T. trisulcum, Bailey.
T. unguiculatum, Grev.
T. venosum, Bright.
T. venulosum, Grev., var. *major*, n. var., Gr. and St.
T. weissii, Grun.
T. weiseflogii, n. sp., Gr. and St.
T. parallelum (Ehr.), Grev., with seven angles, Gr. and St.
T. parallelum (Ehr.), var. *gibbosa*, forma *ovalis*, Gr. and St.
Trinacria ligulata (Grev.), Gr. and St.
Trin. pileolus, var. *gutlandica*, Grun.
Trin. simulacrum, n. sp., Gr. and St.
Trin. ventricosa, n. sp., Gr. and St.
Xanthiopyxis oblonga, Ehr.
X. constricta, Ehr.

ART. XXXIV.—*Notes on a Deposit of Moa-bones in the Te Aute Swamp, Hawke's Bay.*

By A. HAMILTON.

[*Read before the Hawke's Bay Philosophical Institute, 9th July and 11th September, 1888.*]

IN this short paper I purpose bringing before you a few particulars with regard to the occurrence of the remains of the great extinct birds commonly known as moas in this island, with more especial reference to the localities in which I have myself obtained their remains.

There will be no necessity for me to do more than call to remembrance that our President (W. Colenso, F.R.S.) and the Rev. W. Williams, of Waiapu, were among those who had the pleasure and privilege of submitting the bones collected by them on the east coast of this island to Professor Owen, from which material his famous memoir was drawn up. In other memoirs the venerable professor has described collections made at various localities on the west coast, under the shadow of Mount Egmont, by Mr. Mantell; and in his classic work Von Hochstetter describes his arduous pursuit of fragmentary bones, and his delight at obtaining some specimens at Tuhua.

It would be hopeless to attempt to record all the localities at which finds of moa-bones have taken place, but I trust that the instances which have come under my personal observation, and which I bring before you to-night, will demonstrate the great length of time during which the moa was the absolute monarch of this land, roaming over this district in a perfect avian paradise, for, with the exception of the giant eagle (*Harpagornis*), there was no enemy of any kind to harass or

destroy them, unless we admit that the natives at a comparatively recent time assisted in their extermination, thereby hastening the final disappearance of a group of dinornic birds, which had inhabited an isolated land-area of limited extent for such a length of time as sufficed for the development of at least twenty well-defined forms or species, a large proportion of which it will be seen were co-existent in this district.

Mr. Park, in the Geological Reports for 1887,* gives an instance of the finding of bird-bones in the brown sands near Kai-iwi, Wanganui, by Mr. Drew, an energetic collector in that district; and goes on to say, "On examination they were identified as belonging to the latter" (small moa). This, I believe, is the first discovery of fossil moa-bones in New Zealand. When I arrived in Napier some years ago, Mr. F. Williams kindly showed me a block of sandy clay containing a well-preserved femur of a moa, and also several fragments of bone and some large pieces of egg-shells, all from one locality. He stated that they had been dug out of a cliff on the shore of the Inner Harbour, at an island called Te Ihu te Otere. These specimens were then sent to the Colonial Museum, at Wellington, where I saw them a short time ago. I visited the place where the bones were found soon afterwards, and succeeded in finding several fragments of bone and plenty of egg-shell.

The bones are found in the face of a high cliff formed of the Petane marls, and lie, together with a few large pebbles or shingle, at the bottom of a small valley of denudation which has been filled in by subaerial formation similar to the Petane clay and sand, containing fragments (blown?) of *Pecten novæzealandiæ* and great numbers of two small land-shells, *Therasia thaisa* and *Helix rotundata*. This filled-up valley has been cut through at right angles by the denuding action of the waves, which has determined the present coast-line of the harbour and bay. The height from the top of the cliff to the bottom of the synclinal trough thus exposed is about 90ft., a few feet at the top of the cliff being the prevalent superficial pumice of the district, and which caps most of the high country.

