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EVIDENCE THAT POSSUMS PREY ON AND SCAVENGE BIRDS' EGGS, BIRDS AND MAMMALS

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The brushtail possum (*Trichosurus vulpecula*) is an opportunistic herbivore feeding mainly on leaves supplemented by a variety of other plant materials. Possums are known to eat more than 100 native plant species and a wide range of introduced plants. Diet varies markedly between regions but within any particular region is concentrated on a few plant species (Green 1984). In addition to plant material, possums will eat invertebrates (Gilmore 1967, Clout 1977, Warburton 1978, Morgan 1981, Cowan & Moeed 1987) and small vertebrates, such as birds (Perham 1924, Morgan 1981) and mice (Cowan 1990). Captive possums readily accept meat (Cowan 1990).

This article describes remains left by possums that have fed on birds and their eggs. Feeding trials were carried out with captive possums to see whether they would eat dead birds and eggs and to see what sign remained after feeding. In addition, we have brought together various accounts of possums preying or scavenging on birds and other animals.

Characteristic sign from feeding trials

Feeding trials with one juvenile male and one adult female possum were carried out by KPB and RMS between 26 November and 5 December 1991. The possums were caught in gin leg-hold traps, the jaws of which had been padded to prevent injury. Each possum was then held separately in an enclosure (dimensions 900 x 460 x 450 mm) which included a sack-lined nest box (360 x 460 x 45 mm). Ample fresh water was provided. The male was denied food for 46 hours after being caught and before feeding trials, whereas the female was offered natural foods and poultry pellets throughout most of the captive period, including the feeding trials (Table 1). Road-killed birds were offered to the captive possums in the evening, and remains were examined the following morning.

The male possum was offered a Greenfinch (*Carduelis chloris*) on night 1 (26.11.91), a Blackbird (*Turdus merula*) on nights 2 and 3 (27-28.11.91),

TABLE 1 — Results of feeding trials with captive possums

Possum and Date of Offering	Food Offered	Results
Juvenile male		
26 Nov	Greenfinch	Ate almost the whole bird, including all meat and bones, both feet, the bill and some feathers. Both wings, the tail feathers, some contour feathers and 16 masticated feather pellets were all that remained (see Figure 1B).
27 Nov	Blackbird	Left the body untouched but removed and ate the head. The lower bill was partially eaten while the upper bill remained intact with a small clump of feathers attached. A small piece of cranium (10x10 mm), two masticated feather pellets and a small piece of skin with feathers attached were all that remained of the head.
28 Nov	Blackbird minus the head	Ate meat, some bones, some feathers and all of the viscera, except the stomach. The remains were major bones picked clean of meat; wing, tail and contour feathers, some of which were connected to flaps of skin. Eight masticated pellets were also present.
29 Nov	Goldfinch	Ate all parts except most of the wing and tail feathers, some contour feathers and one leg. Three masticated feather pellets were produced.
Adult female		
1 Dec	Hen's egg (size 6) and another half that size	The smaller egg was broken into c. 30 pieces 2-28 mm long and the yolk and most of the white were eaten. The larger egg was untouched.
2 Dec	Two hen's eggs (size 6), mixed native and exotic foliage, carrots and poultry laying pellets	Both eggs were intact in the morning. Most of the natural food was eaten and the poultry laying pellets were untouched.
3 Dec	Starling nest containing four eggs, mixed native and exotic foliage, carrots and poultry laying pellets	The nest was pulled apart and strewn about the enclosure and the eggshells were broken into small pieces. Some infolding of shell remains (see Figure 2B). Presumably some shell and most of the egg contents were eaten. Most of the natural food was eaten.

