

the relative length and thickness of corresponding bones shows that the birds must have been of at least two varieties. Among the bones are a lower jaw and part of the upper one of the same bird. Moa-bones have also just been found among the sandhills near Nukumaru, but so decayed that they would not bear handling. In fact, people are hardly aware how common such bones are, as they mistake them for those of cattle or horses, and thus many finds are never reported.

ART. LIII.—*On the Shifting of Sand-dunes.*

By H. C. FIELD.

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IN reading the Transactions of the New Zealand Institute, one often sees mention made of the shifting of sand-dunes through the action of the wind; but, except in a paper by myself, read in Wellington in December, 1876, I have never observed any estimate of the rate of such movements. I then judged the rate to be about a chain in ten years on the north side of Cook Strait, but it probably varies in different parts of the colony; and I think it would be well if persons in various localities would note the rates which they have had opportunities of observing, as we might thus get tolerably accurate data from which to estimate the dates of past events, particularly that of the extinction of the moa, which, so far as I can judge, has varied very greatly in the several districts. Possibly, therefore, the following results of forty years' observation on the coast from Paikakariki to Patea may be worth recording.

My first experience of sandhills, on any scale, was when I walked from Wellington to Wanganui in 1851. I had seen such hills on a small scale in several parts of England, but had no conception of their ever attaining the dimensions which they do in New Zealand. As, however, I was a new-comer, and there were so many novelties, in the way of strange birds, shells, fish, vegetation, scenery, &c., to engage my attention, the extent of the sandhills was the only thing which I particularly noticed. When I again travelled by the same route, in the following year, I found a very noticeable change at one point—viz., Otaki. In 1851 the river had run northwards, parallel with the beach, for about a quarter of a mile, before it entered the sea, and the accommodation-house kept by the ferryman was on the south or Wellington side of the river.

In 1852 the river had broken itself a fresh course straight out to sea, leaving the accommodation-house so far from the river's mouth that it was very difficult to attract the ferryman's attention by shouting. On inquiry, I learned that the drifting of the sand had left a hollow opposite the point at which the river bent northward, and that consequently a flood had broken through. On this same journey, I observed that the mouths of the Ohau and Waikawa Rivers had also shifted, so as to be farther apart than in the previous year; and that the track leading from the beach to Putiki Pa (in those days we had to follow the beach nearly to the mouth of the Wanganui River) had also changed materially in appearance, though I could hardly describe the change, further than that the hollows through which it ran had shifted their position.

At Waikanae, at the dates which I have mentioned, there was a constabulary station a short distance from the river's mouth, on the south side. A nice grassy flat served as a parade-ground, and the men lived in whares on both sides of it, while the commanding officer's house faced the upper end. I did not pass the spot again till I went to Wellington by coach in 1868. I was only there for the few minutes that were occupied in changing horses; but the place seemed entirely changed. The station was gone, and, though there was a small hotel, it did not seem to stand on the site of the former officer's residence. I have since learned that I was right in all this. The river by this time had entirely changed its course for a considerable distance inland; the new channel had cut right through the old parade-ground; and the only trace of the officer's house consisted of some narcissus roots which had been planted in the garden, and which still struggle up through the sand year after year. Since 1880 the hotel, as such, has ceased to exist, and has been occupied as a residence by my eldest son, whom I have visited once or twice in each year, and so have observed the changes that have latterly taken place. A sandhill 30ft. to 40ft. high, which formerly stood almost behind the hotel, and which, from the immense amount of pipi-shells which it contained, formed a very conspicuous landmark for entering the river, has been entirely blown away, and its contents are now scattered over nearly flat ground. An isolated hill nearly as high, which stood close to the beach on the south side of the river, and behind which there was a hollow through which the coach was sometimes driven, has also almost been blown away; and where the track passed there is now a damp sand-flat, some eight or ten chains wide, arising from the other sandhills behind it being blown further inland. A very appreciable portion of this flat occupies the site of a shallow lagoon, the size of which has been proportionately reduced.

At the back of the hills a considerable extent of what was good grass-land is now buried under sand.

In the course of these changes many long-buried articles have come to light. Not only have old kitchen-middens and immense numbers of old cooking-stones been exposed, but at one place what appeared to have been an ancient Maori cemetery was laid bare, and a good many skulls were picked up and carried away by visitors. Very many moa-bones—some broken and bearing the traces of fire, and others forming more or less perfect skeletons—have been exposed, as well as large numbers of obsidian flakes, adzes (more or less perfectly finished) of greenstone, chert, obsidian, and hoop-iron, intermixed with other articles of unquestionably European origin.