At one of my visits to this interesting locality I found a large block had fallen to the sea-level or beach (which is here about 10ft. or 12ft. below the moa-bones), and on one face of it I found a small femur which corresponds exactly with the figure given by Owen of that of *Notornis mantelli:* this I dug out carefully, and it is now in our Museum. Nearer the surface of the water, where the boring crustaceans had begun to riddle the block, I saw traces of egg-shell, and, examining it

* "Rep. Geol. Surv. of N.Z.," 1887, p. 63.

more closely, found that there were two regular layers extending over a considerable distance. Having cut out a large piece of the block, I brought it home, and you can now see on the table before you a fossil moa's egg. The egg has evidently been flattened, and thus shows two layers of shell extending all round the block more or less continuously.

Owing to the nature of the cliff it is impossible to make any further excavation in this place, although many fragments of bone and bits of egg-shell indicate that the bottom of this old gully yet contains many bones.

The Marine Parade of Napier does not seem a very likely place for moa-bones, but at the end of the Coote Road the sea cuts into a deposit of brick earth or loëss, which abuts sharply against the Limestone Bluff. The upper part of the section exposed is full of *débris* from the Bluff Hill; but below this, and more towards the steps, bird-bones of various sizes are occasionally to be found, and sometimes a moa-bone. I had the pleasure of showing one *in sitû* to Dr. Hector when he was here in 1878: since then several have been exposed. I have seen one within the last month. At the foot of the hills between Pakipaki and Mr. Douglass's station are some very deep creeks, coming from the limestone hills and cutting through slope-deposits and flood-silts. In one of these creeks I obtained about a dozen good moa-bones. In a valley of the Greenmeadows Estate, close by the Puketapu road-cutting, a large number of moa-bones in a very fragmentary condition were found when the swamp was drained and the ground first broken up. I was fortunate enough to get a few good bones of a small species of moa and some bones of the extinct eagle (*Harpagornis*).

Another very interesting locality, about which I hope to have something to say some day in detail, is the sea-beach near the woolshed at Waimarama. Here the beach is often swept of the sand by the waves right down to the blue clay, in which are seen stumps and roots of trees and moa-bones. Mr. Hill and I, the last time we rode by there, saw about half an acre of blue clay thickly studded with bones, all in too rotten a state to bear removal. Many bones have been got from the creek which here runs into the sea.

I have dug out a stout femur from the cliff on the north side of the Waikare River, near Mohaka; and in the Museum are four very fine bones which were found in the Poutou Creek, in the same neighbourhood.

This brings us to surface-finds, and here I must note some very large but much-decayed bones found by Dr. Hector in the Raukawa Bush, now in our Museum. They were found on the surface, but all the small bones had disappeared. Mr. Pine, of Raukawa, and myself found several good moa-bones in a creek

which drains a large swampy valley near the Raukawa Station, and I am in hopes that some day a large deposit of bones may be found there.

Away up the Tutaekuri River is a large tributary called the Mangahone. Here one of our members, Mr. Taylor White, has found some more or less perfect bones. Still further up the same river, at Glenross, Mr. Balfour has sent us down moa-cropstones and bones of kiwi and moa. Several bones have been picked up from time to time in the bed of the Petane River, and a femur and two or three vertebræ were dug from a small swamp close by the Petane School.

One rather interesting find was a tibia found by me just at the edge of the bush at Takapau. The bone was in the bed of a small creek, and, though in good preservation, one-half was thickly covered with moss.

With the exception of the last-mentioned and the bones from the Poutou Creek, all the bones recorded were too imperfect to be of much use; but, fortunately, others have been found in a most exceptional state of preservation and of great scientific interest. One day I was shown a very fine tibia which had been found at Patangata: this was in the possession of a gentleman at Waipawa. I then saw an equally good one in the possession of our President from the same neighbourhood, and on further inquiry heard that a large number of bones had been found during the works which were being carried out for the drainage of the Te Aute Lake. The Rev. S. Williams (now Archdeacon of Hawke's Bay) very kindly allowed me to examine the bones which had been preserved, which I found indicated the occurrence of a large number of moas, many of them of gigantic size, the length of one tibia being 37½in., only a trifle short of the largest specimen hitherto recorded. During the last summer the progress of the great drain enabled me to examine the locality carefully, and, through the courtesy and kindness of the Rev. S. Williams and Mr. Allan Williams, I was able to secure a most interesting collection of bones, some of which are now before you. The spot where the bones were found is at the south-east end of the large tract of swampy land which surrounds the lake. The overflow from this area, which was frequently flooded to a considerable depth by a channel cut by the Waipawa River, was carried off by a small creek or stream which rejoined the main river at Patangata. A deep channel was blasted through a bar of limestone rock which formed the end of a low ridge of hills forming the eastern boundary of the swamp. By lowering this outfall and cutting a great drain nearly two miles long, the whole of the swamp has become passable, and will shortly be carrying a very large number of cattle and sheep.