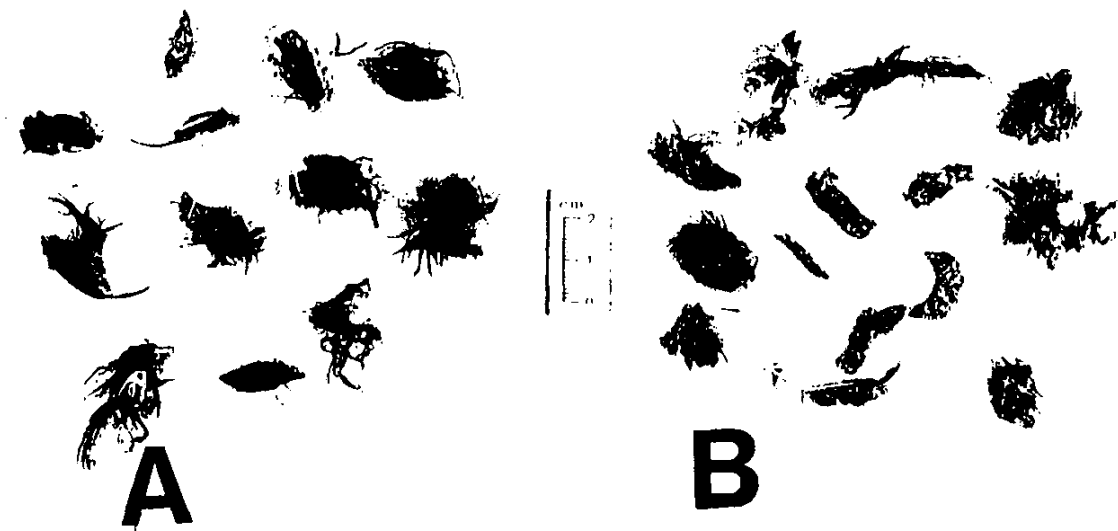


FIGURE 1 — A Regurgitated feather and bone pellets found on a Kokako killed on a nest at Rotoehu Forest, recovered January 1991

B Feather and bone pellets remaining after captive starved possum fed on road-killed Greenfinch, November 1991

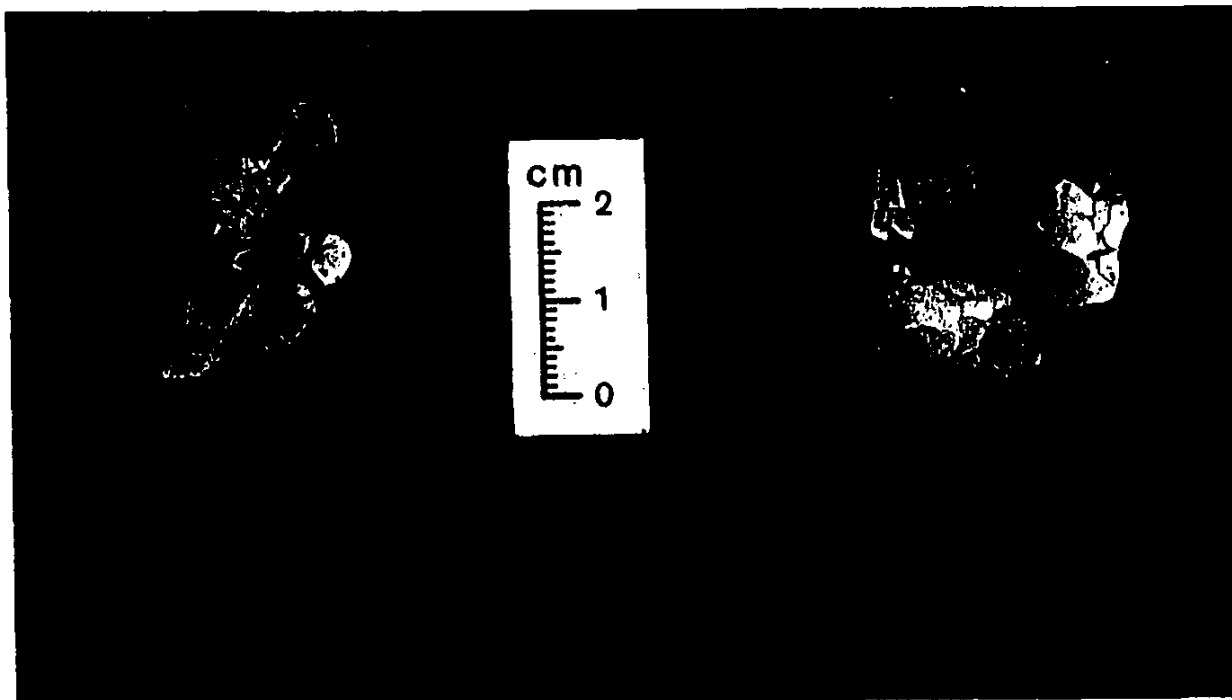


FIGURE 2 — A Kokako eggshell fragments formed into "pellets" by possum, Rotoehu Forest, December 1991

