Why bless you, Sir," they cried, "there's room for all;
You would not have a tailor sow your grain,
  Although the snip and farmer you would call
Britons alike? And if each man needs think
  His own trade best, sure 'tis a noble fault
And makes best work. Give us your hand, and drink
  A hearty toast to us in—British Malt!"

The old man dried his tears and ceased his groans,
  And as he was an agèd man and grey,
They placed him high upon a cairn of stones
  And made him pledge them first that summer's day.
And on the hills there rose a plaintive strain,
  Unearthly notes sung at each man's sweet will,
And the old chorus once more used again
  That erst had sounded on another hill.

"Toast we here in three times three,
Plant, and stone, and giddy flea,
Mountain Club, and Willow Tree
            Salix herbacea floreat!"

"Toast we one and toast we all,
Members short and Members tall,
Those who sing and those who bawl
Salix herbacea floreat!"

"Now upon Ben Law'rs are met
Hammer, vasculum, and net,
Worldly strife may we forget,
Salix herbacea floreat!"

"Though a different work has each,
We the gay world well may teach
We have all one end to reach,
Salix herbacea floreat!"

"Toast we here in three times three,
Plant, and stone, and giddy flea,
Mountain Club. and Willow Tree,
Salix herbacea floreat!"

M. B. W.

On 13th August we went to the banks of the Almond, near Millhaugh Bridge. This excursion was partly geological, partly botanical. The geologists had their innings first, and spent several hours perched in picturesque attitudes on a precipitous cliff, at whose base the brimming Almond rolled along in full spate. The focus of attraction was some strata containing the curious fossil plant *Psilophyton*, which occurs here and there on the rocks of the Almond, this particular place being one where I found it some years ago. After some hours' work, in which the ladies who took part in the excursion especially distinguished themselves, a large amount of material was collected, on which Mr. Robert Kidston (who was with us) reports as follows:—

On the right bank of the River Almond, three-quarters of a mile below Millhaugh Bridge, in some beds of thin-bedded fissile micaceous buff-coloured sandstone, some remains of *Psilophyton princeps* Dawson were found. The fossils consist mostly of fragments of simple and bifurcated branches, and in one case a few of the rudimentary leaves are still attached to the stem. Two examples of the circinately coiled-up extremities of the branches were also found. On the slabs, along with the plants, were some indistinct remains, which may perhaps be referred to *Pterygotus*, and also what appeared to be a fish scale.

Mr. Henry Coates has furnished the following note:—

The beds in which the plant remains are found dip towards the S.E. at a moderate angle, and form part of the northern limb of the great synclinal trough formed by the sandstones of Strathmore. The strike of these beds runs approximately N.E. and S.W., and the horizon can be traced in the former direction as far as Carmylie, in Forfarshire, where there is an outcrop of similar plant-bearing beds. If careful search were made, it is highly probable that further developments of these beds would be revealed, and more light thrown on the very obscure Flora of the Old Red Sandstone. Some very fine slabs were obtained for the Museum.

Regarding the botany of the district traversed, there is not so much to report as would have been the case had the Almond not been in such high flood as to make access to its rocky banks difficult or impossible. While walking across from Methven *Radiola linoides* was observed in great abundance on an old road, the kind of habitat to which this little plant is very partial. Near the spot where the geological operations were being conducted the recently described *Hieracium euprepes* Hanb., was noticed in the place where it had been gathered before, whilst not far off *Paris quadrifolia*, *Circæa alpina*, &c., were gathered. About one o'clock the party divided, the greater number returning home, but a few carrying out so far as they could the original programme. As it was impossible to go along the river's edge, we crossed the picturesque bridge at Millhaugh, and proceeded to Logie House. On the way thither *Sambucus Ebulus* and *Corydalis claviculata* were found. Near Logie House the only noteworthy plant observed was *Carex sylvatica.* Passing the house, a descent to the river was made, with the result that the party got entangled amongst the rocks, a position from which they extricated themselves with some difficulty, owing to the slippery nature of the precipitous banks. In the woods *Paris* was seen in great abundance, the blue berries being conspicuous above the already decaying leaves. After lingering for a few moments on Dronach Haugh, where Bessie Bell and Mary Gray "bake fornent the sun," Lynedoch was passed and the Bridge of Dalcrue reached. Thence the left bank of the river was followed to Pitcairngreen, near which *Epipactis latifolia* was seen in its old station, and in due time the train caught at Almondbank.

On the 25th of August we renewed our acquaintance with Kincardine Glen, near Auchterarder, and, favoured with brilliant weather, had an enjoyable stroll through this lovely wooded and winding valley. Since the botany has been described in notices of previous excursions to this place, I need only mention two plants—namely, *Carex lævigata*, which we had not observed here previously, and the curious fungus, *Strobilomyces strobilaceus*, very rare in Britain, and only once found before in Scotland (near Crieff) some years ago.

This completes the list of the official excursions which were carried out; but, as in former years, there were some other excursions of which it is desirable that some record should be kept.

On 13th June Colonel Drummond Hay and I explored a rocky ravine near Pitlochry, where he had shortly before discovered a new station for *Polygonatum verticillatum.* In addition to this plant we found *Carex paludosa* (first found in the same place by Mr. James Coates some years ago), *Stellaria nemorum*, and *Festuca sylvatica* var. Outside a garden we noticed *Geranium pyrenaicum.* On the evening of the same day we went to the other side of the Tummel to look at a new station for the very local *Astragalus glycyphyllos.* This plant grows also on the banks of the Garry, and, as *Astragalus hypoglottis* also grows in the neighbourhood, and *A. alpinus* in one spot on the hills, Pitlochry has the distinction of being the only locality in Britain where the three British species of *Astragalus* occur within three miles of each other. On 14th June we went to the Pass of Killiecrankie.

