# MOAS OF THE SUBALPINE ZONE

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The highest recorded altitude at which bones of moas (Aves; Dinornithiformes) have been found is 1600 m above sea level (a.s.l.) in the Garvie Mountains, Central Otago (Wilmot 1885). Bones of five moa species were recorded by Bell & Bell (1971) from 1350 m a.s.l. on Mt Owen, northwest Nelson. Although the published records of moas in subalpine areas are few, speleologists, when exploring caves in such areas on Mt Arthur and Mt Owen, have often noted, but not identified, moa bones. Such observations generally go unrecorded but some are noted in the *New Zealand Speleological Bulletin.*

Perhaps because of the few records there is a feeling, echoed by Trotter & McCulloch (1984), that moas generally did not frequent subalpine areas:

> ". . . with isolated, but largely unconfirmed reports of moa bones being found up to 2000 metres, well above the maximum altitude for present-day tree growth. High elevation records might suggest that the moa was not restricted to a forest habitat, but we believe that they should be treated with caution. Assuming the reports are accurate it is not impossible, for instance, that the remains were of birds driven upslope by forest fires."

These remarks treat all moa species as a unit, not allowing for varied ecological preferences. Currently 11 species of moa are recognised (Worthy 1988), all of which probably had distinct, although no doubt overlapping, ecological niches.

The purpose of this note is to show that some species of moa *did* frequent subalpine areas, one species in particular being predominant. Moa bones are found in three main types of deposit: aeolian deposits of dune sands and loess, swamp deposits and cave deposits. Fossil deposits in the first two occur only at low altitude, and caves, although common at low altitudes, are in only four small areas of the subalpine zone. Therefore the records from this zone are few.

The four areas are Mt Arthur (1795 m) and Mt Owen (1870 m) in northwest Nelson and Mt Luxmore and Takahe Valley adjacent to Lake Te Anau in Fiordland. Here I review past data and present new data on moa discoveries from these areas. Identification of bones follows the criteria outlined by Worthy (1988).

**Mt Arthur:** On Mt Arthur the uppermost limit of forest growth is about 1200 m a.s.l. Almost the whole mountain is marble, and it has many caves. The only published records of moa remains are in the *NZ Speleological Bulletin.* Those in Archey (1941) and Oliver (1949) refer to localities on the Salisbury Tablelands about 1050 m a.s.l. (which is below the bushline, although land clearance has resulted in large tussock clearings). Moa bones from Mt Arthur have been recorded from HH and Laghu Caves (Worthy 1980); and from TCC 1, PSV 10, PSV 15 (Pugsley 1987) and Obscene Phonecaller Cave (Bunton 1983), all near HH Cave. In the Ellis Basin, Newman (1973) recorded a skeleton in EK 316 and 2 skeletons in EK 353.

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Moa bones were also recorded from Misty Pot (Ravens 1987) and Blizzard Pot (Ravens 1988). Only those caves in the Ellis Basin and TCC 1 are above the present forest edge. The other sites are mainly in the forest-shrubland zone. In addition I have observed moa bones in Farriers Cave and EK 401 in the Horseshoe Basin about 100 m above the forest edge.

All these records are of unidentified species, except for the three skeletons in HH Cave, which are of *M. didinus* (Upland Moa). A cranium and pelvis of one of these specimens is in the Waitomo Caves Museum (WO 66). However, other than a specimen in Misty Pot, all the Mt Arthur records appear to have been small moas of similar size to the Upland Moa.

The timely discovery in January 1989 of Ratites Rest Home, a cave in the upper Horseshoe Basin at c. 1480 m a.s.l., has revealed a fossil bird fauna that is rich for a subalpine site. The only moa was the Upland Moa [minimum number of individuals (MNI) = 5], for which the voucher specimens National Museum of New Zealand (NMNZ) S 25890 were collected but most were left *in situ*. Eight other bird species are represented: *Apteryx australis* or *haastii* (Brown or Great Spotted Kiwi) (MNI = 2, NMNZ S 25886), *Gallirallus australis* (Weka) (MNI = 4, NMNZ S 25888), *Fulica chathamensis prisca* (Extinct Coot) (MNI = 1, NMNZ S 25882), *Euryanas finschi* (Finsch's Duck) (MNI = 1, NMNZ S 25883), *Strigops habroptilus* (Kakapo) (MNI = 7, NMNZ S 25889 plus 7 skeletons left *in situ*), *Falco novaeseelandiae* (Falcon) (MNI = NMNZ S 25885), *Circus eylesi* (Extinct Harrier) (MNI = 3, NMNZ S 25884), *Xenicus ?gilviventris* (Rock Wren) (MNI = 1, NMNZ S 25887).

Of these species only weka and falcon still inhabit the mountain; kiwis and Rock Wrens are further west, and Kakapo persisted until recently in the headwaters of the Karamea River (Williams 1956).

