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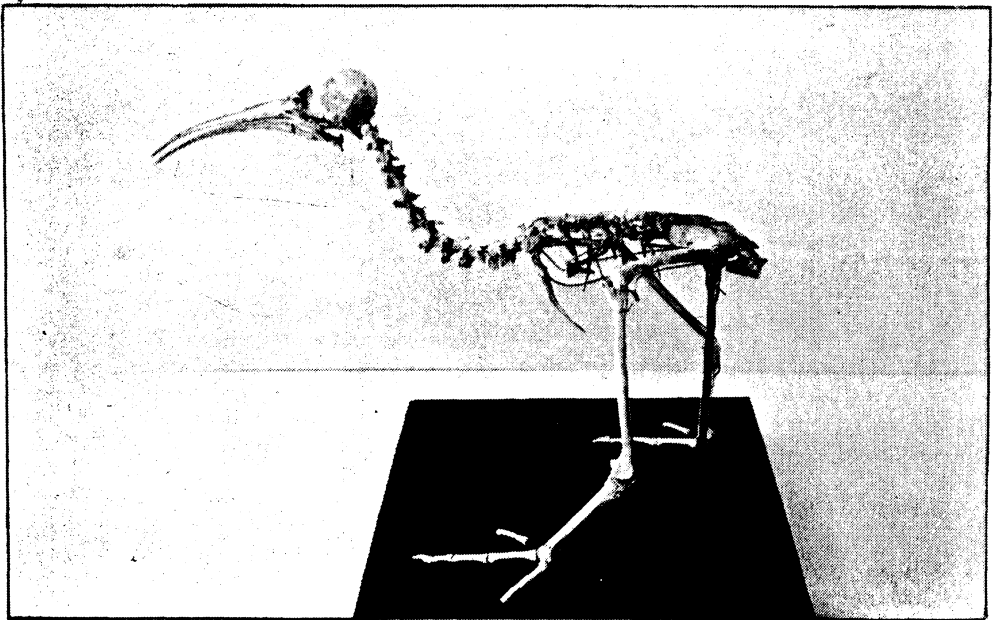
*Irevor Crosby*

redents  
Carnulionoides  
etc.  
caves  
fossils  
etc.

**MOAS**

**AND OTHER**

**SUBFOSSILS**



20p.

1983

WAITOMO CAVES MUSEUM SOCIETY INC. *Waitomo*

With the compliments of  
J. H. Watley.

MOA AND OTHER SUBFOSSILS:-

A Glimpse of the Prehistoric New Zealand Fauna

Trevor Worthy

published by

Waitomo Caves Museum Society Inc.  
Waitomo Caves



Front Cover - A New Zealand Cave Rail -  
Capellirallus karamu - photo by T.H. Worthy

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## INTRODUCTION

The scarcity of vertebrate fossils in New Zealand, all of which have been located in marine deposits, makes it difficult to trace the evolution of New Zealand terrestrial fauna. However subfossil\* deposits give a good indication of what was here during the last 50,000 years. It is apparent that at this stage New Zealand's fauna was in a state of change. Many species were dying out naturally before the advent of man. After his appearance many species became extinct and others severely restricted in distribution.

If it were not for these subfossil deposits many previously occurring species would not have been known and man's effect not fully realized.

The following is a brief description of the subfossil deposits of the Waitomo area, the species represented and their method of deposition. Some comments on the changes inflicted on the New Zealand fauna by the first settlers are made.

\* Subfossils are the unmineralized remains of animals and plants preserved by virtue of their location. Thus bones buried in caves are kept, to a large extent, from the ravages of wind and water, and although many thousands of years in age, they are often well preserved.

THE OCCURRENCE AND DEPOSITION OF SUBFOSSILS

Throughout New Zealand there are three common sources of subfossil material - sand dunes, swamps, and caves. The Waitomo region, underlain by limestone over most of its extent, has many caves and potholes, and is a rich source of subfossils.

Animal remains have to get into caves first and in New Zealand this occurs commonly as a result of two processes.

- (a) Animals for a number of reasons fall into the cave or pothole and are trapped.