(I may remark that an attempt is often made to charge for admission to the old road which goes through the Pass. I understand that the right to make any charge is very doubtful, and therefore any member of the Society who may wish to botanise there should decline to pay). The first plant to attract attention was *Neottia nidus-avis*, first noticed here some years ago by Miss Drummond Hay. This curious plant had not been previously recorded for the Athole district. Farther up the Pass *Symphytum officinale* and its var. *patens* were seen to be increasing in quantity in a spot where they have been for many years. The chief object of our search was, however, the very rare *Lathyrus niger*, which it was feared might have become extinct. This, we are glad to say, is not the case, for, though we found one plant only (which we did not touch), it is probable that there may be others. It is to be hoped that few persons know the exact station (the Pass of Killiecrankie is well known as a locality, but that is sufficiently vague), and that those who do know it, or who may find it, will remember the importance of preserving this, one of the rarest of British plants. At Killiecrankie Station we looked in vain for *Arabis perfoliata*, which used to occur here. It may, however, reappear. Leaving the Station, we went a little way up the Allt Girnaig for the purpose of seeing whether *Galium Mollugo* still grew there, which it does. We saw also *Polygonatum verticillatum* in its old locality. Retracing our steps, we crossed the river and ascended to the rocks of Corrie Hoolachan (phonetic spelling !). The botany of this spot has been described in the reports of previous excursions, so need not take up time now. On 15th June we paid a visit to Loch Tummel to have a look at *Schœnus ferrugineus*, which, I am glad to say, shows no falling off since the time that it was first found by Mr. Brebner in 1884. The great abundance of *Drosera anglica* on both sides of the loch is a noticeable feature. On each side of the ferry a *Lysimachia* (presumably *L. vulgaris*,* but very narrow-leaved and not in flower) is abundant. *Isöetes lacustris* was found in the loch, and *Iris Pseud-acorus*, a rare plant in the district, near it. This excursion, like some others, ended in heavy rain.

Having in consideration that part of the course of the Earn had not been thoroughly (if at all) explored, Mr. Barclay and I made two excursions along the banks of that river. On the first occasion we went to Tullibardine Station, and, after a walk of some miles, struck the Earn near Kinkell Bridge. We then explored the right bank to near Dunning, without, however, much reward for our trouble, the rarest plant we found being *Nasturtium sylvestre*. Some of the willows, however, seem to deserve further attention.

On our second visit to the Earn we started from Crieff, and went up the left bank to near Comrie. This portion of the river is not only much more picturesque than that traversed on the previous excursion, but much more productive of plants. Amongst other species observed the following may be mentioned:—*Equisetum hyemale*, in much greater abundance than in the other three Perth-

* Colonel Drummond Hay has, since this was written, proved it to be *L. vulgaris* by growing a plant.

shire stations known to me. We first saw this plant during the visit we paid to the railway cuttings in May. *Teesdalia nudicaulis,* being the third place only in Perthshire in which I have seen it, though one or two other stations are recorded. *Sagina ciliata*, which, though common near Perth, is either very rare or has been overlooked elsewhere in the county. *Carex lævigata*, which is very local and rare with us. *Carex vesicaria*, *C. sylvatica*, and *C. muricata.* On the shingles *Alchemilla alpina* was seen, and is mentioned only because the shingles of the Earn, unlike those of the Tay, are almost destitute of alpine plants, and we had not seen the *Alchemilla* previously. On one of the shingles an exotic *Sedum (S. lividum?)* had made an attempt to establish itself, whilst nearer Comrie we found two other plants naturalised, viz., *Antennaria margaritacea* and *Polemonium cæruleum.* We returned to Crieff by the road, and were glad to see that *Lactuca muralis* was not only holding its own, but seems to be spreading on the wall at Clathic, where we first found it during an excursion some years ago.

A brief record of another excursion made by Mr. Barclay and myself may conclude these notes. Starting from Stanley, we went down the road and struck the Tay at Thistle Brig. On our way we took a look at the station for *Carex pendula* (discovered a few years ago by Mr. Dow), and found this rare (with us) sedge not diminished in quantity. Near Thistle Brig *Sagina ciliata* and *Carex muricata* were observed, making a new station for both species. The most interesting plant seen on the banks of the Tay was *Astragalus glycyphyllos.* This is probably the station recorded by Rev. Mr. Liston in the "Statistical Account."

8th December, 1892.

Mr. Henry Coates, F.R.S.E., President, in the Chair.

The following donations were intimated—

Museum—Perthshire Collection.—Wryneck—from Mr. T. Marshall, Stanley. Two Green Woodpeckers and two Scops Owls—from Mr. John Stewart.

Library.—Books from Miss Wakeham and Mr. Henry Coates.

Mr. T. M. M'Gregor exhibited specimens of rare Perthshire Hemiptera taken during the past season.

Miss Wakeham (Forgandenny), Mr. J. Hume, Mr. A. Holm, Mr. W. Jardine, Miss C. M'Donald, Mr. T. .N Miller, Mr. R. Ewing, Rev. R. Kemp (Blairgowrie), Major Chalmers (Blairgowrie), Mr. W. E. Frost (Crieff), and Rev. J. Ferguson (Aberdalgie) were elected Ordinary Members.

The first portion of a series of papers on the Natural History of the Banks of the Tay was read by Mr. James Coates (on behalf of himself and Dr. H. R. Mill), Mr. Henry Coates, and Rev. F. Smith. (These papers will be published in Vol. II. of the Transactions).

12th January, 1893.

Mr. Henry Coates, F.R.S.E., President, in the Chair.

The following donation was intimated—

Museum—Index Collection.—Garnetiferous gneiss—from Mr. James Hay.