Mr. Allan Williams kindly took me to the drain, and the

foreman showed me the place where the bones had been found most plentifully. A slight examination showed that there were plenty more bones to be got. I decided on excavating for them.

The spot where the bones were found is just at the very mouth of the drain, where it empties itself into a very deep pool, of which the rock-barrier forms the further side. The section exposed in the cutting of the drain is about 15ft. deep, and is 8ft. or 10ft. of silt-deposit (pumice and washing from the cretaceous rocks of the district): then a forest-bed, consisting of trunks of trees and roots matted together—about 4ft.; from that downwards a stiff blue clay. It is in the lowest part of the forest-bed and in the stiff blue clay that the bones were found.

The line of the drain has passed over a spring round which the blue clay is so soft that it was impossible to stand very near to it.

I had two of the men who were working at the drain to help me, and we got quite interested in the work, as we found that in the clay under our feet at the bottom of the drain there were hundreds of bones. Having to work up to our middle in clay and water was certainly somewhat awkward; but, as every now and then an exceptionally fine bone was fished up, the discomfort was forgotten. The floor of the drain was not more than 10ft. wide, and, as the area over which we found the bones did not extend more than 15ft. up the drain, the number of bones recovered is certainly remarkable.

The appliances we had did not permit of as careful an examination as I could have wished, as many of the valuable small bones were undoubtedly lost and thrown down the talus slope into the deep pool, where there are undoubtedly many more, as we found out by accident. One of the shovels having slipped into the pool, we raked about for it as far down as we could put a long-handled rake, and at the first haul, instead of the shovel, up came a splendid tibia 32in. long. I hope to dredge this hole some day, and by washing the results through a screen shall probably get many of the smaller bones which I still require to complete the skeleton I am now restoring from the bones obtained.

It was from the first apparent that (as in the case of the Glenmark and Hamilton finds) no perfect skeletons would be met with, and I could observe very little sequence or order in the manner in which the bones were found deposited, the only point of interest being that most of the larger leg-bones were found in a vertical position, the tibia and metatarsus often in their relative positions. A sequence of eleven vertebræ of a large species was found in one part of the bank; but generally speaking the bones, great and small, were locked

together in great confusion. The men who assisted me were very careful in extricating the specimens, and very few were injured considering the difficulty of working under water, and in the stiff and extremely tenacious clay.

After two days' work at this place, and an examination of two places higher up the drain where a few bones had been found, we ceased operations.

Mr. Williams kindly had the spoils conveyed to the station, and the railway authorities kindly conveyed the bones to Napier free of charge.

The bones which I have referred to as having been got on the first cutting of the drain were also presented by the Archdeacon to the Museum, and sent down to Napier.

The cleaning, sorting, measuring, comparison, classing, and identification of more than a thousand bones and fragments has necessarily taken me some time, and I regret that I shall have to leave what will perhaps be the more interesting part of my paper till another occasion, on which I hope to enumerate the kinds and relative bulk of the species met with, and to draw your attention to the more striking features in the anatomy of the gigantic moas.

It may possibly be asked how can such an accumulation of bones in the one place be accounted for. This I hope to give a reasonable theory for in the next paper. At present the facts lead me to the conclusion that the most tenable hypothesis is that the spot was a narrow crossing-place in a swampy forest, and that the springs caused the ground to be so soft and swampy that moas were often bogged and unable to extricate themselves. The reasons in support of this I shall advance for your consideration.

P.S.—Within the last few days I hear that another find of moa-bones has been made in the same swamp. If such is the case I trust that the new discoveries will enable us to complete our series of the North Island forms of *Dinornis*.

In the notes which I had the honour to read to you at the July meeting, I gave some account of the deposit of moa-bones examined by me at Te Aute, and promised to continue the paper.

Just before our last meeting I paid another visit to the lake, and found that another discovery had been made in a spot nearly two miles from the original find.

