

MOA TRACKS: AN UNRECOGNISED LEGACY FROM AN EXTINCT BIRD?

Summary: Evidence is put forward suggesting that at least some species of moa (*Aves: Dinornithidae*) used regular tracks, and that these tracks are still visible in various parts of New Zealand. Tracks at Poukawa, Hawke's Bay, are illustrated. Studies of the tracks may provide further information on the distribution and habitat preference of moas.

Keywords: moa, *Dinornithidae*, Poukawa, tracks, distribution, habitat preference.

Introduction

Since the dramatic announcement by Owen (1842), after examining the shaft of a moa femur, that "there had existed and perhaps still exists in New Zealand a race of struthious birds of larger and more colossal size than the ostrich or any known species", our knowledge of the moa has advanced considerably. Investigations can be classified broadly into three groups. First was the indiscriminate collection of large numbers of bones, particularly from swamps last century (e.g. Booth, 1875; Hamilton, 1889). Then from the late 1930s, bone deposits (both natural and archaeological) were studied more systematically (e.g. Duff, 1941). This provided information on the interaction of man and moa, and material for more refined taxonomic studies. From that base of information the emphasis during the last 15 years has been on determining the habits of moas. Various studies have examined feeding (Burrows, 1980; Burrows *et al.*, 1981), distribution (Millener, 1981), habitat preferences (Anderson, 1982) and breeding ecology (Hamel, 1979), as well as adding further to the discussion of the group's taxonomy (Cracraft, 1976; Millener, 1982).

Historical sources of information

All of the studies cited above have relied on tangible remains of species which are now extinct. However, early historians and explorers made many references to the moa in their records of Maori tradition (Buick, 1931). Some accounts were reputed to be from people who had actually seen or hunted the bird (Hamilton, 1875; McDonnell, 1889). However, these accounts must be viewed with caution because of possible fabrication or exaggeration. Although there are conflicts (Buick, 1931, p. 216), there is also a lot on consistency in the information from different sources about the habits of the moa and the Maori's methods of hunting them.

The documented methods used to hunt the moa are varied. Fire (Taylor, 1873; Roberts, 1875) and

large parties of people (Taylor, 1873; Graham, 1919) were used to drive the birds from hiding into lakes or swamps where they became easy prey. McDonnell (1889) recounted how the birds were chased by relays of runners until they tired and could be killed. This method would be most effective if the likely path of the pursued bird was known, that is if it followed regular tracks. Nets suspended in trees ready to be dropped on birds would also have a low success rate unless moas could be expected to pass below the net (Beattie, 1958). The three remaining methods of capture also relied on moas using well beaten tracks. Hunters hid beside tracks with spears which were designed so that the shaft would break off on the vegetation beside the track, leaving the barbed end in the bird (Travers, 1876). The weakened moa could then be followed and killed. Roberts (1875), Whatahoro (1911), Hongi (1916) and Beattie (1958) recorded the use of flax nooses set across tracks in positions likely to catch the birds by the neck or feet. Finally, Graham (1919) and Beattie (1958) documented the use of pits dug on the tracks into which the moas were chased. The Maori called the tracks *ara-moa* (Graham, 1919).

Therefore, at least six independent accounts inferred that moas used "regular beaten paths, like sheep tracks" (Roberts, 1875). If this is true, then moa tracks should be as widespread as was the moa, but there are few eyewitness descriptions of tracks in the literature. Graham's (1919) informant stated, in 1910, that the tracks of the bird could still be seen on the ridges it formerly frequented. Graham saw tracks himself near Auckland and found that they were still fairly well defined among the scrub. Gizzard stones (presumably passed with faeces) often were found along them. In 1863, on a flat-topped mountain near Jackson Bay, Hector (1872, p. 119) observed "numerous well-beaten tracks, about 16 inches wide, intersecting the scrub in all directions, and which, owing to the height of the scrub, could only have been formed in the first instance by the frequent passage of

a much larger bird than either the kiwi or kakapo . . . No pigs or any other introduced animal having penetrated to this part of the country, it appears manifest that these are the tracks of some large indigenous animal, but, from the nature of the vegetation, it is probable that such tracks may have been for a very long period in disuse". Clearly, Hector considered that these tracks had been formed by moas.