Mr. Daniel Sinclair, Dr. Carruthers, Mr. J. Ritchie, and Mr. J. Winter were elected Ordinary Members.

The second portion of the series of papers on the Natural History of the Banks of the Tay was read by Dr. Buchanan White (on behalf of himself, Mr. W. Barclay, and Mr. R. H. Meldrum).

After the Meeting a number of Microscopical Slides sent by Dr. Urquhart were exhibited in the library by Dr. Hay.

9th February, 1893.

Mr. Henry Coates, F.R.S.E., President, in the Chair.

The following donation was intimated—

Museum—Perthshire Collection.—A deserted nest and eggs of Capercailzie—from Mr. C. M'Intosh, Inver.

Sir A. Moncrieff, F.R.S., and Mr. D. Taylor were elected Ordinary Members.

The concluding portion of the series of papers on the Natural History of the Banks of the Tay was read by Colonel Drummond Hay of Seggieden and Dr. Buchanan White.

9th March, 1893.

TWENTY-SIXTH ANNUAL MEETING.

Mr. Henry Coates, F.R.S.E., President, in the Chair.

The following donations were intimated—

Museum—Perthshire Collection.—A stuffed specimen of the common Seal—from Mr. R. S. Brand, Milnefield, Dundee. Two Rabbits (varieties)—from Captain Drummond Moray of Abercairney.

Library.—"Contributions to a Fauna of the Shetland Isles"—from the author, Mr. J. A. Harvie Brown. "Modern Science and Modern Thought" (S. Laing) and "Note Book of an Amateur Geologist" (Lee)—from Miss Wakeham.

The following Reports were read and adopted :—

REPORT OF COUNCIL.

Your Council are much pleased that their Twenty-sixth Annual Report, which they now lay before you, shows signs of considerable progress. There have been six monthly meetings, with an average attendance of 45, the greatest number at one meeting being 58, on the 9th February, 1893, and the least, 28, on 7th April, 1892. This is the largest average attendance the Society has yet attained, and your Council are glad to think their effort to increase the attendance by the issue of reminder cards has been to some extent successful, and they hope that the very good papers, which have been read at these meetings, will prove an incentive to those whose attendance is rather lax to become more regular in the future. Twelve papers were read at these meetings, in addition to the retiring address of the late President, Dr. Buchanan White, and the annual and opening addresses of the President, Mr. Henry Coates. Thirty-four ladies and gentlemen have been admitted to membership, making up a total of 295, including 1 honorary and 12 corresponding members and 8 associates. During the summer seven very successful excursions took place, and the Council have pleasure in most heartily thanking those gentlemen who granted the liberty to visit their properties, and who in other ways contributed to the pleasant and profitable issue of these excursions. The Museum has again been visited largely by the public, the number amounting to about 2,800.

Your Council have again taken up the question of the extension of the Museum, and, having made an appeal to the public for funds, which has met with a very generous response, plans have been prepared and estimates obtained for such extension, and your Council hope a start will soon be made with building operations, so that the work will be carried out during the summer months. The erection of a substantial building, fitted with suitable cases, will cost a large sum of money, but your Council believe that the ample space which this extension will afford, and the greater value and interest which the Museum will thereby acquire, will encourage the members and all interested in educational and scientific matters to assist in the endeavour to raise sufficient funds to complete the scheme with credit to all concerned.

Death has again removed several of our members, amongst the number being Colonel J. Wedderburn Ogilvy of Rannagulzion, who has long been a member of the Society, and made various contributions to our Museum, in which he took a very great interest, often paying it a visit when in Perth. We have also lost a life-member in Colonel Macdonald of St. Martins.

During the year your Council have again granted the use of the Lecture Room to various local Societies.

REPORT OF TREASURER.

(See Balance-Sheet, page clxxvi).

REPORT OF CURATOR.

Your Curator, in tendering his Report for the past year, has to congratulate the Society on the long-needed enlargement of the Museum, speedily, he trusts, now to be accomplished. This, he need hardly say, has been a great stimulus to all concerned in endeavouring to render the various collections, not only worthy of the new building, and satisfactory to those subscribers who have so generously come forward in aid of it, but that the Museum, as a whole, shall be a credit to the city and county at large; but to do this thoroughly help will be required from all. This, your Curator may say, has been nobly begun by the munificent gift of our late President, Dr. Buchanan White (as many of you may be aware), of the whole of his splendid collections of Plants and Lepidoptera; but though all cannot compete in such handsome contributions, still we can but do our best. And it is a great pleasure to report some most valuable additions made in the Bird department, through the generosity of members and others, for which, in the name of the Society, our most cordial thanks are due:—From Mr. John Stewart, the presentation of a pair of Scops Eared Owls, as well as a pair of Green Woodpeckers—both most rare in the county; a Wryneck, from Mr. Marshall, of Stanley; a Pied Woodpecker, from Mr. Hugh Young, gamekeeper, Kilgraston, through Mrs. Bald; a Hoopoe, from Mr. Harry Wedderburn, Yr. of Birkhill—all most valuable local additions made since last Report. In the Nest department, a Capercailzie's Nest and Eggs, from Mr. Athole Macgregor; a deserted one, with Eggs, from Mr. M'Intosh; a Goldfinch's Nest and Eggs, now a great rarity in the county, from Mr. Duncan Dewar, Remony Lodge, Loch Tay. Furthermore, the Society are to be congratulated on having made a most valuable purchase from this same gentleman, not only of Mammals, now most rare in the county, if not extinct, but also of many rare Birds. These latter are now being remounted, and will be reported upon when finished. The Curator may also here mention that several birds have been prepared by himself for the Museum during the last few months, some of which have already been placed in it; others are awaiting further space, when the new building is completed, by which time he hopes to have made further additions. They are as follows:—One Hedge Sparrow, one Long-tailed Titmouse, one Coal Titmouse, one Rock Pipit, one Sheldrake (young female of the year), one Velvet Scoter (adult male), one female Red-breasted Merganser (adult), three Rock Doves (male, female, and young), one Buff-coloured form of the Common Snipe, three Purple Sandpipers (two males and a female), and one Red-throated Diver (adult), in winter plumage. With a view of more thoroughly elucidating the subject of Ornithology, a new form of label has been compiled, giving an epitome of the habit, migration, food, &c., of every species found within the county of Perth and basin of the Tay; also a set of labels for the nests, giving site, structure, number of eggs and their colour. Thus, taken as a whole, these labels will be found descriptive of every species within the said district, as it is the intention to have every label placed according to the classification, whether a specimen of the species be in the Museum or not. This not only shows, to those inclined to help, what is wanted to complete, but at the same time will afford to the general visitor a knowledge of the whole bird-life of the district. It may furthermore be mentioned that, under the sanction of the Council, the labels have been printed, making them much more distinct and legible, and are now finished and ready for the insertion of the names of the respective donor, locality, date, sex, and stage of plumage of each specimen, which necessarily has to be in writing, but that will be made as distinct as possible. The new labels being so much fuller and more explicit in detail, it is hoped that by their means a still greater interest will be afforded and knowledge obtained than was possible by means of the old ones. In conclusion, the Curator has only to add that the several collections are all in good order, and that, previous to building operations, everything will have been made secure against dust or damage of any sort.