It seems that when the drainage operations reached the actual shore of the lake itself the drain was continued in a straight line nearly half a mile into the lake, passing through the centre of an irregular winding lagoon forming the exit of the lake. The result of this was an immediate lowering of

the water in the lake, and the laying-bare of the whole of the winding lagoon, which was then seen to consist of a matted network of forest-roots and timber, together with innumerable seeds of hinau and manuka.

Lying on and among the roots were quantities of bones, which the foreman of the works, Mr. Pickett, carefully collected for me, and which prove of surpassing interest.

The bones were, as in the former case, nearly all in one small area, and, strange to say, just at the foot of a spur, as in the first find; but here they were lying on the surface, and were in a most wonderful state of preservation, young and old, great and small. One bone, an immature tibia, measures 35½in. The bones of the moas are in, as I said, a wonderful state of preservation; but by far the most interesting are the small bones which have been disclosed by this lowering of the water.

Although my identifications are not yet complete, I have got bones of the great extinct goose—the *Cnemiornis*—a breast-bone quite perfect, the bones of the legs, and some of the wing-bones. In general, these bones are smaller than those found in the South Island.

Of the great extinct eagle (*Harpagornis*) I have several bones—amongst others an ungual phalanx, or claw-bone, and several tibiæ. This is extremely interesting, as I did not meet with this species in the other deposit.

The next treasure is a perfect lower mandible of *Notornis*. This gigantic rail can therefore be undoubtedly added to our list of Te Aute birds. I show you the life-sized drawing made from the specimen obtained by Mr. Mantell, now stuffed, and placed in the British Museum.

Many other bones occur, which I have not yet been able to recognise. There are three or four tibiæ (immature) of a large wading-bird as large as our white heron, or kotuku.

At the time of my visit the spot itself where the bones were found was under water, owing to the lake being filled up with the rain; but I could see the higher parts of the stumps and roots above water. On the level muddy floor of the lake, some chains from the edge, a very large pelvis was found quite exposed.

Without further investigation it would be rash to conclude that these bones are very recent. I think it more probable that they are of the same age as the bones at the rock, but that the action of the flowing water from the lake has removed the accumulation of vegetable matter in which they were buried, and left the bones entangled among the roots and timber.

Two points may be noticed in connection with this discovery:—

1. That the bones were a second time found collected at the end of a spur running into the swamp.
2. That there is again an unaccountable absence of skulls and neckbones.

Art. XXXV.—*Discovery of Fossil Moa-feathers in Rocks of Pliocene Age.*

By H. Hill.

[*Read before the Hawke's Bay Philosophical Institute, 12th Nov., 1888.*]

I beg to bring under the notice of the Society a very interesting discovery made by me a few days ago. I refer to the finding of excellent specimens of fossil feathers in rocks which I think are pliocene, and, indeed, are so classed by the Geological Survey Department.

The place where the fossils were found is situated at Ormond, about ten miles north-west from Gisborne, in the Poverty Bay district. A range of hills bounds the northern part of the Poverty Bay plain. This range extends from the coast in a north-west direction, passing behind the Ormond township, and continuing to a point five miles or so further to the north-west, where it is cut through by the Waipaoa River, which empties itself in the bay. The hills behind Ormond, where the fossils were found, must be about 350ft. above sea-level. They are composed of blue clays, coarse sandy fossiliferous limestones, and pumice mud and sands, the latter being the highest beds. All the beds appear to rest conformably on one another, and they agree in stratigraphical arrangement with the beds exposed in a high bluff on the Whataupoko, opposite the town of Gisborne. The pumice-mud deposit is one of great interest, as it is from this deposit, which must be at least 100ft. in thickness, that the fossil feathers were obtained, together with a large collection of beautifully-preserved leaf-impressions, ferns, seeds, fishes (vertebrates), crabs, and other interesting specimens.

The pumice-mud is of a creamy whiteness, clayey to the touch; is free from grit of any kind; can be used like chalk for writing; can be slit like slate into thin plates, which will bend without fracture; and, lastly, it has a slaty cleavage. In places, however, the rock passes into coarse pumice-sand, and in others it becomes indurated, and has the appearance of a siliceous sinter. Last year, in a paper on the "Distribution of Pumice along the East Coast,"* I referred to this deposit as

* "Trans. N.Z. Inst.," vol. xx., p. 293.