

Subfossil kakapo (*Strigops habroptilus*) remains from near Gibraltar Rock, Cromwell Gorge, Central Otago, New Zealand

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Subfossil bones show that, before the arrival of humans in New Zealand, kakapo (*Strigops habroptilus*) were common across North and South Islands, and were most common in high rainfall areas west of the main divide where rimu (*Dacrydium cupressinum*) and beech (*Nothofagus* sp.) dominated the forest canopies (Worthy & Holdaway 2002). However, there is a notable absence of kakapo remains from subfossil deposits in the dryland regions of Central Otago

and the Canterbury Plains (Worthy & Holdaway 2002). This does not appear to be due to lack of subfossil sites, as, although there are few sites suitable for accumulation and preservation of bird bones on the Canterbury Plains, 32 bird species have been collected from numerous sites throughout Central Otago (Worthy 1998; Wood unpubl.). Nor does the absence appear to be a result of the type of subfossil sites present in these regions; the most diverse avifaunal assemblage from Central Otago consists of at least 18 species collected from Earnsclough Cave, near Alexandra (Worthy 1998). Kakapo are not yet recognised in this assemblage, although their bones are abundant in other New Zealand cave deposits such as those from Waitomo (Millener 1981), Takaka Hill (Worthy & Holdaway 1994) and West Coast (Worthy & Holdaway 1993). This note describes the first verified kakapo remains recorded from the Central Otago region, and material associated with these remains.

During the 1970s and 1980s, State Highway 6 linking Clyde and Cromwell was reconstructed at a higher elevation, before the old road was submerged by the filling of Lake Dunstan for the Clutha Valley hydroelectric scheme. Earthworks during road construction uncovered several deposits of subfossil bones. Two of the earlier discoveries, the first near Firewood Creek on 13 June 1979, and the second near the Cromwell railway station in February 1981, were described by Ritchie (1982). A third discovery was made in early 1987. While removing landslide debris from a slope 600m downstream from Gibraltar Rock (Fig. 1), a construction worker uncovered a deposit of plant material and bird remains. Jeff Bryant, an engineering geologist at Ministry of Works and Development, arranged for material to be collected from the site before earthworks proceeded. The discovery was reported in local newspapers (*Southland Times* 1987; *Otago Daily Times* 1987) and on radio news (J. Bryant pers. comm.). Newspaper reports indicate that remains of moa, tuatara (*Sphenodon punctatus*), kakapo and takahe (*Porphyrio mantelli*) were discovered at the site (*Southland Times* 1987). Unfortunately the current location of the collected faunal material remains a mystery. A dried foot of a kakapo, photographed by the *Southland Times* (1987), was collected from the site, but has since been lost (J. Bryant pers. comm.).

Geologist Roydon Thomson, who visited the site soon after its discovery, recorded the exact location of the deposit as 2214140 / 5563750 (NZMG coordinates) at an altitude of 240 m.a.s.l. (R. Thomson pers. comm.). The deposit is reported to have been 14m below the original ground

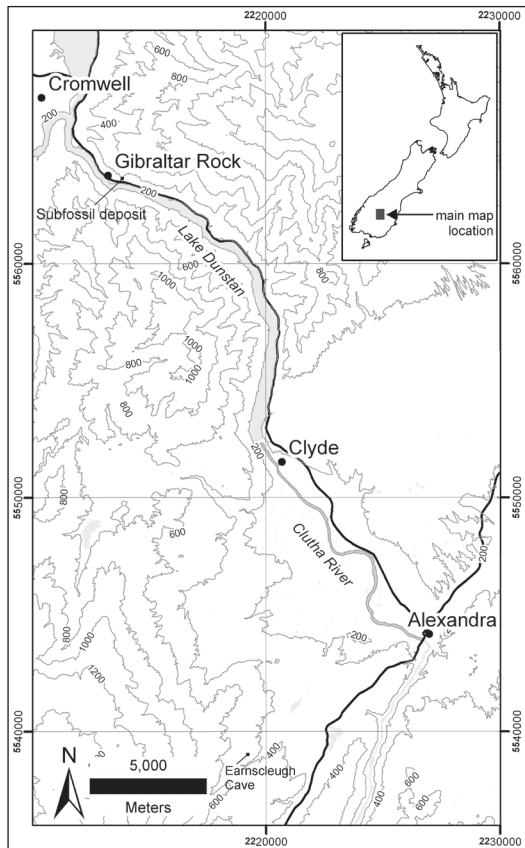


Figure 1 The location of the Gibraltar Rock subfossil deposit, Central Otago, New Zealand.

surface (*Southland Times* 1987), probably in a small cave within the rocky landslide deposit, the entrance of which may have been covered by subsequent landslides.