On my last visit, in October, 1890, I found the remains of the largest moa I ever met with about a quarter of a mile south of the river. I secured the pelvis, tarsi, and eleven of the vertebræ, and, had I had means of digging, should no doubt have got the remainder of the leg-bones, as the remains appeared to be on the spot where the bird had lain down and died. The rib-bones were there, as well as fragments of the skull, but all so broken by the trampling of men and animals as not to be worth picking up. Alongside of the bones, however, and within a yard of them, I picked up two pieces of hoop-iron, three of broken bottles, of which the surfaces are dulled by the action of the sand, two bits of crockery of different patterns, and two of very old clay tobacco-pipe. Of course it does not follow that these articles were contemporary with the bird—they may have been dropped at a higher level, and have sunk to that of the bones as the sand drifted away; but the frequency with which such things are found in company with moa-bones in this part of the colony certainly seems to bear out the uniform statement of the Maoris that the last of these birds hereabouts were destroyed by means of firearms, about the time when Christianity was introduced.* I have

* Shortly after this paper was read, the drifting-away of the sand enabled my son and myself to get the lower leg-bones, and all those of the feet. Close to the last, and at a slightly lower level, I found a small hoop-iron adze, which seems to indicate that the bird must have been alive after Captain Cook visited that locality, and probably after whalers were located there. Later still, the further drifting-away of the sand exposed, just above the site of the moa-bones, and at a higher level by 2ft. or 3ft., a fragment of a jaw of some large animal—apparently ox or horse—containing three molar teeth. This fragment is actually more decayed than the moa-bones, but this may arise from its having belonged to a young animal. I also found some moa-bones in a neighbouring kitchen-midden, which, from the straightness and cleanness of the fractures, seem unquestionably to have been cut to pieces with a steel weapon. The drifting of the sand seems far more rapid at Waikanaë than at Wanganui, owing, probably, to the winds being stronger so near the narrow part of Cook Strait.

been repeatedly assured by old Maoris that they had eaten the flesh of the moa in their youth; and they seemed well acquainted with the habits of the birds. They have a proverb, "*Huna i te huna a te moa*" (Hidden with the hiding of the moa), to express a clumsy attempt at concealment, as they say that the birds, when hunted, would often try to hide themselves among bushes quite inadequate to enclose their bodies, just as the ostrich is said to do.

The Waikanae natives assert that their fathers, even sixty or seventy years ago, not only ate moa's flesh, but that they also used to catch young ones and keep them as pets. Mr. Wilson, too, who kept the hotel, and who came to the colony about the year 1830, always asserted that he had not only seen live moas on the Nelson side of the Strait, but that, on one occasion, he and his mates caught a young one and sent it as a present to a gentleman at Sydney, though he could not tell whether it reached there. I have also apparently reliable evidence of the birds having been both heard and seen alive in the neighbourhood of Collingwood as late as 1857 or 1858, and of one being cooked at a Maori feast at Taupo not long previously.

Besides the instances mentioned in my paper, read on the 22nd January, 1882, of gigantic birds, answering to the description of moas, having been seen by settlers in this part of New Zealand, I lately heard of a man who asserts that he saw two of them a few miles inland of Marton within the last thirty years. In all these cases the reports have come from ignorant labouring-men (newly-arrived immigrants), who were not likely to have heard of moas.

When I came to Wanganui, there were several young totara-trees on a flat below Putiki Pa which the Rev. R. Taylor told me had been planted to mark the sites of Maori graves. They were at that time fully 30ft. high, but when I surveyed the place in 1863 they were so deeply buried in an advancing sandhill that only a few feet of their tops were visible, and even these have long since been covered up, and the foot of the hill is two or three chains beyond them. In the same way I saw a nice patch of pine-bush on the late Captain Rhodes's run, south of the Turakina River, which in 1858 was being buried in sand, and which a few years later had quite disappeared.