REPORT OF LIBRARIAN.

In the Report for 1891-2 a hope was expressed that, in consequence of the large number of new volumes which had recently been placed on the shelves, a fresh catalogue might be printed before another year. This hope has now been fulfilled, and the catalogue, arranged with much care and completeness, has been circulated gratis among the members. The addition to the volumes in the Library has already shown good results, as the number of readers has this season risen from 30 to 40. Still there are a large number of members who fail to take advantage of the privilege they possess in having access to a large stock of literature fitted both to instruct and amuse. If any of those could find time to examine the shelves, they would certainly find in the collection something to repay their trouble. It is gratifying to find the Treasurer's balance on the right side; but there are many who might mark their interest in the spread of scientific knowledge by something more than the yearly sacrifice of 5/6.

The following Office-Bearers were elected :—

President—Henry Coates, F.R.S.E.

Vice-Presidents—J. Morison, Dr. A. Thomson, F.R.S.E., R. Brown, F.E., R.N., W. Barclay.

Secretary—S. T. Ellison.

Treasurer—John Stewart.

Curator—Colonel H. M. Drummond Hay, C.M.Z.S.

Librarian—James Coates.

Editor—F. Buchanan White, M.D., F.L.S., F.E.S.

Councillors—W. Ellison, J. M. Barker, Colonel John Campbell, and Ex-Dean of Guild M'Arthur.

The President delivered the following Address :—

GENTLEMEN,—I have to thank you for the honour you have done me in re-electing me your President for the ensuing year. I also wish to thank the Council and members for the very hearty way in which they have supported me during the past year in my endeavours to promote the prosperity of the Society, and for their kind indulgence towards my shortcomings.

The more I see of the working, both of this Society and of similar societies in other parts of the country, the more am I convinced of the usefulness of such organisations. In an age like ours, when utility counts for so much, when the struggle for existence has become so keen, and the distractions of social life so great, it is surely well to be able to turn aside now and then to consider those laws of nature which remain eternally unchanged. Sometimes, when I am asked what is the practical use of the study of Natural Science, I am tempted to reply that its chief benefit lies in its lack of practical use. With all of us the affairs of everyday life must necessarily occupy the greater portion of our time, and it is therefore a relief to turn occasionally to the study of truth for its own sake. Of course I am very far from implying that Natural Science has not yielded results of practical value to man. To take only Geology as an example, the agriculturist, the engineer, the manufacturer, etc., have derived immense advantage from recent additions to our knowledge of the earth's crust. But what I wish to emphasise is that, to the student himself, the reflex action of the study on his own mental nature is an ample reward for his labour.

It may be argued, however, that the student can carry on his investigations quite as well, or even better, by himself, without the aid of societies such as ours. In a few cases this may hold true, but experience has shown that in no subject is the interchange of opinion more useful than in Natural Science. Its branches are so varied and so interdependent on each other, that we are almost certain to fall into the errors either of a narrow specialism or a vague generalism unless we constantly compare notes with each other. Then, again, I have constantly found that new subjects of investigation, new facts to be ascertained, and new problems to be solved, have been suggested by papers that have been read and questions that have been asked at our meetings, as well as in the personal intercourse between our members. Thus it is that errors are corrected, views are broadened, and "Knowledge grows to more and more."

Before leaving the introductory part of my address, I wish to say a few words upon the work of the past session. I think we have cause for congratulation in the satisfactory nature of the Reports that we have just heard read. It is certainly gratifying to know that so many new members have joined our Society, and that the attendance at our meetings has been so good; but the question which concerns us still more vitally is this, What amount of really scientific work has been done? This is a question which perhaps it hardly becomes us to attempt to answer, but, if we are to believe the testimony of more than one naturalist at a distance, our work has not been altogether in vain. In particular, the scheme of papers on the Tay Valley which was drawn up by the Council has met with very friendly criticism from two or three authorities, who have urged that the papers, when completed, should be published as a separate memoir. As I have already pointed out, however, much yet remains to be done before we can have anything like a complete knowledge of the natural history even of the limited area prescribed in these papers, and I sincerely trust that this will be an inducement for some of our members, who have not yet taken up the study of any particular branch, to do so at once. This I would urge specially on some of the younger members who have joined during the past session, and I am sure I may promise them the encouragement and assistance of our more experienced workers. I give this assurance because I never knew any naturalist, either in this or in other societies, who was not always willing to give such assistance.