In April 2005, I examined plant material labeled as a 'native eagle's nest, or moa nest', (ALEX 05.16.01), that had recently been gifted to the Alexandra Historical Museum from a private collection. Information associated with the plant material indicated that it had been collected from near Gibraltar Point c.1990. Feathers amongst the plant material were identified as kakapo, so it seems likely that this is a sample of material collected from the Gibraltar Rock deposit.

The sample was examined for faunal remains. The most common items present were kakapo feathers, including faded green and brown contour, wing and tail feathers (Fig. 2), and brown and white facial feathers. The only other feather in the sample was a red facial feather of a parakeet (*Cyanoramphus* sp.). Three small fragments of moa eggshell were identified, together with three fragments of thin white eggshell. The fine-granular texture of this thin eggshell is consistent with eggshell of kakapo (Higgins 1999). Two lizard dentaries, and two rabbit bones were also present in the sample. Takahe remains were reported to have been found in the Gibraltar Rock deposit (*Southland Times* 1987); this cannot be verified at present as no takahe remains were present in the sample analysed.

Kakapo coprolites found within the deposit contain primarily moss leaves and stems, with lesser amounts of grass and dicotyledonous (*cf. Muehlenbeckia*) leaf cuticle.

The plant material from the Gibraltar Rock deposit appears to have been deposited as a nest. Although no nest structure remains, the bulk of the material is finely chewed bark resembling that chewed by a Psittaciforme (Fig. 3). Kakapo typically nest in natural cavities at, or below, ground level (Higgins 1999). Items identified in the Alexandra Museum sample represent an open woodland habitat and include seeds of *Muehlenbeckia australis*, *Pittosporum tenuifolium*, *Coprosma* sp., *Pseudopanax ferox*, *Myrsine* sp. *cf. nummularia*, *Carmichaelia* sp. *cf. nana*, *Rubus cissoides*, *Acaena* sp., *Centipeda* sp.; woody remains of *Muehlenbeckia* sp. and lacebark (*Hoheria* sp.), and fragments of moss.

An AMS age of 2482 ± 35 years B.P. (Wk17228) was obtained for one of the kakapo feathers. This contrasts with a previously reported age for the site of 9500 years (*Southland Times* 1987). No official records of this earlier age seem to exist, so the actual material which was dated cannot be determined. The late Holocene age is more consistent with ages obtained for other cave and rockshelter deposits in the Central Otago region (Worthy 1998; Wood unpubl.).

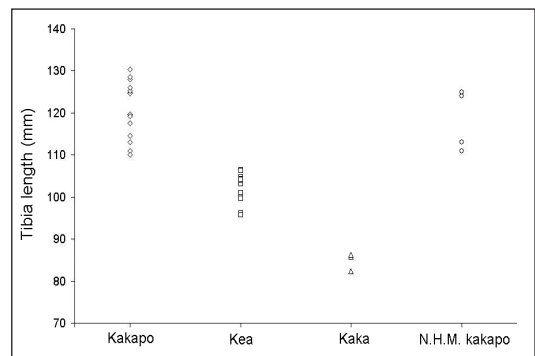
Two tentative subfossil records of kakapo from Central Otago await further examination. A small collection of bones labeled as originating from Earnsclough Cave are present in the collections of the Natural History Museum, London.



► **Figure 2** Kakapo feathers found amongst nesting material near Gibraltar Rock, Cromwell Gorge (Alexandra Museum 05.16.01). Scale bar in cm.