This is the most common source of subfossil deposits. Some potholes are more effective death traps than others due to their hidden nature and far more animals get trapped at these sites. Ground birds and animals, are the most common species found in these potholes, eg. moas, kiwis and wekas.

- (b) Carcasses or bones of animals are washed into caves by streams and deposited.

For the remains to be preserved, one of two things have to happen - (i) either the bones get buried in sediments or - (ii) they get deposited by floodwaters beyond the reach of all future floods.

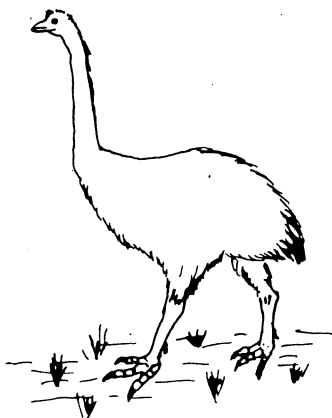
A third and rarer reason for subfossil deposits is flying into caves. Three bat species lived in caves and other bones provide evidence that an extinct bird, the owllet-nightjar, frequented caves by choice, penetrating long distances underground.



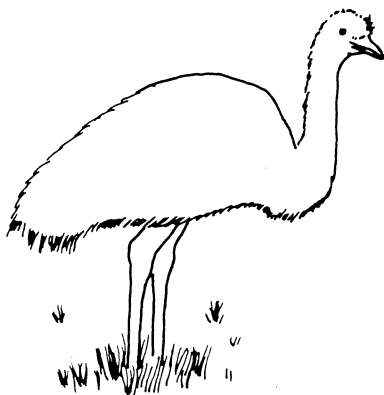
THE ANIMALS REPRESENTEDThe Moa

By far the most impressive and popular remains found belong to one or more species of the moa. In the past up to 38 species and subspecies of these impressive birds were recognised, but more recent studies have reduced this number to twelve.

The traditional conception of a moa is a bird standing 3.7 metres high - really quite an awesome spectacle. Recent studies have led to a change in ideas and now the accepted normal stance of a moa is similar to that of a cassowary or emu with its head held on a level with its back and with its neck coming down in a long sweep. They ranged in height from over 1.5 metres at the middle of the back, to under 90 centimetres. A better comparison is that the smallest was a little larger than a turkey, while the biggest would have weighed over 227 kilograms (500 pounds).