Speaking of the publication of the Tay Valley papers reminds me of the importance of having both these and other papers in our *Transactions* adequately illustrated. Illustrations are of immense service in rendering a scientific subject intelligible and interesting even to the unscientific reader; but, besides this, they are of distinct scientific value in placing on record details which could not be chronicled by any amount of verbal description. Within the past few years the art of permanent photographic reproduction has been brought to such perfection that illustrations of the kind to which I refer are very much more easily obtained than they formerly were; and the same may also be said with regard to the art of map-engraving and colouring. Of course the cost of illustrations is considerable; but perhaps this difficulty might be surmounted, as in some other scientific societies, namely, by a voluntary illustration fund.

One more feature of our work during the past session remains to be noticed—namely, the Museum Extension Scheme. On the financial aspect of the scheme I need not perhaps add to what I have said on former occasions, except to remark that I am sure the Treasurer will be glad to receive contributions from friends who have not yet subscribed! Apart from the raising of funds, however, your Committee have not been idle during the past months. Both personally and by correspondence they have been making enquiries in London, Edinburgh, Glasgow, and other towns, as to the most approved principles of museum construction, heating, lighting, etc., and the most suitable forms of cases, and they will utilise the information thus obtained in making the very most of the space and funds at their disposal. I take this opportunity of returning thanks to those in charge of other museums who have so willingly given us the benefit of their experience and advice.

I now pass on to the theme which I have chosen as the subject of my address to-night—namely,

THE HISTORY OF SCOTTISH GEOLOGY.

I am well aware that this subject is a very wide one—that it is, in fact, absurdly wide to be chosen as the subject of a brief address such as the present. Yet, as it is one which, so far as I can ascertain, has not yet been systematically taken up, I have thought that a slight preliminary sketch of it might not be without interest.

The history of the rise of Geology in Scotland is practically the history of the beginning of geology as a modern science. Just about one hundred years ago—namely, in 1796,—a book was published in Edinburgh which was destined to revolutionise men's ideas regarding the crust of the earth. This was James Hutton's* "Theory of the Earth." The book was halting and unattractive in style, and even its meaning was obscure in parts, but yet it possessed qualifications which rendered it far in advance of its time; so much so, in fact, that only now are its merits being fully recognised. It was written by one who brought shrewd common sense to bear on a subject which for generations philosophers had treated chiefly with imagination and speculation, mingled with a certain amount of superstition. Hutton wrote only of things which he had observed, and therefore of things which he knew. His preparation for the task, moreover, was ample, for he wrote his treatise at the close of a long life, spent in quiet observation of the facts of nature and contemplation of their meaning. The apparently accidental circumstances of his career, too, all tended to fit him for the task he was to perform. At first it was intended that he should follow medicine as a profession, and with this view he studied in Edinburgh, in Paris, and in Leyden. This not only brought him in contact with the best scientific teaching of the day, but it also gave him some insight into rock formations different from those to which he had been accustomed. In the meantime, however, a small property had been left to him in Berwickshire, and he decided to abandon medicine in favour of agriculture. He therefore went to Norfolk for two years to study agriculture. Here the training of the future geologist was still steadily, though unconsciously, progressing. Chemistry had always been with him a favourite study, and now he applied his knowledge in the improvement of the soils for agricultural purposes. His interest in mineralogy, too, was both stimulated and turned to practical account in investigating the origin of these soils. The next fourteen years were spent on his Berwickshire farm, and, if they were the least eventful, they certainly were not the least useful years of his life. First his attention was turned to the physical geography of the district, and he made himself thoroughly familiar with its systems of hill and valley and its water-courses. Not content with this knowledge, however, he began to ask himself what was the origin of these valleys. Had they existed since the beginning of the world, or did they result from the action of some natural forces?

* Born, Edinburgh, 1726; died, Edinburgh, 1797.

Were the rocks which formed the hills part of the primeval crust of the earth as at first created, or had they, too, been moulded and fashioned in Nature's laboratory during the silent ages of the past? These and similar questions James Hutton pondered and wrought out during long years of patient research, and the answers which he gave to them laid the foundations, not only of Scottish geology, but, as I have said, of all modern physical geology.

It may seem to some of you that I have given undue prominence to details in the life of one geologist, but it is surely of interest to note how ideas, which to us are scientific commonplaces, were gradually developed in the mind of their first exponent.

Hutton died the year after the publication of his "Theory of the Earth," and, so retiring had his life been, that his work might long have remained in obscurity had it not been for the efforts of a devoted follower. This was John Playfair,* who, in 1802, published an exposition of Hutton's views, entitled "Illustrations of the Huttonian Theory." In this book, while modestly disclaiming the credit of original research, he throws much fresh light on the subject as the result of his own observations. It contains, in fact, the result of so much careful study, and is put in such clear and graphic language, that it may still be regarded as a standard work of reference.

We will now glance very briefly at what Hutton's theory was, and how it compared with earlier theories of the earth.

The essential point of departure in Hutton's view of nature was that the phenomena which he observed were to be traced to the working of laws and forces which were still in operation around him. He believed that the earth's surface has assumed its present complex form through a gradual, uninterrupted, and majestic process of decay and reconstruction; that the materials of the rocks of other days have again and again been pulverised, and anon new rock-masses built up with their ruins. This was the conclusion which the old chemist and mineralogist arrived at from the study of the soils of his farm, and it is one which a century of research has since confirmed.