**Mt Owen:** Mt Owen, like Mt Arthur, is marble and has caves all over it. The forest edge is about 1200 m a.s.l.. Moa bones were first recorded from the subalpine areas of Mt Owen by cavers: Coates (1963), when describing Giants Staircase Cave, stated "found a moa bone -800 feet [depth] – the first one found in the area." The first 'identification' was recorded by Doug Wheeler, although whether the bone was collected and who identified it are not stated. In describing Chunder Din Cave, Wheeler (*in* Watson 1970) recorded a "leg bone of *Euryapteryx gravis*".

Bell & Bell (1971) made the first study of a collection of moa bones from Mt Owen. They recorded five species: *Dinornis novaezealandiae* (2 birds) *Euryapteryx gravis* (1), *Megalapteryx hectori* (1), *Anomalopteryx didiformis* (1), and *A. parvus* (1). I have re-examined these remains in the National Museum of New Zealand (NMNZ) and confirmed the identity of the *Dinornis* (NMNZ S 23342, 23343), reidentified the *E. gravis* as *Pachyornis australis* (NMNZ S 23345), confirmed the identity of the *Megalapteryx* (NMNZ S 23344), which by synonymy is now called *M. didinus*, and reidentified bones previously identified as being from two *Anomalopteryx* species as being from 1 individual of *M. didinus* (NMNZ S 23346).

In January 1987 I collected the partially mummified remains of a *M. didinus* (NMNZ S 23808) from Whales Blowhole Cave (Worthy 1989).I also

collected bones from a cave in Poverty Basin at 1645 m a.s.l. as follows (x/y = no. of bones/minimum number of individuals): $^{53}$ + /12*M. didinus* (NMNZ S 23527-557, 23559-567), $^{7}$/1 and $^{2}$/1 *Dinornisstruthoides* (NMNZ S 23570, 23571), $^{5}$/1 *P. australis* (NMNZ S 23568). Also two bones from a skeleton of *M. didinus* discovered in Owen Heights Cave, about 1740 m a.s.l., were deposited in the National Museum (as NMNZ S 23558). Bones were also found in the Castlekeep Entrance to the Bulmer Cave System at 1600 m a.s.l. In January 1989 I visited this site and identified bones *in situ* of 3 adult and 1 juvenile *M. didinus* and 1 adult *Pachyornis australis*. Of this last, a tibiotarsus (NMNZ S 23569) had been collected in 1987, but I saw a premaxilla, mandible and femur still in the cave. Further bones of this specimen lie deeper in the cave, below vertical drops of 10 m and 44 m. The specimen is unusually robust for the species. I observed bones of 2 adults and 1 juvenile *M. didinus* in a small cleft discovered by Judith Fraser 150 m west of the main Bulmer Entrance in January 1989 (Fig. 1). A preliminary description of the Bulmer Cave System is given by Paterson *et al.* (1989) and provides location data.

FIGURE 1 — A skeleton of *Megalapteryx didinus* lying with its bones essentially in their position of articulation. This skeleton was found and left in a small cave near Bulmer Entrance on Mt Owen in January 1989

**Mt Luxmore:** On the southern flanks of Mt Luxmore are two small discrete karst fields, at about 1000 m a.s.l., developed in shallow Oligocene limestone. In November 1985 I visited caves in these karst fields and collected a few moa bones (now in the Waitomo Caves Museum) as follows: Steadfast Cave,

a tibiotarsus and a fibula of *M. didinus;* The Hole, a tarsometatarsus of *M. didinus* and a femur shaft of *D. novaezealandiae*; a small cave near Third Cave, a tarsometatarsus and a tibiotarsus of *M. didinus.*

The cave areas of Mt Luxmore are surrounded by a typical subalpine tussock and low shrub community. The few caves do not present many pitfall traps and so have a limited fauna, but as on Mt Arthur and Mt Owen, moas were represented.

**Takahe Valley:** Limestone strata similar to those on Mt Luxmore crop out on the flanks of the Takahe Valley, west of Lake Te Anau. Many moa bones were collected from small caves in the subalpine zone at about 900 m a.s.l. in August and December 1949 by R.A. Falla, K. Miers, and J. Ollerenshaw. This collection, split among the National Museum of New Zealand (NMNZ S 443-449), Canterbury Museum (CM Av 8505, 8507, 8513, 10335-9) and Otago Museum (OM A. 52.1-.14), includes at least 37 femora, or conservatively 19 *M. didinus.*

G. R. Williams collected on 20 February 1954 2 bones (NMNZ S 472) of *M. didinus* from Point Burn, a valley adjacent to Takahe Valley. Also T. Riney collected 15 bones (NMNZ unreg.) of at least 3 *M. didinus* from Takahe Valley in 1952-53.