B Similar eggshell remains after Starling eggs fed to captive possum, December 1991

and a Goldfinch (*Carduelis carduelis*) on night 4 (29.11.91). The female was offered two hen's eggs (one a size 6 and the other about half that size) on night 1 (1.12.91), two hen's eggs (size 6) on night 2 (2.12.91), a Starling's (*Sturnus vulgaris*) nest containing four eggs on night 3 (3.12.91), and a Greenfinch on night 4 (4.12.91). The possums were killed and the gut contents of both were examined the morning after the trials were completed.

The results of feeding trials are summarised in Table 1. The male possum ate all three birds offered to it. Examination of the gut contents revealed many feathers and some bone fragments. Twenty-nine feather pellets were found in association with the bird remains. These pellets of masticated feathers, some of which also contained bone fragments, were oval and 2-10 x 12.5-22.5 mm in size (Fig. 1B). The pellets were more compact when first collected than shown in the photograph.

The female did not eat the one bird provided. However, she ate the smaller egg and four Starling eggs, but not the three size 6 hen's eggs. No trace of eggshell was found in the gut. Some pieces of Starling eggshell were infolded and clean, giving the impression that they had been held in the palate and sucked clean of most of their contents before being spat out (as eggshell pellets) (Fig. 2B).

Evidence from Kokako nests

On 16 December 1979, a Kokako (*Callaeas cinerea wilsoni*) nestling at Mapara Wildlife Reserve (King Country) was preyed on (J.R. Hay. The Kokako. Forest Bird Research Group Report, 1981). "The single nestling had its head, breast and wings eaten off, the remains being left in the nest along with a number of pellets of chewed material each about 10 x 30 mm in dimension. They were primarily of feather material though one consisted of bone fragments. The type of predation was characteristic of rat but the pellets were of unknown origin." The pellets from Mapara were almost identical to those resulting from our feeding trial (R. Hay, pers. comm.).

The following breeding season, on 28 January 1981, three Kokako nestlings 7-10 days old were preyed on at Pureora Forest, central North Island. "All three were partly eaten in the nest, one still being alive but badly injured. Generally, the head and breasts of the nestlings were chewed, leaving the rear portions. Aluminium foil placed below tin-plate on the trunk of the nest-tree recorded the tracks of a large animal (probably possum)..." (Hay, Forest Bird Research Group Report, 1981).

Three accounts of possum scavenging or predation have arisen from a study by the authors of Kokako breeding at Rotoehu Forest, Bay of Plenty.

The remains of an incubating female Kokako were recovered from her nest on 6 January 1991. Insect pupae indicated that she had been dead for probably about two weeks. The head had been removed; the cranium was two-thirds eaten and very clean; major flight muscles on the dorsal surface were eaten. The bird had probably not been turned over once dead because one leg was uneaten and she was found in a natural sitting position. All ventral (i.e. breast) flesh was gone, but this was probably done by insects because all fine bones were intact. Many feathers adhered to the nest around the dead bird. There were no faeces in the nest, but there were about 10 pellets

of masticated Kokako feathers and one of bone (Fig. 1A). These were uniformly c. 4-8 x 15 – 20 mm, scattered around on top of the corpse.

On 3 December 1991, a remote time-lapse video camera using infrared light filmed a possum eating two Kokako eggs from a nest which the female had deserted that afternoon. The possum returned briefly to the nest the following night. The collected nest showed fewer eggshell fragments than expected from two eggs, suggesting that some may have been ingested or dropped outside the nest. Most fragments were smaller than 8 mm long, but two were larger (20 and 14 mm) and one was very infolded as if it had been taken into the mouth, sucked, and then ejected (Fig. 2A).

On 14 December 1992, two possums were filmed by remote time-lapse video preying on eggs in a Kokako nest. The sitting Kokako fled the nest when the closest possum was 1.5 m away. Later, several small (<4 mm) eggshell fragments were found up to 15 mm into the nest bowl lining, and one larger (c. 6 mm) characteristically infolded piece was found just outside the bowl.