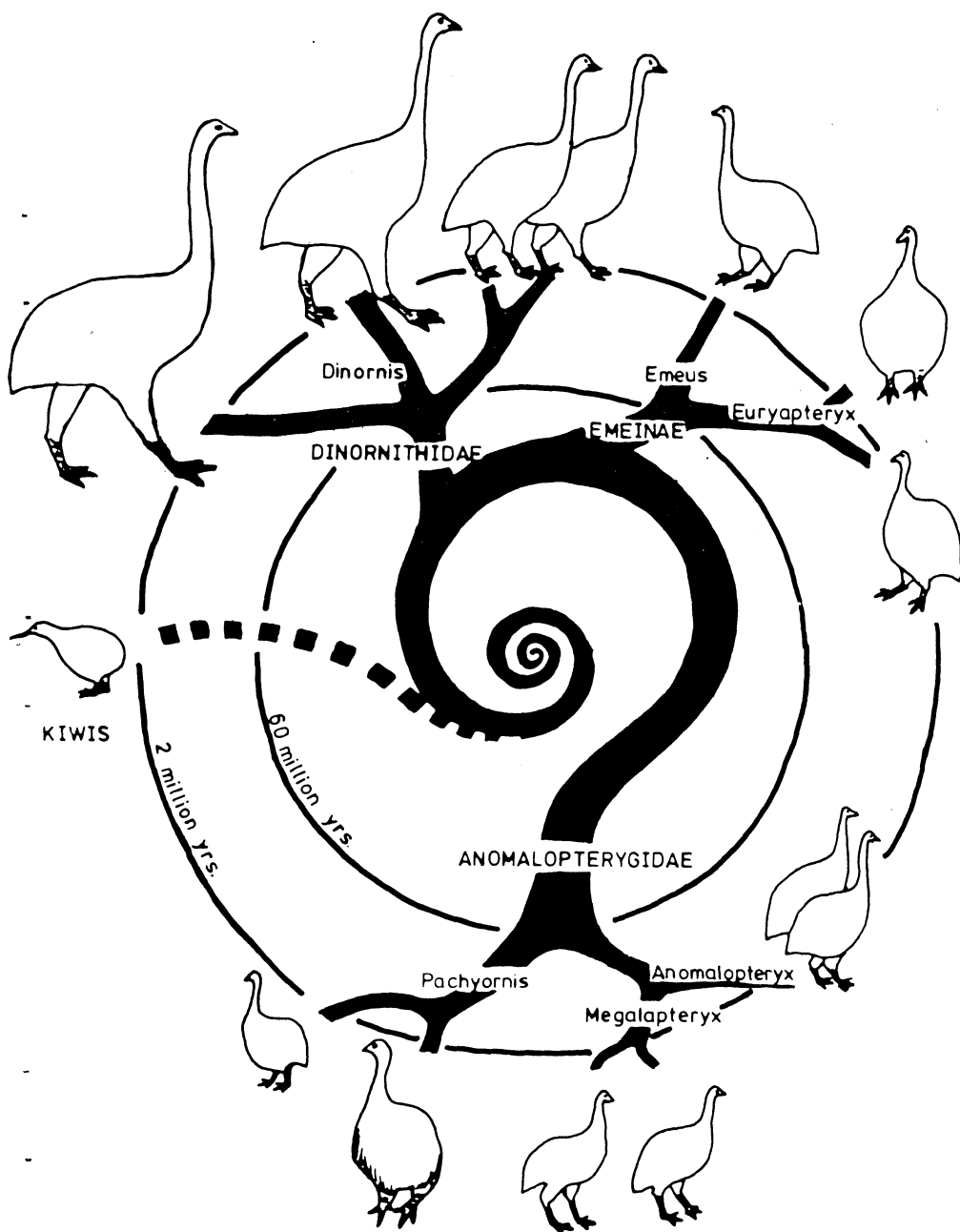


MOA [classic posture]



EMU

The moas nearest living relative is the kiwi and together they share close ties with the emus and cassowaries of Australia. Once isolated in New Zealand, moas evolved rapidly to fill vacant ecological niches (occupied by grazing mammals in the rest of the world. Six genera



ADAPTIVE RADIATION IN NZ RATITES [MOAS & KIWIS]  
after Fleming 1974

evolved and due to geographical separation and other factors at least twelve species came into being. Within species a great deal of variation occurs, part of which at least is due to sexual dimorphism (different shapes for the male and female of a species).

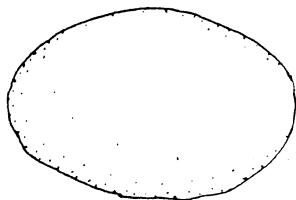
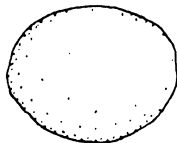
The various moa species became extinct at different times with the larger species dying out first. Climatic conditions following the last few ice advances probably started the process of extinction, but humankind finished it off. The larger species, eg. Dinornis, died out in the North Island 800 - 1000 years before present, with smaller species persisting for another few hundred years.

Although at least twelve species have been recorded there are only seven species found in the North Island and all are located in the caves around Waitomo. Over half of all finds are the remains of Anomalopteryx didiformis. The most ponderous types, species of Euryapteryx and the largest, Dinornis giganteus, are among the rarest which may indicate either lower population levels and/or an earlier extinction date.

#### Moa Eggs and Where Moas Nested

Over the length and breadth of New Zealand very few whole moa eggs have been recovered. Those that have been indicate that moa eggs were large and oval in shape and ranged in size from 152 x 121 millimetres (6 x 4 3/4 inches) to 253 x 178 millimetres (10 x 7 inches). The smaller size is presumed to be for one of the smaller moas - Anomalopteryx didiformis and the larger for Dinornis giganteus, the largest known species.

#### Relative Size of Moa Eggs



hen

kiwi

moa eggs

In a couple of caves around Waitomo moa egg shell has been found. In at least one of these caves the moas actually nested within 30 metres of the entrance. Even today the spacious dry nature of the cave makes an ideal camping site. Rock shelter caves in the Hawkes Bay region have also been found to be nesting sites for moas.