The only recent reference to moa tracks that I know of postulates that some compacted paths in the Hawke's Bay and Taupo areas are attributable to moas (Brewster, 1986). Brewster's sources are items of unpublished correspondence held in the files of the National Museum.

The search for tracks of the moa

Many types of animal tracks are visible in New Zealand. None are more common than those made by sheep, but the tracks of deer, pigs, goats, man and other smaller animals can be seen in various parts of the country. All of these tracks depress and compress the ground surface. It is likely, therefore, that any tracks made and used frequently by moas would also have modified the surface of the ground, especially if used by the larger species. Even so, they would not be easy to detect after being unused for so long, and when so much of the land has been cleared cultivated and grazed. If they are detectable at all, they would be on gentle slopes, too steep for cultivation but not steep enough to have eroded.

The Poukawa region (15 km south-west of Hastings, Hawke's Bay) was inhabited by moas, particularly species of *Pachyornis*, *Dinornis* and *Anomalopteryx* (Hamilton, 1889; Price, 1963, 1965; Horn, 1983). Some land forms in this area matched the above criteria for finding tracks so I began to search for them there. I have since observed them in other parts of Hawke's Bay, North and South Canterbury, Taranaki, Wanganui and Manawatu. Reasons why the tracks were attributed to moas are outlined below.

Tracks in the Poukawa region

Presumed moa tracks were most apparent on gentle, heavily grazed slopes when observed from a distance (> 50m). They have several common characteristics. They frequently led to freshwater springs (Fig. 1) or to rocky outcrops (Fig. 2) and the bases of cliffs (which may have been roosting or nesting areas). Branching tracks are quite common, as are tracks that go over saddles in ridges. Tracks often run at a constant altitude around a gully rather than taking a shorter

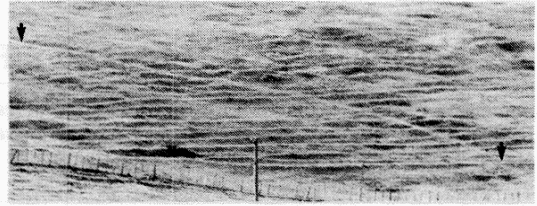


Figure 1: Moa track curving down a hillside (between arrows). This track culminated at an artesian spring (not shown in the photograph). Note the clearly defined sheep tracks (running horizontally) crossing the moa track.

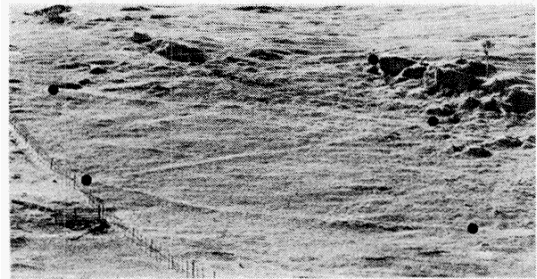


Figure 2: Moa track appearing to zig-zag in four sections up a slope (between the dots) and culminating at a rocky outcrop.

route down into and then out of the gully. This could indicate that the position of some tracks reflected boundaries in the vegetation, e.g., between swamp edge vegetation and drier scrub.

Pollen in soil samples from the vicinity of Lake Poukawa show that a dense podocarp-hardwood forest was present in the area between about 1000 and 4000 years BP (McGlone, 1978; Pocknall & Millener, 1984). During the last 1000 years and before European settlement, the forest was gradually burned off and replaced by bracken and scrub (McGlone, 1978). None of the presumed moa tracks at Poukawa were in areas likely to have been swampy within the last 5000 years so they probably passed through scrub or forest.

Why the tracks are attributed to moas

The presumed moa tracks are frequently crossed by sheep tracks (Figs 1 and 3), so were certainly formed before extensive sheep grazing modified the ground surface. Tracks ranged in width from 40 to 90 cm; those formed by sheep, pigs or goats are seldom even 40 cm wide. While the tracks of ungulates are narrow relative to body width, and deep, the presumed moa tracks appear wide and only slightly dished (Fig. 3).