Other evidence

The only published eyewitness account of possums preying on a bird is Morgan's (1981) account of a captive possum at Rangiora catching and partially eating a House Sparrow (*Passer domesticus*). Bird remains were found in the Rangiora possum enclosures on several occasions subsequent to the observed predation (suggesting further predation), but no pellets or bone were found (D. Morgan, pers. comm.). Perham (1924)¹ reported two separate accounts of nestlings and feathers in possum stomachs, but this has not been reported by subsequent workers despite the analysis of nearly 1900 stomachs (Morgan 1981).

However, M. Coleman (in. litt.) found Greenfinch remains in the stomach of an adult female possum killed in the Forbes Creek catchment (Rangitata headwaters, South Island). He wrote: "I found considerable numbers of loose feathers, and flesh with feathers and bone fragments attached.

"The possum was killed on 16 September 1992, 750 – 900 metres above sea level. The winter in the Southern Alps was particularly harsh this year; snow covering normal herb/shrub food supplies for possums in the area may have induced this 'addition' to a 'normal' possum diet. However, all the possums killed were apparently quite fat and healthy (3-4 kg in weight). This was the only animal (of 43) containing feathers." The feathers were identified as Greenfinch by Dr E. Murphy.

Fur adhering to the eggshell of eaten, deserted eggs of North Island Brown Kiwi (*Apteryx australis mantelli*) implicated possums as culprits. The animal responsible had "chewed an 80-120 mm wide hole in the top or side of the egg" (McLennan 1988).

¹ Perham, A.N. 1924. Progress report of investigation of the opossum-genus *Trichosurus* in New Zealand. NZ State Forest Service. Unpub. report. 10 pp.

Further unpublished accounts of observed or implicated predation and scavenging are as follows:

1. A possum was seen to climb down a pukatea (*Laurelia novae-zelandiae*) in pursuit of a fledgling Australasian Harrier (*Circus approximans*) which fluttered to the ground. The possum caught the fledgling on the ground and carried it off up a nearby tree. This observation was made in 1957 or 1958, in the Fitzroy area, Taranaki (J. Roberts, pers. comm.).
2. Possum fur was found attached to the nest cavity entrance of a preyed on North Island Saddleback (*Philesturnus carunculatus rufusater*) nest containing eggs on Kapiti Island in 1982 (T. G. Lovegrove, pers. comm.).
3. In winter 1989, a possum was shot while eating Fantail (*Rhipidura fuliginosa*) eggs from a nest on the edge of Egmont National Park, near Kaponga, Taranaki. The observation was made at 2-3 m range, just on dusk (G. Priest, pers. comm.).
4. In 1989 or 1990, a possum was observed near Whakatane at c. 3 m range in a *Cupressus elegans* tree, eating very young nestlings (barely feathered) of Blackbird or Song-Thrush (J. White, pers. comm.).
5. Possum fur was found adhering to freshly eaten eggs of Kereru (*Hemiphaga novaeseelandiae*) in the Maungatapere area of Northland in 1991 and 1992. The larger pieces of eggshell remaining at each nest were infolded, but many small fragments were scattered on the bowl, rim, tree and ground at each nest (R. J. Pierce, pers. comm.).
6. Possums have been seen feeding on the flesh of dead chicks of Westland Black Petrel (*Procellaria westlandica*) which had probably been killed by cats or Weka (*Gallirallus australis*) (L. van Dijk, in litt.).
7. Possums have been seen eating dead ship rats (*Rattus rattus*) caught in snap traps (P. Cowan, pers. comm.) and feeding on the carcasses of dead sheep on Chatham Island (B. Tuanui, pers. comm.).
8. A mouse captured with a possum in a box trap was found half eaten when the possum was removed (P. Cowan, pers. comm.).

Discussion

Possums now occupy more than 90% of New Zealand's land area (Cowan 1990). They occupy a large variety of habitats, from subalpine grassland to lowland city gardens, but reach particularly high densities in mixed podocarp/broadleaved forests. Green (1984) cited estimated densities for eight mixed forest habitats of 8.5-24.2 possums/ha.

