

Feeding sign of Moreporks (*Ninox novaeseelandiae*) on birds

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ABSTRACT

The identification of predators from prey remains is dependent on predators leaving distinctive sign. Captive Moreporks (*Ninox novaeseelandiae*) were fed birds and birds' eggs and the remains were examined for distinctive features. Moreporks left distinctive feeding sign; severing wing feather shafts and removed wing feathers from birds. Predator feeding sign can aid bird conservation by providing strong circumstantial evidence of predator identity.

KEYWORDS: Predator identification, Strigidae

INTRODUCTION

The Morepork (*Ninox novaeseelandiae*) is a nocturnal, predominantly forest dwelling native owl. Moreporks prey mainly on invertebrates but also on birds, rodents and lizards (Saint Girons *et al.* 1986). Predation is an important reason for the decline of several forest passerines (Innes & Hay 1991) but the predators responsible have rarely been identified (Brown *et al.* 1998). Two studies using video cameras have identified introduced mammalian predators as the main cause of nest failure but native avian predators were also responsible (Innes *et al.* 1996; Brown *et al.* 1998). Identification of predators allows conservation managers to target actual predators of native species rather than presumed predators.

Feeding sign alone can not provide definitive evidence of predator identity because sign left after predation can be confounded by scavenging, parental bird behaviour and overlap in sign between different predator species (Brown *et al.* 1993; 1996; 1998). However, characteristic sign left at a fresh kill can provide strong circumstantial evidence of predator identity. Feeding trials with captive predators enable distinctive predator sign to be identified (Moors 1978, Brown *et al.* 1993; 1996; Innes *et al.* 1994; 1996). This feeding trial was initiated after distinctive sign thought to have been left by a Morepork was found at Maruia, South Island, in 1996. This study aimed to identify distinctive sign left by Moreporks after feeding on birds and birds' eggs.

METHODS

Feeding trials were carried out at Nga Manu Nature Reserve, 5 km north of Waikanae on the Kapiti Coast, New Zealand, December 1997. Three Moreporks (probably female) in two separate enclosures (two in a nocturnal house 8.4 m x 5.2 m x 2.6 m and one in an outdoor aviary 11.4 m in circumference and 2 m high) were fed adult birds, fledglings (>15 days old) and/or chicks (<15 days old) of Blackbird (*Turdus merula*), Thrush (*T. philomelos*), Starling (*Sturnus vulgaris*) and/or House sparrow (*Passer domesticus*). Birds were killed humanely, either with ether or a blow to the head. Dead day old Chickens (*Gallus gallus*) were also provided. Starling and/or King Quail (*Coturnix chinensis*) eggs were provided on three occasions (Table 1). All dead birds were placed at feeding stations while eggs, House sparrow, Starling and Blackbird chicks and occasionally fledglings were presented in Blackbird or Thrush nests. Food was presented between 9.30 am and 11.45 am and collected 6-24 hours later. Bird remains were individually labelled and frozen for later examination.

Table 1. The number of individual food items provided to the two Moreporks in the Nocturnal House and the Morepork in the Outdoor aviary at Nga Manu Nature Reserve during December 1997. The number in brackets indicates the number of trials. During seven trials more than one food item was presented.

Food items	Nocturnal house (two Moreporks)	Outdoor aviary (one Morepork)
Blackbird adults	2	1
House sparrow adults	6	3
Thrush adults	0	1
Starling adults	2	0
Blackbird fledglings	4	2
Thrush fledglings	2	1
Starling fledglings	2	0
Blackbird chicks	3	0
House sparrow chicks	2	2
Chicken chicks	20	11
Total birds	43 (39)	21 (20)
Starling eggs	4	0
King quail eggs	3	4
Total eggs	7 (2)	4 (1)

RESULTS

All eleven eggs remained untouched in the three trials. Of the 64 birds presented in 59 trials, 32 were eaten (50%), 12 were untouched (19%) and 20 were partially eaten (Table 2). Morepork left sign 66% of the time after feeding on adult birds (6/

9), 80% of the time after feeding on fledglings (8/10) and only 18% of the time after feeding on chicks (6/33). Bird remains were always found at nearby perches except on one occasion when plucked and severed feathers of Starling fledglings were found in a nest (Fig. 1).

