has been thrown up by wind and tide, and consolidating by bent grasses against the boulder bar. There seems every reason to believe that these agencies are still at work gaining land from the sea, and will probably continue in operation (especially if care be taken to protect the bent grasses), until the sands extend out to the point of the Scurdyness, where the shore would be exposed to the force of coast currents. The elevation of the land to its present level seems to have steadily gone on since the glacial era, but it is certainly less decided as we approach the more modern deposits.

If, in these brief observations, I have correctly interpreted the old estuarine deposits at the mouth of the South Esk, I have little doubt but that the same conditions, with trifling local variations, hold good in all our east coast estuaries, and that the patches of brick-clay along the banks of the Firth of Forth, Tay, &c., are mere remnants of a much more extensive sea-bottom which was swept away, after its elevation, by the great post-glacial currents.

II. *On the Causes which seem to have led to the Extinction of the New Zealand Moa.* BY JAMES MELVIN, Esq.

In travelling over the hilly dales, and through the bush of the middle island of New Zealand, the absence of animal life becomes very apparent; rats, which are now diminishing, and a few birds, appear to have been the only native occupants.

In riding along the banks of a stream, or where some cutting of the surface has been made by a rush of water, or for roads or water-races, you may see jutting out of the soil a portion of bone; or on the lonely hill-tops, along with the scraggy scorched remnants of pine timber, a weather-worn object meets the eye. When picked up it is also found to be a bone.

In certain districts the quantity of these relics of a past type of existence is considerable: they are found in different states of decay, depending very much on the nature of the soil in which they have been preserved. Some found in the silt, produced by the disintegration of the schist, are beautiful and white as the finest stucco, but crumbling, and as soft; others tough, tenacious, and strong. From most the gelatinous matter has disappeared, and the phosphate of lime has assumed the form of carbonate. In certain situations they are light, as are the bones of birds recently dead—in others, to appearance, they have added to their weight by abstracting either iron or lime from their bed.

The gigantic size of many of the specimens makes it hard to believe they have formed part of any bird; yet this is the case, and seemingly they all belong to the *Dinornis*. Thirteen different species have been enumerated, varying in size from four feet in height to about thirteen or fourteen, compared with which the

Emus are pigmies ; the ostriches, dwarfs ; and the largest known bird, the *Epyornis* of Madagascar, rivalling only the smaller species, while the cameleopard would be overlooked by the largest.

My attention was first drawn to the existence of so many records of the past occupants of the country, by noticing the number of bones turned over by the plough when the virgin soil was being broken up. On a flat piece of ground near the sea, and close to a stream, called the Awamoa Oamaru, Otago—near which Mr Mantell was said to have found some of the specimens supplied to Professor Owen—in extent about four acres, I traced a dozen of places where an animal had fallen. The spots where they had gone to decay might be distinguished by a somewhat rougher grass, and any of the bones which protruded from the soil were covered by the vegetation. The plough, in passing at the depth of five or six inches, seemed to lift up entirely the rotten bone-matter. The thigh bones being only entire, and those of the leg often broken.

In the heart of the mass, when the foot was pressed into it, three or four or more handfuls of quartz pebbles were seen—these, as in those on the table, were smooth and polished ; bone debris, pebbles, and the thigh and leg bones, thus formed the deposit. Over many hundred acres, in this the north-east of Otago, I traced the same remains, clearly showing vast numbers of birds had died there, and that also at no very remote period. In the same locality, six miles from the sea, in the Tertiary limestone district, there were several caves in which many bones had been found,—some of those on the table were obtained there. They were embedded in a calcareous mud, which had been carried down by the water passing through the openings in the limestone rock, and portions of which may be seen within the bone. In one of these caves I visited, leg bones, varying from three inches in length to thirty-four inches, were found, evidently the remains of young and old, and of different species. In other caves, in widely apart districts, similar collections of bones have been found ; and in the Dunedin newspaper, for November last, there is an interesting account of a great find in a cave at Saddle Hill, about eight miles from that town. By the river sides, in the interior of the country, on the Clutha, the Taeri, a place called Moa Flatt, on the Kawarau and Lindis, or wherever gold-digging has broken the surface, bones are exposed. As mentioned before, strewed over the hills, you may see them,—such as those on the table,—grey with age, but far more decayed on the upper than lower side, and at the elevation of about 3000 feet where these were got, within the destroying influence of occasional winter frosts, as well as the rain, sun, and wind. In the province of Canterbury and in Marlborough they seem to have been plenti-

ful, although their remains are found up to where the snows of winter lie. Yet it is in the plains or valleys where they seem to have existed in the greatest numbers, and in these situations they most abound where the soil is richest and driest; as, for instance, at Glenmark, Oamaru, Totara, Waikawaita, Moa Flatt, and in certain of the best soils of the Maniototo Plain; while in Southland, over the many thousand acres of the flatter downland of that country, few are found. These plains of Southland are all intersected with swampy water-courses, with a somewhat wet winter climate. In the higher districts of that province, where less rain falls, the bones of the bird begin to appear. Like the monks of old, they knew the best land, and chose it. They appear also to have preferred a somewhat open country with a certain amount of shelter, and apparently near to where forests existed; indeed, just such situations where they would have the best shelter, driest land to tread over, and where a variety of food could be had most readily.