From this limited information it appears that, as most animals do, moas sought dry, warm locations for nesting.

#### Other Birds Found

Over 55 species of other birds have been found indicating a far greater diversity of species occurred than is found today. In keeping with the usual type of deposition, flightless and semiflightless birds far outnumber other species.

The kakapo or night parrot, a flightless species unique to New Zealand, accounts for perhaps 50% of all individual birds known from caves in the area. The species is now confined to Stewart Island where a few hundred individuals survive, and Fiordland where six males are known to exist.



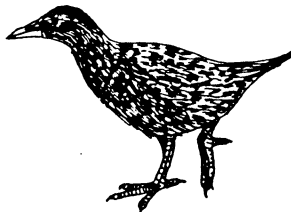
kakapo

The weka, kiwi and the weak flying kokako or blue-wattled crow are the next most common species encountered. In addition five species of duck, six species of rails, various native parrots and parakeets and many other species occur.

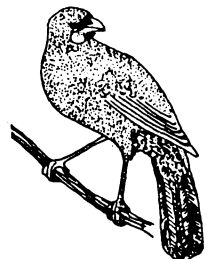
kiwi



weka



kokako

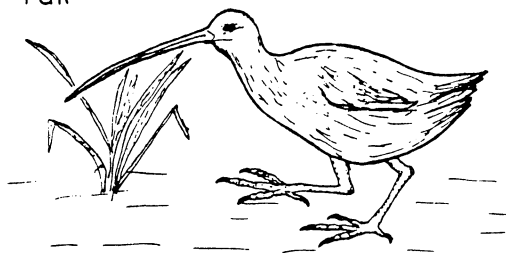


A high proportion of species recorded from sites in Waitomo, 78% in one example; are either regionally extinct or totally extinct. These extinct species include some of the more spectacular forms.

New Zealand has an extinct goose which stood about one metre high. Closely related to Tasmania's Cape Barren goose it is among the rarest of species known from the Waitomo area, with only seventeen individuals having been recorded.

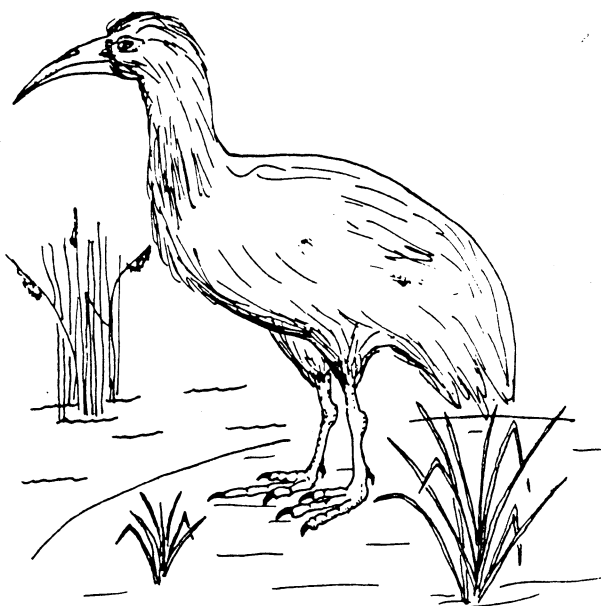
Evolution among rails (weka-like birds) in New Zealand led to a number of species with the smallest and largest both showing remarkable divergence in form. The adaptive radiation exhibited by rails is similar to that of moas. The cave rail (Capellirallus karamu), one of our smallest rails at 25 centimetres high, had developed a long beak similar to that of a kiwi (possibly indicating similar habits). This is a rare species with only some two dozen part or complete skeletons known plus a few odd bones.

cave rail



The Apatornis, our largest rail which stood over one metre had evolved a large outsize skull with a heavy bill. This is again a rare species with only about a dozen individuals represented in the area.

At present New Zealand has one falcon and one hawk, but in former times a hawk at least 20% bigger roamed the skies and an eagle occurred. The extinct hawk is rare in deposits in Waitomo and the eagle seems to have been confined to the South Island.