Between 500 and 600 m lower, and in beech forest, is the extensive Aurora or Te Ana-au Cave System from which I recorded 4 *M. didinus* and 2 *A. didiformis* (Worthy 1985). However the National Museum has additional material which was not located by me in 1984. So a complete list for the cave is as follows: *A. didiformis* $^{7}/_{1}$ (NMNZ S 478) and $^{4}/_{1}$ (NMNZ S 479) collected by K. H. Miers on 5 May 1955; NMNZ S 435,438 – skull and 9 vertebrae of *M. didinus*, NMNZ S 436-7 – $^{7}/_{1}$ juvenile *A. didiformis*, NMNZ S 439 – $^{3}/_{2}$ *M. didinus* and $^{6}/_{2}$ *A. didiformis* all collected by R. A. Falla in January 1949; WO 201 $^{37}/_{1}$ *A. didiformis* from Kneewrecker Entrance, WO 209 $^{4}/_{4}$ *M. didinus* from Kneewrecker Entrance, WO 200 $^{12}/_{1}$ *A. didiformis* from Midway Entrance, collected by me in 1984. To summarise, 7 *A. didiformis* and 7 *M. didinus* are recorded from Aurora Cave.

*The vegetation of subalpine areas near the cave site:* In all subalpine areas tussock (*Chionochloa* spp.) predominates but a wide variety of dicotyledons occurs as well; for example, *Celmisia* spp., *Ranunculus* spp., *Aciphylla* spp., gentians and orchids. Low-growing shrubs are also common, for example, *Dracophyllum* spp. and *Hebe* spp. The vegetation is thus characteristically open and provides little shelter, especially for a bird as large as a moa.

*Age of fossil deposits from subalpine areas:* Areas now in the subalpine zone were probably covered by permanent ice and snow during the last glaciation (Otira). On Mt Arthur and Mt Owen glaciers extended below the present forest edge, as shown by ice-scoured surfaces, cirques etc. Thus, although some major caves developed before and during the last glaciation, most of the surface karst features and the associated pitfall traps developed after the retreat of the ice. Therefore, fossil bones in these subalpine caves are probably less than 14 000 years old. There is a remote possibility that older remains will be discovered on Mt Owen. The erosion of the marble has left fragments of very old phreatically developed caves in which there

are fluvial gravel deposits. These deposits are undated but probably are hundreds of thousands, if not millions, of years old. Owen Heights Cave, one such example, is only about 130 m below the summit of Mt Owen.

There are only three radiocarbon dates for bone material from Mt Owen, and none from Mt Arthur, Luxmore or Takahe Valley. The following dates are reported as calculated using the old half-life for C14 (Libby T½) equals 5568 years. Two of the bones described by Bell & Bell (1971) were dated: *Dinornis novaezealandiae* (NMNZ S 23342), R 4901/1, CR 4550, was dated as 2100 ± 60 yr BP; *M. didinus* – NMNZ S 23446 (R 4901/2, CR 4600) was dated as 11 850 ± 2250 yr BP. The other dated specimen is NMNZ S 23808 – *M. didinus* (R11412/1, NZ 7325), which gave a result 3350 ± 70 yr BP (Worthy 1989). These results support the contention that most bones are likely to be younger than 14 000 years.

## DISCUSSION

In subalpine areas there are only a few restricted areas with caves, which are also often difficult of access, and so recorded moa remains are few. The few caves reported here have many remains of moas, showing that some moas did occupy the subalpine zone. Only three species are confirmed from subalpine sites: *Dinornis novaezealandiae*, *Pachyornis australis* and *Megalapteryx didinus*. The last is by far the most common moa species represented, and the largest accumulations of its bones are from subalpine sites. Bones of *P. australis* are next most abundant. In the Oparara, at Honeycomb Hill Cave,*M. didinus* dominated the fauna during the Otira Glaciation, when the cave was at the forest-shrubland junction (Worthy & Mildenhall 1989), and the main associate was *P. australis*. Thus, although bones of *M. didinus* are found in sites at lower altitude, which are currently forested and probably were during deposition, its remains are relatively less abundant than those of other species. The conclusion derived from observations of the Aurora Cave fauna and Honeycomb Hill (Worthy & Mildenhall 1989) is that the similar sized *Anomalopteryx didiformis* (Little Bush Moa) replaced *Megalapteryx didinus* at lower alitude. There would, however, have been a broad altitudinal zone of overlap because *M. didinus* would have been forced, seasonally, into lower altitudes by the onset of snow.

In general, if something is there to be eaten something will eat it. It is thus no surprise that the rich seasonally available flora of the subalpine zone was a habitat for some moas. On general ecological principles only one or two species would predominate and I have shown that *M. didinus*, the Upland Moa, was the main species using such areas, in association with *P. australis*, the Crested Moa. Invoking catastrophic events such as forest fires to explain the presence of moas is unwarranted.

## ACKNOWLEDGMENTS

Collection of data for this report was made possible by several organisations. In particular I thank the Department of Lands and Survey, who supported excursions to Mt Luxmore and Aurora Cave in Fiordland; and the NZ Forest Service and the Department of Conservation that permitted collection of voucher specimens from Mt Arthur and Mt Owen.

The patience of many fellow cavers has been sorely tested time and again as, instead of getting on with exploration, I have been sidetracked by an old bone.

I thank P. R. Millener for comments that improved the manuscript during its preparation.

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