On the north side of the Wanganui River, just below the town, there was, in 1851, a large and high sandhill, on which the artillerymen stationed here used to set up their mark when they practised with cannon and mortars from the old York Stockade. This sandhill has long since been nearly all blown into the Wanganui River, to the detriment of the navigation, and its site is now occupied by the flat on which the new gaol

and sundry cottages stand. Farther north there used to be two tracks leading to the mouth of the Kai Iwi Stream. I used generally to travel by the inland one, as the other, though shorter, passed for considerable distances over drift-sand. I used, however, occasionally to go that way, and always found a difficulty in following it, owing to the changes that occurred in the position and form of the sandhills. About ten years ago, I tried in vain to trace the old route, which had ceased to be used, through the enclosing of the land. I found that several lagoons, by the position of which I had thought to fix the line of the track with approximate accuracy, had been entirely filled by the sand, so that their sites could not be identified.

I have mentioned the manner in which the Otaki River ran parallel to the beach when I first saw it, and afterwards straightened its course. The Wanganui has a similar bend to the northward as it approaches the sea; and since 1851 the actual mouth of the river has shifted several hundred yards farther north, what is known as the South Spit becoming lengthened in proportion. Two or three times the river has actually broken over the spit when the drifting of the sand has formed low places; and our Harbour Board have foolishly spent thousands of pounds in raising these places—in resisting the efforts of nature to improve the navigation of the river, instead of being thankful for such assistance.

Between 1852 and 1856 I very frequently travelled up and down the coast between Wanganui and Waitotara, and, as the track at the Waitotara end passed for more than five miles across and among sandhills, I acquired a very accurate knowledge of the locality. As a rule, the changes were so gradual as hardly to attract notice, though occasionally, after a heavy gale, some of the sandhills would perceptibly shift their position, the alteration being marked by the fact that the forward end of the hill assumed a steep slope, which afterwards eased off under the influence of lighter winds from other quarters, and of the traffic along the route, which was very considerable.

I did not visit the locality again till I went out, a few days after the fight at Nukumarū, to point out to General Cameron a route by which cannon and carts could easily be taken from the Nukumarū camp to a point near the mouth of the Waitotara where it was easily fordable at low tide. On this occasion I was quite surprised at the changes that had taken place. Old landmarks by which I had been accustomed to steer my course had disappeared, and nice grass flats and Maori cultivations had been buried by the sand. I have visited the same locality on several occasions since then, and each time I have observed further changes. The trampling of

the stock disturbs and breaks the surface-soil; drifting begins, and in the course of a few years what has been a hill covered with fern and grass becomes a barren waste of shifting sand, which overwhelms the good flat land to leeward of it. Thus the area of the drift constantly increases, and, as the old hills shift their position, kitchen-middens and other buried articles are exposed. It was in a hollow thus formed by the drifting-away of a sandhill that I found the moa-bones, with unmistakable tomahawk-cuts upon them, in 1881; and I have never since visited the locality without finding more moa-bones.

About the year 1853 the Waitotara natives told me that their river formerly flowed out to the sea two or three miles south of its present mouth. At the time I felt very doubtful as to the correctness of the statement, as bare sand filled up what they pointed out as the old course to a height of considerably more than 100ft. Even the name "Tomotomo Ariki" (Lordly Entrance) by which they called the place failed to convince me. I have since, however, found that they unquestionably spoke the truth, as the drifting-away of the sand has left the whole course of the river perfectly well defined, though at a height of at least 80ft. above the present channel. This is only one of many instances in which I have found the Maori tradition of ancient geological changes perfectly reliable, though the changes must have occurred ages and ages before they came to New Zealand; and thus they must have received the traditions originally from their negro ancestors.

Nearer this way, the route from Wanganui to Waitotara used to run ordinarily for about five miles along the sea-beach. At high tide, however, the sea came right up to the base of the cliffs; and it was then necessary to follow a track which led among sandhills upon the cliff-tops. At one point, just to the northward of the Okehu Stream, on the land now belonging to the Hon. R. Pharazyn, the track passed just to seaward of a very high bare sandhill, which was known by the name of "Popoia," and is so marked on the original Waitotara map. I often wondered at this particular drifting sandhill having a special name, as such a thing is not usual. In 1871 I had to lay off a road just inland of it, and it then struck me that the hill was far lower and flatter than before, and that it was encroaching on the good soil farther from the sea. A few years later I found that it had not only buried all Mr. Pharazyn's land immediately inland of it, but that it had crossed his boundary-fence, and was covering up Mr. J. Handley's land as well. The latter gentleman has checked its further progress in his direction by planting a sand-grass, but the hill has travelled onwards towards the Okehu Stream, and has left a flat where it formerly stood. This flat has a

hollow, evidently an ancient watercourse, running along it towards the Okehu; and near the head of this hollow the site of an ancient pa has been exposed.