Aptornis otidiformes

Other Animals

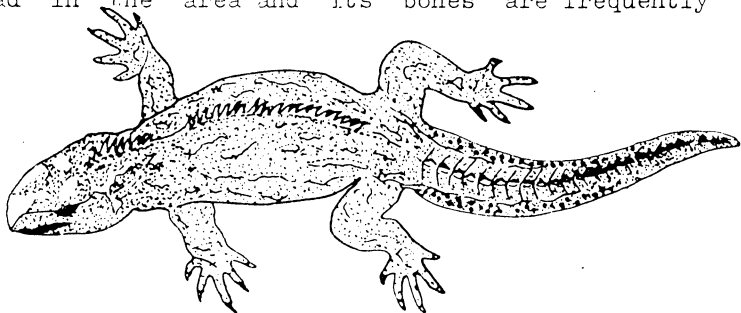
Bats: New Zealand has three species of bats, remains of which have been found in the local caves. The short-tailed bats - Mystacina tuberculata and Mystacina tuberculata robusta, are ground feeders and, due to predatory pressures, are now very rare. They were the species which used caves the most. A third species, the long-tailed bat uses the caves primarily for breeding. Its remains are rare.





Lizards - skinks and geckos: The taxonomy of New Zealand lizards is still not complete, but it is apparent that a number of undescribed extinct species once occurred in the area. Subfossil remains of lizards up to 25 centimetres long have been found.

Lizards - tuataras: This unique New Zealand lizard, a 'living fossil' from the time of dinosaurs, was once widespread in the area and its bones are frequently found.



Frogs: There are at present only three native species still alive, none of which are known from the area now. Again subfossil remains indicate that several species, some much larger than modern frogs once existed.



### The Occurrence of Recent Animals

Unfortunately for the local farmers sheep and cattle frequently fall down caves or die in the shelter of entrances and their bones are consequently very common in caves.

The number of modern birds found in caves is quite low, indicating the huge time span involved in the accumulation of subfossil deposits. The species found to date are shown in the following table. Although not a complete list the frequency and kind of species expected is shown.

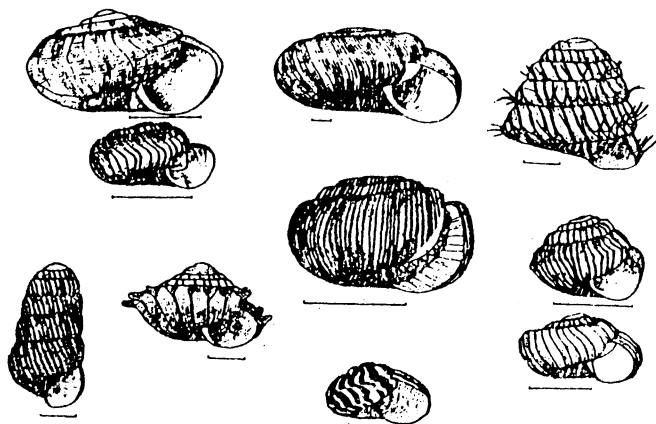
<u>Species</u>	<u>No. of Occurrences</u>
Blackbird - most common	dozens
White Backed Magpie	3
Pukeko	3
Californian Quail	1
Pheasant	2
Domestic Goose	1
Harrier Hawk	2
Mallard Duck	1

The hawk is not a species which commonly frequents the ground, but perhaps it is attracted to caves by carrion.

#### Subfossil Invertebrate Remains

If the conditions are right insect and land snail remains may be preserved in caves. Deposits containing these remains are usually near entrances although some stream wash deposits contain snails.

Subfossil Snails: New Zealand has over 400 species of land snails. Limestone areas tend to have a greater species diversity than other areas, thus in Waitomo over 50 species may be found from one deposit. Most are minute, smaller than five millimetres diameter, but when

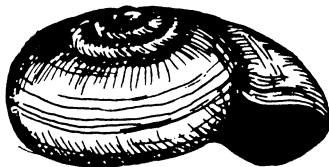


scale 1mm [after Climo 1975]



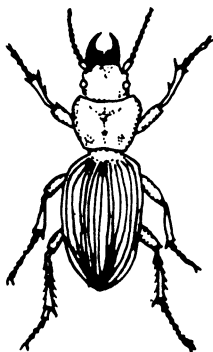
viewed under a microscope their exquisite sculpture is revealed.