Figure 3: Detail of a moa track (running between the arrows) showing its relatively broad and slightly dished shape. Note the sheep tracks running across the moa track.

The wide flexible foot of ratites produces low tread pressure and 'rolls' over the substrate, but the small ungulate hoof produces high pressure per unit area and has a chiselling and shearing effect on the substrate (Duncan & Holdaway, 1989). This would produce differences in track shape. Cattle tracks, although sometimes wider than 40 cm, are generally similar in shape to sheep tracks, and I have never seen cattle using the presumed moa tracks. On farms today cattle usually form tracks only when their ability to range freely is restricted such as in gate-ways and stream fords. When land was initially broken in they may have made tracks in the dense vegetation, but this would not explain the tracks in the Poukawa region for two reasons. Firstly, at the time of European settlement most of the area was covered with native grasses or low fern (Wilson, 1939, p. 201), which would not have constrained the cattle to use tracks. Secondly, the first official stock return for Hawke's Bay in 1853 listed about 19,000 sheep but only 119 cattle, many of which were house cows (Wilson, 1939, p. 229). The early emphasis on producing wool rather than meat ensured that cattle numbers remained low until well after pastoral land was broken in.

Human tracks associated with pa sites are sometimes similar in shape to tracks attributed to the moa. Well-used human tracks were present in Hawke's Bay in the late Maori era (Wilson, 1939). However, many of the presumed moa tracks are in places that would not have been traversed often, if at all, by humans. Well worn tracks occur in many areas of inland Hawke's Bay (e.g. Kereru, Puketitiri) in densities too great to be explained by the occasional and dispersed hunting expeditions of the Maori, who dwelt predominantly on the coast (Prickett, 1982). Even when tracks coincided with a dense Maori population, it is difficult to interpret them in terms of human traffic networks or hunting techniques when

they end at a cliff face or rock outcrop. However, such sites would be ideal for moa roosts or nests (Hamel, 1979). Although tracks were formed and used by moas, humans could well have used them too. By making tracks the moa may even have hastened their own extinction by helping hunters to find them or their eggs. Some moa tracks may have been incorporated into the human traffic network and used long after moas had disappeared as access to, for example, freshwater springs.

There is little chance that presumed moa tracks were formed by early European inhabitants and their pack-horses for reasons similar to those outlined for the Maori - they occur in areas which people would not have visited often enough to create a worn track. None of the cliff faces or rock outcrops with tracks leading to them showed any evidence of quarrying. However, when searching for tracks, one must be aware of patterns of cultivation, as track-like ruts can be formed at the margins of cultivated areas, such as along earlier fence lines or at the cultivation limit on ridges.

The use of tracks by extant ratites

The behaviour of extant species of ratite has been well studied. In terms of generalised habitat preference, two groups are apparent. The ostrich, emu and rhea are savanna dwellers, which generally avoid wooded areas and do not appear to use tracks (Gilliard, 1958; MacDonald, 1973). The other ratite group comprises the cassowary and kiwi, which are forest dwellers. The cassowary of the north Queensland and New Guinea rain forests follows regular tracks through bush and along stream banks (White, 1912). Tracks leading from the burrows of Stewart Island brown kiwis have been reported (Soper, 1963), but the formation of tracks by mainland kiwis has not been noted (Dr. J. McLennan, pers. comm.). It is logical for the cassowary to make tracks because it lives in a densely vegetated environment. Conversely, it is reasonable for savanna dwelling ratites not to do so because no dense vegetation impedes their movement or vision.

Gizzard contents (Burrows *et al.*, 1981), and palaeobotanical and archaeological evidence (Anderson, 1982) indicate that the moas were browsing animals that generally inhabited margins of forests and watercourses, and dense scrub. Although they must have traversed open ground at times, there is little indication that they were grassland feeders. They are probably best placed in the forest dwelling group with the cassowary and kiwi. Thus, by analogy, it is logical to infer that moa would have used regular tracks for travelling in their densely vegetated habitat.