The older philosophers believed either that the earth had always existed as we find it to-day, or that its progress had been one of alternate periods of convulsion and quiescence. Never dreaming that wind, rain, frost, and stream could carve out a valley, they must needs suppose that at some past stage in the world's history the forces of nature had gathered head, and, with one mighty effort, changed the surface of the land. Such was the theory of cataclysm, or catastrophe, a theory which lingered on long after Hutton had shown its inconsistencies, which survived the brilliant attacks of Sir Charles Lyell, and which, even in our own day, has seemed to die hard.

About the same time that Hutton and Playfair were at work in Scotland, a new school of geology was springing up in Germany. This was the school of the Wernerians, called after Werner, a professor at Freiberg, in Saxony. In this professor's class there happened to be a young Scottish student, Robert Jameson,† who had

* Born, Bervie, near Dundee, 1748; died, Edinburgh, 1819.
† Born, Leith, 1774; died, Edinburgh, 1854.

come from Edinburgh to complete his scientific studies under the famous teacher. Shortly afterwards (in 1804) the chair of Natural History in Edinburgh University became vacant, and Jameson received the appointment. Thus, by a curious combination of circumstances, just two years after Playfair had published his plea in favour of the views of his late master, the chief official scientific post in Edinburgh was occupied by one who was deeply imbued with the teaching of a master whose views were diametrically opposed to those of Hutton. The consequence was that rival factions were formed, and for the next quarter of a century Edinburgh was the scene of a fierce war of words.

Werner, in trying to be all-comprehensive, had missed the true breadth of view of Hutton. Instead of arguing backwards from present known causes, he sought to frame a theory which would account for the beginning of the solid crust of the earth, and for all the varieties of mineral substance found in it. His supposition was that at first the globe was enveloped in one vast ocean, in the heated waters of which were dissolved all the minerals which were afterwards to form the solid land. These minerals, he then supposed, were gradually precipitated from their state of solution and deposited at the bottom of the ocean in the order in which we now find them.

Such were the two theories for which the gauntlets were flung down almost simultaneously. Out of the protracted battle which ensued truth and knowledge at length emerged, strengthened and purified by the contest. The followers of Hutton were known as "Vulcanists," or "Plutonists," and those of Werner as "Neptunists." Jameson, with true Scottish doggedness, stuck to his guns as long as he had an argument left; but at length even he had to confess, before a meeting of the Royal Society of Edinburgh,* that Hutton's view had been correct.

To us it may seem strange that so fantastic a theory as that of Werner should have survived so long; but we must remember that in those days, while chemistry and mineralogy had already made considerable progress, physical geology was in its infancy; and that, while the theory seemed to explain many of the facts of the former sciences, it was from the latter that it was to receive its death-blow. We must not forget, however, that the Wernerians did invaluable service to the cause of science. Professor Jameson was not only a most painstaking naturalist himself, but he gathered round him a band of enthusiastic workers, who constituted the Wernerian Society of Edinburgh, and the Memoirs of that Society still attest the value and accuracy of much of the work done. Indeed, the precision with which the Wernerians gathered and arranged their mineralogical facts was one cause which helped to keep the Wernerian doctrine alive. Another cause was that they took account of the presence of fossils in the stratified rocks, whereas the Huttonians appear to have almost entirely ignored organic remains.

While the conflict of these rival schools was in progress another original thinker was quietly following up the work of Hutton, and laying

* The exact date of this incident is uncertain.

the foundations of another great branch of geological science. This was Sir James Hall, Bart.,* of Dunglass, in East Lothian. He had the shrewdness to perceive that if the processes which Hutton asserted were going on in nature on a grand scale could be repeated in the laboratory on a small scale an important step would be taken towards proving the accuracy of Hutton's view. He therefore undertook a series of ingenious experiments with different rock masses and mineral substances, and was able to show that changes could be induced in their structure similar to those which Hutton believed had taken place over large areas. Thus, for example, he proved experimentally that a molten lava could consolidate into a basalt or trap-rock, that a limestone could crystallise into a marble, and that a stratified rock could be contorted into a schist.†

Thus far we have seen that to Scotland belongs the honour of having given birth to what may be regarded as the two most philosophical branches of geological science, namely, Physical and Experimental Geology. It is perhaps not too much to say that we owe this distinction to the analytic and logical tendencies of the Scottish mind. The next two steps in advance were taken by an Englishman, William Smith,—the "Father of English Geology," as he has been called. He it was who first traced out the orderly sequence of the sedimentary rocks, and showed that it is among their fossil contents that we must search for the key to their relative ages; and thus stratigraphical geology and palæontology sprang into existence.

William Smith's discoveries were first published in England in 1815, but at that time the Scottish geologists were so much taken up with their own disputes that little attention was paid to the order of the Scottish strata for some years to come. One of the earliest workers in this direction was Dr. John Macculloch,‡ who was employed by Government to make some scientific surveys in Scotland as early as 1811. His duties took him much into the Highlands and the Western Islands, which were then but little known to the scientific world, and he had thus a magnificent field for observation. He certainly made good use of his opportunities, so far as the careful noting of facts was concerned, but he was too conservative to allow himself to be influenced by the new views which were springing up regarding the origin of the earth's crust, and thus his writings, although voluminous, and in parts very graphic, lack the scientific value they would otherwise have. Indeed he never advanced very far beyond the pre-Huttonian mineralogists. In one respect, however, his work possesses considerable historical interest, for it was he who first drew attention to the fossiliferous limestones of the extreme north-west of Scotland, which were destined to be a bone of contention among British geologists during the next three-quarters of a century. Indeed the questions which were raised by the weather-beaten rocks of that "Ultima Thule" can hardly be said to be settled even at the present day.

* Born 1761; died 1832.