There is now no doubt that the *Dinornis* is extinct. You meet many people who believe that in the deep valleys of mountainous country along the West Coast it will yet be found, and there are not a few who have stretched their imaginations into the belief of having seen it stalking with majestic stride in these lonely regions, for it must be recollected that the Moa is the great Sea Serpent of the New Zealanders; and many who believe in little else of the marvellous, seem acted on by some strange mysterious influence when it is talked of. The intense desire which exists to be the first to discover a real live Moa often leads to practical jokes, such as that which the assistant-surveyor Mailings played on his chief, Brunner, by inventing on the snow the track of a bird with a three or four feet stride.

It is hard to say how long it is since the last disappeared; some of these bones do not appear to indicate that centuries have passed. There is ample proof that they were contemporaneous with the present race of aborigines. In the Dunedin Exhibition, in 1864, an egg about $9\frac{1}{2}$ inches by 6 inches was shown: it had been found in the hand of the skeleton of a native in Marlborough Province. At the mouth of the Shag River quantities of bones, charred, and as if cooked, exist. In the heaps of refuse, near the Maori ovens, the bones of young birds, egg-shells, sometimes roasted-looking, are dug up. I heard repeated in various districts, the saying, "Moa kill Maori," "Maori kill Moa;" and early settlers, when the Maori race were more numerous in the Middle Island than now, repeat traditions they heard from them, that they had extirpated the Moa, because "it had killed their children." This, however, it is difficult to believe. The Maori race never seem to have been abundant in the interior of the Middle Island; there are few vestiges of their abodes or

kaiks. It is seldom that their skeletons are found even in the caves or under rocks where they generally put their dead; and suppose not a few were eaten, as cannibalism prevailed, their charred bones would have been found along with those of the Moa. This, however, is not the case. Indeed, although I carefully looked for human bones, I never met with any, or heard of many being seen.

In the great alpine ranges, extending along the west coast of the Middle Island, save on a few spots along the coast, there were no native settlements; and in the interior of that district there is no account existing of natives having lived there. Of course, from the altitude and severe winter climate, and the frequent summer rains, if other lands could be had, these would not be resorted to; and as the bones of the Moa are found at great altitudes, it may be supposed that they would have ample room to retire to when driven from the coast by the natives. It is in this region that the Kiwi or Apteryx is still to be got, and from Hokitika, or the Buller, or Greymouth, specimens are obtained.

Neither did any superior race of animals exist to aid in their extermination, and it never can be maintained that the pigs which Captain Cook let loose, and which multiplied so greatly, could have destroyed their eggs. Indeed, the last of the race seems to have disappeared before his visit.

In change of climate, from a rising of the land, it cannot be sought. The situations near the sea-level, where many of the remains are found, with vegetable soil beneath them, prevent the belief of this theory. There is more likelihood that certain atmospheric changes may have caused diseases to spread; as certain diseases, when once introduced, sweep off vast numbers of animals. For instance, were scab allowed to rage unchecked among the Australian flocks of sheep, the many millions now depasturing there would in a few years vastly diminish. But it is possible some might escape. Of all the sources by which the numbers of living creatures are increased or diminished none is more potent than food; and it appears to me that it is in this direction we may expect an explanation, rather than in movements of the earth's crust, in pestilence, or in the destruction caused by the aborigines, as the only superior race. In travelling over country fresh taken up, and comparing it with land long occupied, there are great changes apparent. Even, however, when man does not interpose, constant changes are going on. The old occupants of the soil are dying out and new tenants taking their place. In many of what are called the Bushes, the pine trees seem going to decay, and their place is being supplied by a very different form of vegetation. When the vegetable soil is turned up, it shows also evidence that it had been occupied with other than the present vegetation; and if the history of the formation of the undis-

turbed vegetable soil which covers the rock formations of the country could be read, it would afford us an insight into the successive races of vegetable, animal, and insect life, whose growth and decay had produced it. For instance, I have seen a portion of bone with an inch of soil covering it; below it, for two inches, there was another portion of soil, then a thin streak about half-an-inch in thickness of red earth, below this more vegetable soil to the depth of say four or five inches, and then the rock formation, on which the overlying soil had been formed. On closely looking at the red streak, it presented all the appearance of having been produced by fire; and in tracing it the extent became defined, and the form of a prostrate tree was apparent. The hollow cup, where its roots had been, and the adjoining mound, formed by the upraising of the earth and the action of fire on soil containing iron, producing the red dust; such process repeated during bygone ages, afford a clue to the appearance presented by the surface of the country at the present time, and may help us to some understanding of how food supplies might be increased or diminished.