► **Figure 3** Comparison of A: modern bark from a lacebark (*Hoheria* sp.) after chewing by a Psittaciforme (*Cyanoramphus novaezelandiae*); with B: inferred kakapo nest material from the Gibraltar Rock subfossil deposit, Cromwell Gorge (Alexandra Museum 05.16.01) (right). Scale bar in cm.



► **Figure 4** Tibiae lengths of kakapo (Otago Museum AV1523; AV1525; AV1561; AV1562; AV7152), kea (*Nestor notabilis*) (Otago Museum AV1634 - AV1638; AV893 - AV896) and kaka (*Nestor meridionalis*) (Otago Museum AV2231; AV2232) compared with kakapo tibiae labeled as originating from Earnsclough Cave (Natural History Museum, London, R70-74).

However, four of the 10 species represented, including kakapo, have not been recorded in other collections from the cave (Worthy 1998). Analysis of photographs and measurements of the bones indicate they are correctly identified (Fig. 4), however closer examination of the bones is required to determine whether their origin is likely to have been Earnscleugh Cave, or if they have been mislabeled.

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The only other record of kakapo from Central Otago is three coprolites from a cave on Old Man Range (Otago Museum, AV10436). However, the size and shape of these coprolites suggest they are likely to be from an upland moa (*Megalapteryx didinus*). Feathers and coprolites from this moa species are common in caves and rockshelters throughout the region.

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SHORT NOTE ► Kakapo in Maori lore

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In Maori lore, there is an old story about the kakapo that has survived the test of time. Legend has it that toroa, the great ocean wandering albatross, was once a land bird but, because of its brilliant white plumage, it was conspicuous and vulnerable on land. So it swapped places with the kakapo, which was once a seabird, and soared out to sea, its markings blending beautifully with the foaming white crests of the southern ocean swells. Meanwhile, the kakapo vanished into the twilight forests of Aotearoa, its mossy green plumage perfect camouflage for its new home. Until the arrival of humans, it had few natural enemies. It was so safe

in the depths of the bush, it eventually lost its ability to fly. Its greatest defence was its colour, nocturnal habits, and instinct to freeze rather than flee.

This survival strategy served it well until the arrival of the Polynesian kuri (dog) that relied on scent rather than sight to flush out game. Kakapo were sitting ducks, so to speak. And kuri grew fat on kakapo when an iwi settled in a new area.

The kakapo is one of a number of native New Zealand birds regarded as taonga (treasured) species to the Ngai Tahu iwi. It was hunted for its meat, skin and feathers. The meat was a great delicacy for tangata whenua, but it had a "strong and slightly stringent flavour", according to western tastes. The bird was plucked and skinned before eating. Some were preserved in their own fat in baskets made from the inner bark of totara trees or in poha (bags) made from kelp. Bundles of kakapo tail feathers were attached to these containers for decoration and to identify the contents.

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Feathers from the kakapo, kaka, kakariki, koekoea and ruru were also used to decorate the head (te reke) of the taiaha, but this decoration was removed during warfare. Kakapo skins with their feathers intact were softened and used to make beautiful kahu kakapo (dress capes) and kakahu (cloaks) for wives and daughters of leading chiefs. Sometimes feathers were individually woven into ceremonial cloaks, a slow and painstaking task. Some of these highly prized garments are preserved in museum collections today. The ceremonial cloak worn by New Zealand team flag-bearer, Beatrice Faumuina, at the Athens Olympics had feathers in it from a range of rare native birds, including kakapo.

The birds were easily caught by dogs, snares and pit traps, cornered on moonlit nights when a food source was abundant or when birds assembled on their whawharua (breeding hollows). One of the most detailed accounts of traditional methods used to catch kakapo comes from ethnographer Elsdon Best (1925), who recorded the following tale from the Tuhoe iwi in the Ureweras. At night the birds congregated at a whawharua (hollow place) and began a strange ritual by beating their wings on the ground, uttering a weird cry [known as booming] and forming a pokoroa (hole) in the ground with its beak. Each whawharua had its leader, known as the tiaka, Best wrote. This bird walked around the outer edge of the whawharua like a sentry and did not join in the activities. At dawn this smaller bird led the flock back to their hiding places. During this mating ritual, hunters captured the birds by approaching from downwind and waiting until the dance started. Obviously, the birds had a keen sense of smell. Provided the tiaka was captured first, the rest could be caught by hand. If the tiaka escaped, so did the rest of the birds.