Historical information on moa habitat

Historical commentaries on habitat preference of moas are consistent, and they generally support conclusions from the more recent studies cited above. Travers (1876) reported that moas lived principally near forests, and visited water frequently. Taylor (1873) was told that the birds were often flushed out of thickets of koromiko; and Graham (1919) stated that they preferred lightly forested ridges and open spaces, and avoided gullies and deep forest. Whatahoro (1911) described moas as birds of open and scrubby places that entered forests only to eat the fruit of certain trees, and stayed near water in the evenings. Whatahoro also stated that their tracks occurred in the bush and followed stream banks and swamp edges, but were not present on open plains. White (1925), recorded that moas lived in open country and along the margins of swamps and water courses, and that they entered forest only to collect berries. Beattie (1958) was told that moas often frequented swamp edges where they ate young raupo and sedge.

The frequent occurrence of moas in "open" spaces as suggested by the historical information is the only point of conflict with recent studies which suggest only a spasmodic association with grassland. However, the nature of the open spaces was never defined clearly, and could mean low fern or open scrub, rather than grassland. Also, these early commentaries described moa behaviour in habitats already modified by human fires (Molloy *et al.*, 1963; McGlone, 1978). Therefore, some of the recorded observations could be describing moa living and feeding in what were previously lesser preferred habitats. In the immediate pre-Maori era, over 95% of New Zealand's sub-alpine vegetation was forest or scrub (Nicholls, 1980), so grassland areas must have featured less in the moa's preferred habitat at that time.

Conclusions

Maori tradition, early historical observations, recent theories on the habitat preference of moas, and an examination of the behaviour of extant ratites all support the hypothesis that at least some species of moa used regular tracks. Tracks observed in the Poukawa region (and elsewhere) are best attributed to moas because of their position and size. This evidence is circumstantial, however, because it is not possible to rule out all other potential causes. Corroborative evidence may be obtained by excavating lengths of the

tracks and searching for gizzard stones that Graham (1919) and White (1925) stated were passed with faeces as moas travelled. Rocky outcrops or cliff bases that have tracks leading to them could be searched for eggshell, gizzard stones and coprolites, as such material could be expected at nesting or roosting sites.

Tracks could assist studies of the former distribution and habitat preferences (and possibly breeding ecology) of the bird. Whereas deposits of bones show only where the moa died or was butchered, tracks show where they live, or at least where they travelled. On the other hand, while bones can be identified to genera and species, the users of tracks remain anonymous. Tracks that have survived will not be typical of the total moa traffic network. Their absence does not prove that moas did not live in an area and Whatahoro (1911) stated that the tracks through bush disappeared on reaching an open space. But if the prehistoric vegetation of a track-covered area is known (as in the case of Poukawa) then habitat preferences can be surmised. At Poukawa, it would appear that the tracks were in areas covered primarily by forest or scrub. Unfortunately, studies of tracks would be difficult in areas which are not heavily grazed today, as even long grass, and certainly bracken or bush, can obscure totally the often subtle modifications to the ground. Also, cultivation and erosion have obliterated or damaged many tracks in recent years, and will continue to do so.

The moa almost certainly used tracks, but whether some of them still exist is open to some conjecture and has not been seriously considered in recent literature. They must, inevitably, be diminishing, but while they remain they do represent a possible source of contemporary evidence from which further information about moas could be deduced. Several studies have attempted to interpret terracettes and tracks on the ground surface in New Zealand and elsewhere, but produced few firm conclusions as to their origin (review by Vincent and Clarke, 1976). I suggest that in interpreting marks on the New Zealand landscape, serious consideration should be given to the possibility that tracks still exist that were made by moas.

Acknowledgements

I thank Drs M. Roche, G. Sherley and M. Winterbourn for their helpful criticisms of an early draft of this paper, and several participants at the 1986 N.Z. Ecological Society Conference for their stimulating discussion. Editing by Dr M. Rudge greatly enhanced the final product.

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