From such observations, it is apparent that great changes have taken place on the vegetation in the district of country where the remains of the Moa most abound. There is an almost total absence of bush, and when first settled, Matautia (*Cardamine divaricata*), Snow-grass (*Schænus pauciflorus*), Flax (*Phormium tenax*), Fern-Trees (*Cyathea*), Cabbage-Tree (*Cordyline australis*), and Tutu or (*Coriaria ruscifolia*), proved the chief vegetable productions; and of these the tutu is poisonous, the leaves and seeds being extremely so, while the pulp covering the seeds is pleasant and agreeable, and harmless, so much so that the colonists make wine of it resembling that of black currants. At certain seasons this plant affords a large supply of berries, and at that period other descriptions of wild food is scarce. It is possible, then, that from great changes having taken place in the vegetable growths, the occurrence of frequent fires, and the rapid increase of the tutu, the seeds of which when dry would be spread by the wind, that the Moas may have been compelled to subsist to a greater extent than formerly on that fruit; and this, combined with the reckless destruction of eggs, young and old birds, by the Maoris, as proved by the digging up of the mounds near the ovens, a very great diminution of their numbers may have taken place. There, however, remains the fact that a large portion of the interior was open to them to retire to, where hardly a human foot had trod, and where entire seclusion existed. Of course, neither the climate nor food might be so favourable there as on the coast country, but many hundreds of warm sheltered valleys run in among the hills, and in the river sides opens exist, and there the Apteryx or Kiwi is still found. The

majestic creatures, however, whose prodigious power is manifest from their bones, are gone; and I cannot but join in the regret, which many of the New Zealand colonists feel, at not being permitted to look on those stately wingless birds, or to indulge the hope that some of their race may yet be seen alive.

III. *A short Account of the Life and Career of Edward Simpson, commonly known as "Flint Jack."* Read by GEORGE LYON, Esq.

Thursday, 5th March 1868.

J. R. S. HUNTER, Esq., Vice-President, in the Chair.

The following Communication was read:—

On the Evidences of Glacier Action in Galloway. By WILLIAM JOLLY, Esq. (Part I.)

CONTENTS:

PART FIRST—GENERAL DESCRIPTION OF THE REGION OBSERVED—THE CENTRAL MOUNTAIN GROUP OF GALLOWAY.

- I. The Locality and Physical Features of the District.
- II. The Geological Structure of the Region.
 - 1. The Lower Silurian Strata.—2. The Granite.
- III. The Glacial Period in Scotland, with special reference to Galloway.

PART SECOND—GLACIAL PHENOMENA EXHIBITED IN THIS REGION.

Method of making our Observations and Field Traversed.

- I. The Striated and Polished Rocks—Roches Moutonnées, &c.
 - 1. Valley of Black Dee.—2. Glen Trool.—3. Central Granite Plateau.—4. Valley of Pulharrow.—5. Granite Region between Wigtown Bay and Loch Ken.—The general Direction of the Striations.
- II. Glacial Remains in the Region.
 - (A.) *Glacial Clays and Debris.*
 - 1. The Merrick.—2. The Buchan Burn.—3. The Minnock.—4. The wild district south-west between the Merrick and the Sea.—5. Glen Trool.—6. Central Granite Plateau.—7. Valley of Dee.—8. Valley of Pulharrow.
 - (B.) *Moraines.*
 - 1. The Moraines of Loch Valley.—2. Glen Trool.—3. Buchan Burn.—4. Pulharrow Valley.—5. Loch Dungeon.
 - (C.) *Boulders, Perched Blocks, &c.*
 - 1. The Central Granite Plateau.—2. The Merrick.—3. "Rocking Stones."
- III. Lake Basins, and their connection with the Glacial Period.
 - (A.) *Lake Basins dammed by Glacial Debris.*
 - (B.) *Ancient Moraine-barred Lakes.*
 - (C.) *Rock-bound Lake Basins.*
 - 1. Loch Trool.—2. Loch Neldricken.—3. Loch Arron.—4. Loch Enoch.—5. Loch Dungeon.—6. Loch Doon.

CONCLUSION.

Some years ago we had the good fortune to be introduced by a friend to the grand mountain land of Galloway, and since then