For several hundred years southern Maori relied on moa from the inland plains of Te Waipounamu and seals on the coast as their primary food source. As these sources declined about 1350 AD, permanent settlements based on these hunting grounds split up and the emphasis switched to a more transient lifestyle, fishing, and seasonal hunting forays into the bush for smaller species such as kakapo.

The birds may have been well camouflaged, but they left plenty of evidence of their movements. Southern ethnographer James Herries Beattie (1994) recorded that the birds had a refined taste for the best aruhe (bracken fern root) and left plenty of sign of gnawed pieces behind them. They only ate the inner part of the best roots and

rejected the stringy fibre. Where this refuse was found, Maori learnt to search closely nearby for the best aruhe. This was a starchy survival food for them during hard times and food shortages.

Another common sign of kakapo activity in an area was when harakeke (flax) blades had been chewed into strips. When this sign was observed, the birds lost condition (maiki or maieke) and the flesh tasted kaua (bitter), according to Beattie's contacts. "The kakapo lives in rua (holes) made like umu (ovens), only deeper", he wrote. "The bird is only sought when it is fat, otherwise it is no good. It has a habit of jumping into its hole and shaking itself and the old people said it was trying to shake the fat out of itself and make itself maiki".

According to Maori folklore, when Polynesians first arrived in Aotearoa over 1000 years ago, kakapo were found throughout the country. Bones found in caves and middens confirm the species was once widely distributed throughout the North and South Islands. By 1843, they were almost extinct in the North Island. In Nelson, Westland and Fiordland were small population strongholds, but the species was already in serious decline in the south as well. European settlement greatly accelerated this decline, with increasing hunting pressure, forest clearance and the introduction of mammals that became kakapo predators and competitors for the same foods. In 1899, Westland explorer Charles Douglas recorded the birds were caught simply by shaking the bush on which they were feeding and they would fall to the ground (Langton 2000)

Sprung by a dog with no recollection of its last meal, the cornered parrot of the night had one last line of defence - a kick like a mule. "Ka kiki te waewae" might have won it the odd battle with a young, inexperienced dog, but kakapo were already losing the war of survival.

GLOSSARY

Localities: Aotearoa – Maori name for North Island but now commonly used as the Maori name for New Zealand; Te Waipounamu - Maori name for South Island; Birds: toroa – albatross (*Diomedea* sp.); kakapo – *Strigops habroptilis*; kaka – *Nestor meridionalis*; kakariki – parakeet (*Cyanoramphus* sp.); koekoea – long-tailed cuckoo (*Eudynamis taitensis*); ruru – morepork (*Ninox novaeseelandiae*); moa – collective name for large flightless birds of Order Dinornithiformes (Family Emeidae and Dinornithidae); Plants: harakeke – flax (*Phormium tenax*); bracken fern – *Pteridium esculentum*

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Agonistic display and social interaction between female kakapo (*Strigops habroptilus*)