One family of snails contains several large species. Powelliphanta spp. which reach over five centimetres in diameter, once existed around Waitomo, but is now presumed to be extinct.

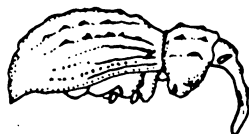


Subfossil Insects: As the exoskeleton of insects is composed of chitin - not  $\text{CaCO}_3$  like in snails - their remains usually disappear. However in deoxygenated acidic deposits several species of ground inhabiting insects have been recorded. These are mainly carabid beetles and weevils. Recently a couple of new species were discovered in a cave near Waitomo.

A.



B.



A. Carabid beetle

B. Weevil [legs & antennae omitted]

Like our bird fauna some insects tended to evolve into large flightless forms. Weevils and wetas are the two main examples of this. Many weevil species evolved to occupy very specialized habitats and some grew to over two centimetres long. One subfossil species found near Waitomo indicates the previous existence of tussock vegetation. Introduced predators, such as the polynesian rat, probably were the main cause of the elimination of these species over most of New Zealand.

- Other Invertebrate Remains: Millipedes and armadillo bugs have been found calcified in caves in several places, however their remains are far from common.

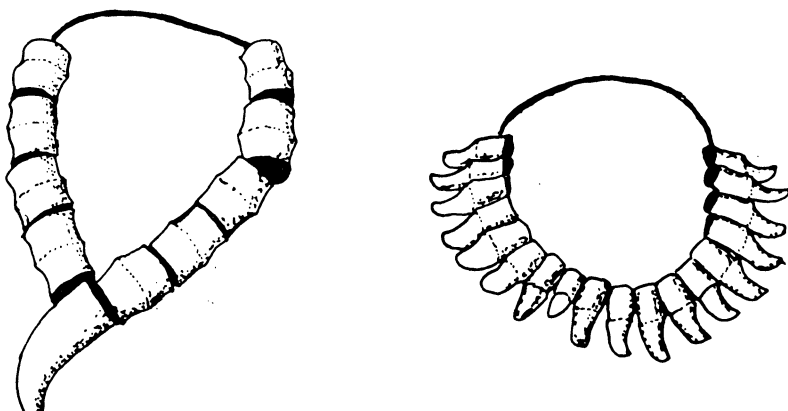
## THE EFFECT OF MAN ON OUR BIRDS

The first people to arrive in New Zealand were Polynesians who came about 1000 years ago. These people belonged to a hunter-gatherer society and thus were nomadic. As various food sources changed with the changing seasons so the earliest New Zealand settlers moved around the countryside. In winter seafoods were harvested while in summer and spring birds were hunted. Numerous fires were lit which resulted in the total destruction of the forests in Canterbury and in other smaller areas, mainly coastal, eg. Karikari penninsular.

### The Moa and Man

These people hunted whatever animals were available and moas were important to their economy. Thus they became known as moa hunters. A single kill resulted in a lot of meat for eating, bone for tool and ornament manufacture and skins for clothing.

Moas were forest inhabiting birds and they were probably hunted by dogs and the carcasses brought back to the camp. All cooking was done in the hangi. The bones were broken to allow the removal of the marrow. A range of needles, sewing awls, and fish hooks were made out of moa bone. In times of plenty the moa hunters had a certain amount of leisure time and ornaments were made. Necklaces made from a dozen or more reels carved from moa bone have been found in several moa hunter burials. Even one or two amulets carved from moa bone have been found.



Moa eggs when found were probably a welcome delicacy, however pierced eggs found in burials show that they were used as water containers also.

Because moas were so important to the early settlers they were hunted and this eventually led to their extinction. It seems that although early man in New Zealand eventually eliminated the moa, the various species were already on the road to extinction, perhaps due to changing climatic conditions. This process was more advanced in the North Island than in the South Island. Archaeological studies at Mt. Camel in Northland have shown that in this location fishing was by far the most important source of food. Over 50 individuals of moa were recorded from this site, but most belonged to the smaller species with the larger species being rare. The economy of most other North Island 'moa hunter' sites was probably similar.