† The results of Hall's experiments were published in the Transactions of the Royal Society of Edinburgh.

‡ Born, Guernsey, 1773; died, Penzance, 1835.

The history of the long-protracted dispute regarding these ancient and most perplexing rocks—or what has been called the "Highland Controversy"—introduces to us the names of most of the eminent geologists who have hammered at the rocks of Scotland since Hutton, Playfair, Hall, and Jameson passed away. It will be convenient, therefore, to glance briefly over this history before proceeding further.

The question at issue in this controversy was one regarding the true sequence and relative age of certain beds of limestone, gneiss, quartzite, schist, and other metamorphosed rocks in that region. As early as 1819, Macculloch prepared and published a section of these rocks as they are exposed on the shores of Loch Erriboll. He was the first, also, to detect in the quartzites the presence of peculiar markings like worm tracks. In 1827 Sir Roderick Murchison * visited the district for the first time, and at once perceived that the rocks presented some very important and difficult problems for solution. Strangely enough, they formed the object of one of the earliest and one of the latest of his excursions during his long career as a field geologist. Although his headquarters were in London, and his greatest triumphs had been accomplished on the Continent, yet he always turned back with pleasure to his native Highlands of Scotland. During his geological rambles he was generally accompanied by one of his brethren of the hammer, partly for the sake of company, and partly that the one might check the results arrived at by the other. Thus the five visits he paid to the region of Assynt, in the north-west of Sutherland, were all in the company of men who were, or afterwards became, celebrated geologists. In 1827 Professor Sedgwick † was his companion; in 1855, Professor Nicol,‡ of Aberdeen; in 1858, Charles W. Peach,§ the naturalist and customs officer of Wick; in 1859, Mr., afterwards Sir, A. C. Ramsay;|| and lastly, in 1860, Mr., afterwards Sir, Archibald Geikie.¶

It might have been thought that even the hardest problem would have yielded to the combined hammering of so many brilliant observers; but not so. It was reserved for two members of the Scottish Geological Survey, working together, and a third geologist, working independently, to discover the true solution; and this they did so recently as 1884. The two members of the Survey were Messrs. B. N. Peach—son of C. W. Peach, above referred to—and J. Horne;** and the independent observer was Professor Lapworth.†† What these observers discovered was that an enormous displacement and inversion of the strata had taken place, so that great masses of

* Born, Tarradale, Ross-shire, 1792; died, London, 1871. See *Life* (1875), by A. Geikie.

† See *Life*, by J. W. Clark and T. M'K. Hughes.

‡ Born, Traquhair House, Peeblesshire, 1810; died, Aberdeen, 1879.

§ Born, Wansford, Northamptonshire, 1800; died, Edinburgh, 1886. See Smiles' *Life of Robert Dick*.

|| Born, Glasgow, 1814; died, 1891.

¶ See Biographical Sketch, *Nature*, 5th January, 1893 (Vol. XLVII., p. 217).

** *Nature*, Vol. XXXVIII., p. 29.

†† Proc. Geologists' Association, Vol. VIII., p. 438.

ancient gneiss, &c., had been actually thrust over the top of more recent deposits. In this way the paradox which had so perplexed the earlier geologists was at once explained. One other name remains to be mentioned in connection with this controversy, namely, that of R. J. Hay Cunningham,* who, in 1840, published a memoir on the Sutherland rocks, which showed great powers of generalisation. It is impossible, however, on the present occasion, to trace the history of this discussion in any detail, as it would afford abundant material for a paper by itself.

Leaving this "Highland Controversy," which bulks so largely in the history of Scottish Geology, we now turn back to fill in some of the remaining details in the general narrative.

The publication of Sir Charles Lyell's† "Principles of Geology" in 1830 marks an important stage in the progress of the science. In this work the doctrine of "Uniformitarianism," or the continuity of the forces of nature, which had been broadly sketched by Hutton and Playfair, was now for the first time worked out in detail, and proved by illustrations from natural phenomena in all parts of the world. Lyell's elaborate demonstration, however, was not fully accepted for many years to come. Men seemed to cling with a longing affection to the idea of periodic outbursts of latent powers of nature, and even Murchison was never able to free himself entirely from its trammels.

By this time the influence of William Smith's discoveries was beginning to be fully felt in Scotland, and therefore we shall find that the attention of Scottish Geologists was now more devoted to working out the relative age and position of their native rocks, and less to the theoretical and philosophical aspects of the science. For the next thirty years much excellent work was done in working out different groups of rocks represented in Scotland, and in carefully mapping out certain parts of the country. Although the conclusions which were arrived at have, in many cases, had to be modified in the light of subsequent knowledge, yet the results remain, both as a storehouse of facts for the modern investigator and as a monument to the earnest labours of workers who have now gone to their rest. I can only refer to a few of the more outstanding names.

In 1838 Charles M'Laren‡ published a "Sketch of the Geology of Fife and the Lothians," which, considering the time at which it was written, displayed a wonderful amount of careful research and accurate mapping. In 1840 Mr. A. C. Ramsay—who afterwards rose to the head of the Geological Survey, and received the honour of knighthood—published the first account of the geology of Arran. The island of Arran, presenting as it does almost an epitome of the geology of Scotland, has always been a centre of interest to geologists, and in 1859 another book on the same subject was published, written

* Trans. Highland Society, Vol. XIII.

† Born, Kinnordy, Forfarshire, 1797; died, London, 1875. See *Life*, by his sister-in-law, Mrs Lyell.