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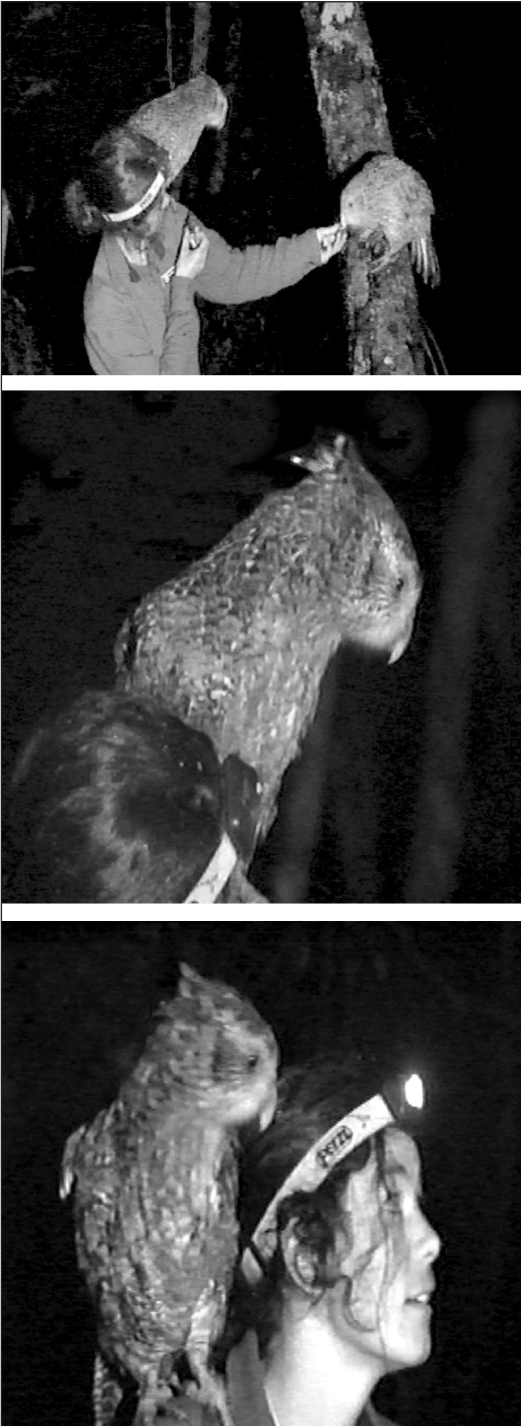
Kakapo (*Strigops habroptilus*) is a giant nocturnal, flightless parrot endemic to New Zealand (Merton *et al.* 1984). It is highly endangered, with (at December 2005) only 86 individuals in existence. It is the only parrot to use a lek mating system, and many aspects of male courtship behaviour have been observed at male display territories or 'track and bowls' (Merton *et al.* 1984; Powlesland *et al.* 1992), although recent video monitoring of nests has recorded female and chick behaviour also. Agonistic displays observed in male kakapo include threat displays that often escalate to fights and occasionally lead to injury and death (Higgins 1999). This paper describes the first observation of an apparent agonistic interaction between two female kakapo.

The observation occurred while filming kakapo on Codfish Island (Whenua Hou) nature reserve, 2 km north-west of Stewart Island, on 8 April 2002. A two-person film crew had accompanied us on a visit to weigh and assess the condition of a three-year-old, previously hand-reared, female kakapo named Hauturu. Although Hauturu had been free-living since mid-1999, she was comfortable with the presence of humans and would alight on a hand-held scale when tempted with food. Individual kakapo could be identified by the unique frequency of the radio-transmitter fitted to each bird.

We located Hauturu near a track in her usual home range at approximately 2000hrs and JJ proceeded to offer her grapes. She approached JJ, was weighed, and then climbed a nearby kamahi (*Weinmannia racemosa*) to about head height where she continued to accept food. She was filmed almost the entire time, and did not appear to be disturbed by the spotlight used for illumination. There was no wind, and it was raining lightly. After about 11 min. another female kakapo, Hoki, approached the group without hesitation. Hoki, a ten-year old bird, had also been hand-reared and was particularly tame. Hoki's nest, in which she was incubating a single-egg clutch at this time, was about 200 m away.

Hoki climbed a tree next to the track after 1.5 min. JJ continued to feed Hauturu, who had become less animated and was only nibbling on the offered food. After 3.5 min Hoki descended the tree and walked towards JJ, raising her anterior crown feathers. Hoki then began to accept grapes from JJ on the ground, but shortly afterwards, climbed onto JJ's shoulder. Hoki was raising her crest regularly at this stage, while feeding on the offered grapes (Fig. 1). Hauturu had 'frozen' in a hunched posture, with head lowered and no detectable movement, about 1.8m up the tree. Both birds were at a similar height, and only about 1.5m from each other (Fig. 1). For the next nine minutes Hoki continued eating grapes, and at regular intervals she leaned over towards Hauturu, raised herself up to her full height, and raised her crest. This caused Hoki's body and head to be elevated with respect to Hauturu's position. This behaviour occurred about six or seven times while Hauturu remained in her 'frozen' position. About five minutes after Hoki had climbed onto JJ's shoulder JJ began to feed both birds. Hauturu nibbled at the offered grapes, but remained 'frozen' (Fig. 1). After eight minutes GH passed some grapes to JJ. At his approach, Hoki raised her crest at GH, and Hauturu moved about 1m further up the kamahi trunk. After nine minutes had elapsed, Hoki climbed off JJ, onto the kamahi trunk that Hauturu was on, and descended to the ground. Hoki then accepted another grape, and one minute later, departed.