Table 2. The number of individual birds gone, left untouched and remains with feeding sign after they were presented to Moreporks at Nga Manu Nature Reserve during December 1997.

Birds	Gone	Untouched	Sign remained
Adult birds	3	6	6
Fledglings	2	1	8
Chicks	27	5	6
Total	32	12	20

Heads were the most frequently eaten body parts. In 20 cases where sign was left, 16 birds (80%) had their heads removed (Table 3). Of the four birds that retained their heads, one had feathers plucked from its back only; one was the only chick of three to remain untouched; another was the only bird reported to smell strongly of ether; and the other bird was taken from a Morepork at the commencement of feeding. In two of these four cases the head was partially eaten. Of the 16 birds that had had their heads removed, 50% had at least one wing eaten (8/16), and 19% had most of their torso and legs eaten (3/16), (Appendix 1).

At least some flight feathers (Fig. 2) were plucked from most (7/8) adult or fledgling birds when heads were removed but both wings remained (Appendix 1). Severed feather shafts (as opposed to plucked feathers) were identified on one bird only.

Table 3. Frequency (%) of different feeding sign on birds left by captive Moreporks. Number in brackets indicates number of occasions when different feeding sign was left.

Feeding sign	Nocturnal house (two Moreporks)	Outdoor Aviary (one Morepork)	TOTAL
Head missing	80% (12/15)	80% (4/5)	80% (16/20)
At least one wing missing	33% (5/15)	60% (3/5)	40% (8/20)
Upper torso missing	20% (3/15)	60% (3/5)	30% (6/20)
Lower torso missing	0% (0/15)	60% (3/5)	15% (3/20)
At least one leg missing	0% (0/15)	60% (3/5)	15% (3/20)
Body partially plucked	27% (4/15)	80% (4/5)	40% (8/20)
Flight feathers removed	33% (5/15)	60% (3/5)	40% (8/20)
Flight feathers severed	7% (1/15)	0% (0/5)	5% (1/20)



Figure 1: The ends of four Starling feathers collected as part of this trial (left) and four Robin feathers collected at Maruia, South Island, New Zealand in November 1996 (right). Note the uneven ends to the 3 "severed" feather shafts on the left. The fourth shaft (from the left) has been pulled from its sheath and retains the rounded shaft end. The remaining four feathers (right) have been clearly "severed", presumably by a Morepork.



Figure 2: Two Blackbird fledgling wings from the same individual collected as part of this trial. Note the flight feathers have been removed from one wing but remain untouched on the other wing.

DISCUSSION

Do Moreporks leave characteristic sign?

Evidence from prey remains suggests that Moreporks eat birds from the head down because the frequency at which body parts were consumed reduced from the head down. After the head is eaten, the approximate sequence of events appears to be, removal of flight feathers from wings, consumption of wings, then the viscera, body and legs though no direct observations of this sequence were achieved despite repeated attempts. Video photography of Moreporks feeding behaviour should be used to determine their method of eating prey.

Moreporks sometimes eat all but the intestines of their prey, behaviour not recorded in rats (*Rattus* spp.) or possums (*Trichosurus vulpecula*) (Brown *et al.* 1993; 1996; 1998; Moors 1978). Moreporks that ate mice at Wellington Zoo frequently left mice intestines uneaten (R. H. Goudswaard pers. comm.) and the intestines and yolk sacks of dead day old chickens were also left occasionally at Nga Manu Nature Reserve (P. A. Clarke pers. comm.). Therefore, intestines uneaten in the absence of other body parts could be evidence of Morepork predation. However, it is not known if other predators also leave intestines only. The frequency at which intestines were left by Moreporks was not measured as part of this study.

Moreporks usually remove prey items from nests and eat them at perches elsewhere or carry them to nesting cavities (D.M. pers. obs.). An empty bird's nest is not, however, definitive evidence of Morepork predation as other predators are also known to remove prey from nests (Moors 1983; Brown *et al.* 1998), scavengers could potentially remove sign, and parent birds can also remove sign after predation events (Brown *et al.* 1998). On one occasion during this study sign was left at the nest.