At such densities possums will frequently encounter birds' nests, but how important they are as predators of particular bird species cannot be told from the limited evidence above. The finding of characteristic sign such as pellets or faeces at a predation does not prove that the implicated species killed the prey – it may have scavenged there after the event or merely have

visited the site. The wild possum filmed eating deserted Kokako eggs may not have eaten the eggs had the female Kokako not deserted the nest, but the 14 December 1992 predation was clearly a rare confirmation of a natural event. The direct and circumstantial evidence outlined here suggests that the case for possums as potential egg and bird predators must be reopened, as suggested by Morgan (1981).

It is possible that some past predations attributed to ship rats (*Rattus rattus*) were in fact the work of possums. Moors (1983) classified nest predation evidence into two main classes based on diagnostic signs described by Moors (1978) and Flack & Lloyd (1978). "Clean" predations with an undisturbed nest and no remains were attributed to mustelids (stoats and weasels) and "messy" predations, in which "shattered or partly eaten eggs and chicks were strewn about the nest and the nest lining was disarranged" (Moors 1983) were attributed to rodents – ship rats and house mice (*Mus musculus*). Video-camera filming at Rotoehu clearly showed a possum 'snuffling' the Kokako nest bowl lining after spilling egg contents there, producing sign which perfectly meets Moors's criteria for characteristic rodent predation. This may also be true of possum feeding on chicks and adults because the possum seen by Morgan to eat a Sparrow's head and breast left a messy corpse similar to those left in ship rat feeding trials described by Innes (1977) and Moors (1978). Possums were present but uncommon at Kowhai Bush, where Moors (1979, 1983) did his study. Such interpretive difficulties are characteristic of predator identification studies throughout the world (Chesness 1968, Loiselle & Hoppes 1983, Nichols *et al.* 1984, Storaas 1988) and are best resolved by photography at nests (Major 1991).

Morgan (1981) suggested that, if possums fed on birds or eggs only occasionally, rejecting most bones, feathers and eggshells, evidence of birds or eggs could easily be overlooked in stomachs. Feathers and eggshell are also rare in ship rat stomachs, being recorded in only 1% – 5% of rat stomachs in three New Zealand samples (Best 1969, Daniel 1973, Innes 1979). Eggshell was not found at all in 162 rat stomachs from Banks Peninsula and 114 from Waimangaroa, West Coast, South Island (Best 1969) or in 173 from the Orongorongo Valley, Wellington (Daniel 1973). It was found in only 3 of 178 stomachs examined from the Tararua Range near Palmerston North (Innes 1979), even though ship rats are important predators of birds and their eggs (Bell 1978, Atkinson 1978, McLennan & MacMillan 1985).

The limited feeding trials described in this note tell us nothing of how readily wild possums prey on or scavenge birds and eggs, but they yielded valuable examples of feather-and-eggshell pellets produced by wild-caught possums. They also suggest that possums may ingest some feathers. The pellets had the same form as others known or suspected to have been left by possums at three Kokako nests. The Kokako nestlings eaten at Pureora in 1981 may have been too young and poorly feathered to yield feather pellets. Possums at the Orongorongo Valley Field Station have been seen to produce similar pellets when eating grasses (B.M. Fitzgerald, pers. comm.). Possum pellets are much smaller than Morepork (*Ninox novaseelandiae*) pellets, which measure about 30 x 13 mm (T. Johnson, pers. comm.).

If the pellets are diagnostic of possum feeding on birds and eggs, they will be valuable clues to identifying possums as an agent of damage in future studies of nest predation or scavenging. We hope that this note will alert others studying forest bird predation to look for the pellets when examining nests or corpses. We are interested to hear of other accounts of sign remaining after nest predation or scavenging, especially by possums.

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SHORT NOTE

Bellbirds eating fruits of strawberry trees

In May 1961, when the OSNZ held its AGM in Dunedin, my very kind hosts were Brian and Nancy Ellis.

In their garden I noticed Bellbirds (*Anthornis melanura*) and Silvereyes (*Zosterops lateralis*) enjoying the fruits of the introduced strawberry tree (*Arbutus unedo*), a native of the Mediterranean and south-west Ireland, where I have found it round the coast.

An American tree, strawberry dogwood (*Dendrobenthamia capitata*), is also sometimes called strawberry tree. In Rotorua in May 1945 and again in May 1947, I had also noticed the same two species of birds feasting on the fruits of a well-grown specimen of this tree.

It would appear that the Polynesians are not the only early inhabitants of New Zealand to be tempted by the tasty foods brought in from other lands.

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