This kind of agonistic interaction between two unrelated adult kakapo has not been observed or reported before. This is despite many hours of filming of male kakapo at 'track and bowl' systems during the breeding season and some direct observations of males in Fiordland and Stewart Island (D. V. Merton pers. comm.), and hundreds of hours of recent filming of female kakapo on nests with chicks. The only other regular observations of kakapo behaviour were of Hoki when she was the sole occupant of an enclosure on Maud Island/Te Hoiere, Marlborough Sounds (Climo & Ballance 1997). Apparent agonistic behaviours that Hoki exhibited included raising all the feathers on her head and shoulders, "like a cat fluffing out its fur to make itself larger and more intimidating" (Climo & Ballance 1997). This behaviour has also been seen in male kakapo (Higgins 1999). Another apparently agonistic behaviour involved Hoki holding a stick in her beak, holding her wings half-raised, and moving from foot to foot (Climo &



► **Figure 1** Upper: Hoki on JJ's shoulder with crest raised, at full height and leaning towards Hauturu, who is 'frozen' on the tree. JJ is offering grapes to both birds. Centre: Detail of Hoki at full height, leaning towards Hauturu, with crest raised. Lower: Hoki with crest raised, but not at full height.

Ballance 1997; GH pers.obs.). This behaviour ceased after the observers had retreated.

Hoki has also used the same threat pose that males demonstrate at 'track and bowl' systems, of raising the wings over her head until they touched, or almost touched, at the tips (Higgins 1999; Climo & Ballance 1997; GH, JJ pers. obs). A male kakapo, Luke, has been filmed directing this display at black petrels (*Procellaria parkinsoni*) that encroached on his 'track and bowl' system on Little Barrier Island (Natural History New Zealand 1998).

Crest-raising has not been previously reported in kakapo, although similar crest-raising has been observed in other New Zealand parrots e.g., kaka (*Nestor meridionalis*) (GH pers. obs.), red-crowned parakeet (*Cyanoramphus novaezelandiae*) (Higgins 1999), and kea (*Nestor notabilis*) (Diamond & Bond 1999). Male kea use a facial display, similar to Hoki's crest raising, called the 'jay face', in which they flatten the anterior crown feathers and raise the posterior crown feathers. This display is used by dominant males when in possession of a resource (Diamond & Bond 1999).

It is possible that Hoki was using the crest-raising display for a similar reason, to show Hauturu that she was in possession of the offered grapes in this case. The 'freeze' response by Hauturu is a common response of kakapo to a perceived threat (Higgins 1999), but has not been previously observed in an interaction between two kakapo. Kea have a similar response, 'hunching', where a bird will crouch, lower the head and become immobile when attacked or chased. This position appears to 'cut-off' aggression stimulus for the dominant individual (Potts 1977). This interaction infers that both females knew each other, which is likely as they had adjacent home ranges, and that Hoki was the dominant individual. This infers some form of social hierarchy within the species, which in turn suggests a greater degree of social interaction than previously described (Higgins 1999).

The recent intensive management of kakapo has resulted in several observations of unrelated kakapo located together e.g., in the same tree, at supplementary feeding hoppers, and visitations to occupied nests and 'track and bowl' systems. These observations concur with those from the late 19th century when kakapo were both widespread and relatively abundant (Buller 1877; Reishek 1884; Pascoe 1957), such as, "...seen them in pairs on their nocturnal rambles" (Reishek 1884), and "...about a few score [kakapo] in a few hundred yards..." (Henry 1903). Conversely, these observers also commented on the largely solitary nature of kakapo, but most of these observations were of kakapo either roosting or in nests during the day. Nocturnal observations were mainly of males during the breeding season. Collectively, these observations, and ours, suggest a greater degree of social structure or hierarchy in kakapo than previously thought.

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