In the South Island, Canterbury in particular, moas were more common, but as the forests were burnt off and the moas hunted out, the 'moa hunters' gradually moved southwards. Moa hunting ceased to be important 3 - 400 years before present. However one or more species of moa probably persisted into the 19th century in remote areas of New Zealand.

#### Man's Effect on Other Birds

It is difficult to say how much man affected other bird species directly, but it is certain that the changes he inflicted on the environment were probably the single most important factor to their elimination. When man arrived in New Zealand he brought with him the dog (kuri) and the polynesian rat (kiori). It is probable that the latter can lay claim to the dubious honour of being the first introduced predator in New Zealand. Small ground nesting or ground frequenting birds would be easy prey for the kiori, eg. Stephens Island Wren, which was thought to have been restricted to Stephens Island in the Marlborough Sounds when discovered by the white man, is

now known to have occurred in both the North and South Islands. It has been found in at least two caves around Waitomo. Larger species may even have fallen victim to kiori, a race was known to attack albatrosses in one island situation. The kiori climbs up on to the back of the nesting bird and eats a hole in the back of the unfortunate bird. Up to a dozen kiori have been observed to flee from the back of a nesting albatross when approached by a person. It is possible that in early New Zealand the kiori attacked other large ground nesting birds in this fashion, eg. moas, extinct goose, giant rails, etc. Perhaps this was the fate of some of our birds.

The early Polynesian bred the dog which appears to have existed only in the domestic situation. He undoubtedly used the dog to hunt birds, but at other times he ate them as well. Studies on dog skeletons in South Canterbury where moa hunting was the most important activity show that the dogs in this area had developed heavier neck and jaws consistent with grabbing and holding game.

Certain species which died out at the same times as the moa, eg. the giant rail Apturnis and the extinct goose Cnemidornis, have been found in the middens (refuse heaps) of early man in New Zealand, so direct hunting of these species may have contributed to their eventual extinction.

Early man made use of whatever birds were available, thus in lake areas, eg. Poukawa (Hawkes Bay), large numbers of ducks were killed - probably during the annual moult when they could not fly. In forested areas, pigeons were a prime target as they were large and easily captured. In coastal situations, the fledglings of petrels and shearwaters were captured from their burrows and preserved for later eating, an activity later called muttonbirding.

In later years the Huia became a much sought after bird as its tail feathers became a token of importance

and wealth.

Generally it can be said that the early Polynesians caught whatever they could catch. This in combination with modification of the landscape by both Polynesian and European led to the extinction of several species.

#### SUMMARY

Scientists can excavate the living sites of New Zealand's first human inhabitants and gain some knowledge of their diet, but the effect these people had on the environment is more difficult to assess. Subfossil deposits dating from times prior to human occupation can provide useful data on not only what birds, but what plants and insects used to occur in New Zealand. The preceeding text has given the reader only a glimpse of the past diversity of life revealed by these deposits. The absence or reduced range of many species indicates sweeping changes in our fauna. These were a result of predation by man, the rat and dog he introduced, and of changes made to the environment such as deforestation.

Great as these changes seem they are minor compared to the changes in our fauna since the pakeha arrived in New Zealand. As subfossils are still being deposited future investigators in years to come will find these changes preserved indefinitely in other subfossil deposits.

SELECTED REFERENCES

- Climo F.M. 1975 "The Land Snail Fauna" in The Biogeography and Ecology of New Zealand. Ed. Kurchell.
- Fleming C.A. 1974 "The Coming of the Birds" in New Zealand Nature Heritage, Vol 1, Part 3.
- Halliday T. 1978 Vanishing Birds - Their Natural History and Conservation. Hutchinson, New Zealand.
- McCulloch B. 1982 No Moa - Some Thoughts on the Life and Death of New Zealand's Most Spectacular Bird. Pub. by Canterbury Museum, Christchurch.
- Prickett N. (ed.) 1982 The First Thousand Years - Regional Perspectives in New Zealand Archaeology. New Zealand Archaeological Association Monograph 13.
- Scarlett R.J. 1972 Bones for the New Zealand Archaeologist. Canterbury Museum Bulletin No. 4.

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