I visited the spot several months ago, and found that there were all the ordinary traces of Maori occupancy, in the shape of old cooking-places and cooking-stones, with bits of bones and shells, flakes of obsidian, and damaged stone implements lying about (any perfect ones had no doubt been picked up); but what was particularly noticeable was that the sites of the old huts were defined not only by the stumps of the uprights of the huts, or holes in which those uprights had stood, but by the receptacles for the hot embers used to warm the huts. These receptacles differ utterly from any which I ever saw elsewhere. As a rule, these are merely shallow round hollows in the centre of the floor, but sometimes are surrounded by a ring of long oval pebbles sunk in the floor to form a margin. In this case, however, the arrangement was far more elaborate. On the beach at the mouth of the Okehu, and thence to the Kai Iwi, there is a seam of thin white stone, resembling the Yorkshire flags used for footpaths in London and elsewhere. Pieces of this stone had been carried up from the beach, and each had had one edge dressed straight, and its arrises rounded, after which they had been sunk in the floor, so as to form oblongs of about 18in. by 12in., standing up 1in. or 2in., and nicely level on top. The neatness of the arrangement, and the trouble taken to effect it, were very noticeable; and there were at least a dozen similarly formed. There had evidently been far more, as the stones which had formed them were lying in groups, having been kicked out by the stock, or pulled up by mischievous Europeans. I have no doubt that Popoia was the name of this ancient pa; and that hence it came to be applied to the sandhill by which the pa was overwhelmed. As invariably happens in cases where an ancient surface is thus exposed, the soil had entirely disappeared. It might have been supposed that the pa stood on a flat of bare clay but for the fact that there were the fern-roots and roots and stems of shrubs lying about to attest the former existence of soil. It seems strange that drift-sand should have the property of apparently absorbing and destroying vegetable mould in this manner, and making fertile land barren.

It was on the top of the Popoia sandhill, as it drifted away, that Mr. Handley found a curious object, now in Mr. Drew's museum at Wanganui. It is of dull obsidian, about the size of the implement known as a bed-key, and formed, in the same way, into three arms radiating from a common centre. Each arm is about as thick as a man's finger, and they are beautifully evenly chipped, but not ground or polished. The use or

object of it is unknown: in fact, the only reasonable suggestion that I have ever heard respecting it is that it may have been formed by some early Christian convert as an emblem of the Trinity. Whatever its purpose was, it is an article that I could hardly have supposed it possible to form in such a material, and indicates wonderful skill on the part of the person who made it. If any similar article has been found elsewhere, possibly the above description may lead to its being mentioned, and its use ascertained. Possibly, too, the above notes may elicit similar ones from persons in other parts of the colony, and thus useful data may result.

At the commencement of this paper I have referred to one which I sent to Wellington in 1876, describing some ancient *caches* which the late Mr. M. V. Hodge and myself had examined on the top of the cliffs north of the Wanganui River, and the articles found in them. Among these were pieces of silicified wood, for the existence of which I was unable to account, though, from the same substance having been met with in company with stone tools elsewhere, it seemed evident that the Maoris used it or valued it in some way. The late Mr. J. White afterwards told me that it was obtained from silicifying springs in the volcanic regions, inland, and was highly prized by the Maoris, who used it for giving the final polish to greenstone. He said they called it "whakaue" and "te ika a Ngahue." When I visited the Terraces at Rotomahana, just before they were destroyed, I found that the object called "the boar's head" was actually the end of the trunk of a very large silicified tree, which was being gradually enclosed in the substance of the White Terrace.

Since 1876 I have several times heard of stone adzes and other articles being picked up near where Mr. Hodge and myself found the *caches*, and of moa-bones and Maori implements being found near the coast between the Wanganui and Wangaehu Rivers. Among these have been perfect skeletons of moas, one of which—a small one—was put together by Mr. Drew, who placed it in his museum. These bones are generally so decayed that they will not bear rough handling, and, unless secured soon after they are exposed by the drifting-away of the sand which has covered them, they rapidly crumble away, and are lost altogether. The only tolerably sound moa-bones which I have ever seen have been found in the beds of streams. Such bones are by no means rare; but settlers fancy, from their size, that they are those of cattle or horses, and so pay no attention to them. If they were collected, I am sure that we should soon have ample evidence that the latest moa survived the introduction of steel weapons; but the difficulty is to make settlers aware of what they are, and so get them to interest themselves in them.