‡ Born, Ormiston, Haddingtonshire, 1782; died, Edinburgh, 1866. First Editor of *The Scotsman*. See *Memoir*, by R. Cox and J. Nicol.

by James Bryce.* In 1841 appeared one of the classics of Scottish geology, namely, Hugh Miller's† "Old Red Sandstone." It has been the fashion with some modern geologists to make light of Hugh Miller's work; but undoubtedly he rendered lasting service to geology, both as an original observer and as a populariser. In some instances, more especially with regard to the crystalline rocks of the Highlands, he made mistakes, and perhaps stuck to his mistakes with a too-unbending tenacity; but on the other hand, when he was dealing with matters of which he knew, few geologists could equal him for graphic descriptive writing. Professor James Nicol, of Aberdeen, published several treatises bearing on the geology of the whole or parts of Scotland, as the North-west Highlands, the Eastern Grampians, Glen Roy, Peeblesshire, Roxburghshire, &c. The mere enumeration of these shows how indefatigable a worker he was. In 1851 Murchison published an important memoir on the Silurian rocks of the south of Scotland,‡ in which, for the first time, the true structure of the Southern Uplands was sketched out. In 1859 there appeared a volume which possesses considerable local interest for us,—namely, "Dura Den, a Monograph of the Yellow Sandstone and its Remarkable Fossil Remains," by the Rev. John Anderson, D.D., Newburgh.§ The plates in this book, from the pencil of the Dowager Lady Kinnaird, are among the finest illustrations we have of Old Red Sandstone Fishes. The last of the descriptive Scottish geologists that I have time to mention is James Smith of Jordanhill,|| whose researches among post-tertiary remains in the west of Scotland have helped to clear up some of the difficult questions connected with glacial geology.

Of geological maps of Scotland several have appeared from time to time, but the older ones are, of course, more of historical than of scientific interest. One of the earliest, strange to say, was by a Frenchman, Dr. Boué, and was published in France as the result of a tour which he had made in Scotland. In 1836 Macculloch's map appeared, and, in 1842, a curious one by William Rhynd, of Edinburgh. In 1848 Professor Edward Forbes¶ published a palæontological and geological map of the British Isles, and in 1858 Professor Nicol published his geological map of Scotland. The most important of the earlier maps, however, was that by Murchison and Geikie, published in 1862.

One important chapter in the history of Scottish geology I have purposely omitted, namely, the work of the Geological Survey. This I have omitted for the same reason that I have passed in silence over

* Born, Killaig, near Coleraine, 1806; killed while geologising at Inverfarigaig, Loch Ness, 1877.

† Born, Cromarty, 1802; died, Edinburgh, 1856. Ses *Life and Letters*, 1871, by Peter Bayne.

‡ *Geol. Soc. Journ.*, Vol. VII., p. 139.

§ Born, Newburgh, 1797; died, Nice, 1864.

|| Born, Glasgow, 1782; died, Jordanhill, 1867.

¶ Born, Douglas, Isle of Man, 1815; died, Edinburgh, 1854; Professor of Natural History in Edinburgh University. See *Memoir* (1861), by George Wilson and Archibald Geikie.

the work of the present Scottish geologists, namely, because their work is not yet finished. I shall only mention, therefore, that the Geological Survey of Scotland was commenced in 1855.

In conclusion, let us glance back over this history of the progress of one department of knowledge in our country and summarise its results. Throughout the narrative I think we can trace the effects of two separate influences,—on the one hand, the inductive tendency of the Scottish mind, and, on the other, the romantic and varied character of Scottish scenery. The history also reflects, to a certain extent, the growth of knowledge in each individual mind. In the earliest stages, men examined and classified rocks as they found them, according to their appearance, and the minerals which they contained, without stopping to inquire how they had acquired their present form and position. Then came Hutton and his followers, and they began to regard nature more as a combination of living forces, and the landscape as something to be studied as a whole, and not only piecemeal. Next, interest was aroused in the evidences of past orders of life hidden in the stratified rocks, and fossils and the succession of the sedimentary formations absorbed all attention for a time. Now, lastly, in our own day, we are going back to the beginning of the cycle, and are finding that there is still work to be done, both in studying the minute structure and composition of the rocks and in viewing the landscape in its broad physiographical aspects.

23rd March, 1893.

Mr. Henry Coates, F.R.S.E., President, in the Chair.

Mr. A. S. Reid, Glenalmond, exhibited two geological photographs.

Mr. J. G. Miller was elected an Ordinary Member.

The following papers were read:—

1. "The British Camp at Castlelaw," by Miss Wakeham.
2. "Concretions," by A. S. Reid, M.A., F.G.S.

BALANCE-SHEET of THE PERTHSHIRE SOCIETY OF NATURAL SCIENCE for the Year ended 28th February, 1893.

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	£	s	d
To Balance at last Audit, ...	£1	1	11½
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,, Balance of Receipts from "Gilchrist Lectures,"	9	18	6½
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,, Sale of Naphthaline, ...	0	14	0
	£98	2	9

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	£	s	d	£	s	d
By Janitor's Salary, ...				£20	0	0
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,, Printing and Postages, ...				12	6	6
,, Books and Magazines, ...				7	0	8½
,, Subscription to the East of Scotland Union of Naturalists' Societies, ...				3	16	4
,, Insurance, ...				1	17	6
,, Miscellaneous Expenses, ...				6	19	0
,, Cash placed in Savings Bank, ...	£25	0	0			
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				26	6	11
				£98	2	9

PERTH, 8th March, 1893.—We, the undersigned, Auditors appointed by the Society, having examined the foregoing, and compared the same with the relative Vouchers, find them correctly stated and properly vouched—the sum in the Bank, at the credit of the Society, being £40 9s 6d, and in the Treasurer's hands £1 6s 11d.

(Signed) JOHN WINTER, JOHN HAY, } *Auditors.*

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Part I. of Volume II. will contain the series of papers on the Natural History of the Banks of the Tay, communicated to the Society during the Session 1892-93.

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