Partial consumption of prey is also not definitive evidence of Morepork predation as other predators can also leave partially eaten birds (Moors 1978; 1983; Brown *et al.* 1996). However, the plucking of flight feathers from prey is not known to be associated with any other predator species in New Zealand and may, therefore, be definitive evidence of Morepork predation.

Clearly severed South Island Robin (*Petroica australis australis*) feathers were found next to the transmitter of an adult Robin during intensive research at Maruia, South Island, in 1996. A Morepork was suspected to have preyed on the Robin, because a Morepork was known to have bitten through the 1 mm nylon cord of its transmitter harness equally cleanly (K.B. pers. obs.). This incident at Maruia provided the motivation for the feeding trial reported here.

Morepork regularly plucked flight feathers from adult and fledgling birds, however severed feathers were recorded on only one occasion (Fig. 1). The shafts of the Maruia Robin's flight feathers were more cleanly cut than most severed Starling feathers in this trial, a difference that may reflect variation in prey species or the individual Morepork involved. It is interesting to note that some Starling feathers were plucked from the wing rather than severed. The value of this sign to conservation management will depend on the frequency at which Moreporks leave it in the wild.

Do Moreporks eat eggs?

No eggs were eaten during this trial. However, food items were not always eaten and the lack of interest in eggs could have been due to chance, given the small sample size involved. The literature on Morepork behaviour and diet contains no reference to predation of eggs and egg shell remains have not been found in Morepork pellets or Morepork stomachs (Cunningham 1948; Turbott & Buddle 1948; Chambers *et al.* 1955; Hogg & Skegg 1961; Lindsay & Ordish 1964; Ramsay & Watt 1971; Daniel 1972; Imboden 1975; Bellingham *et al.* 1982; Saint Girons *et al.* 1986; Brown *et al.* 1998). Moreporks may however, eat eggs but not ingest the shell. A Morepork was observed finding a fantail nest with eggs at Ohau in 1997 and leaving the nest untouched (D. M. pers. obs.). Moreporks are known to be reluctant to eat in the presence of observers and therefore the observer may have influenced the Morepork's behaviour or alternatively Moreporks may find eggs distasteful.

It may, however, be advantageous for Moreporks not to eat eggs. North Island Robins (*P. australis longipes*) regularly return to their nests after predation events and will continue to brood a chick despite the loss of its sibling (Brown *et al.* 1998). However, Robins will desert nests from which single eggs have been removed (K. B. pers. obs.). Moreporks will return to nests to retrieve chicks that have been left behind on previous visits and will attempt to catch adults at the nest (Brown *et al.* 1998). Therefore, by not eating eggs Moreporks maybe increasing their chances of a more substantial food supply in the future. More extensive feeding trials or direct observations of Moreporks at wild nests containing eggs are needed to determine if Moreporks eat eggs.

Implications for bird conservation

Documentation of feeding sign characteristic of different predator species is growing with increased sample sizes of videoed predation events and feeding trials like this one (Brown *et al.* 1993; 1996; 1998; Innes *et al.* 1994; 1996; Moors 1978; Sanders 1997). Feeding sign could provide a valuable tool when used in association with radio-tracking of prey species because the observer is not restricted to evidence left at the nest.

If adults and fledglings were radio-tagged and subsequently located after predation events the location of the remains (e.g. stoat den or below a Morepork roost) and nature of sign (e.g. severed or plucked flight feathers) could provide strong circumstantial evidence of predator identity. For example, predation of radio-tagged Shore Plover (*Thinornis novaeseelandiae*) that had been released onto Motuora Island, Hauraki Gulf was attributed to Moreporks when transmitters were found in trees (O'Connor 1998). The presence of characteristic Morepork feeding sign would have provided more compelling evidence to support this conclusion.

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Appendix: 1

Predator sign left by Moreporks after feeding on birds at Nga Manu Nature Reserve in December 1997.

Location	Birds	Sign
Nocturnal house	Thrush fledgling	Body & legs remain; head & wings missing
	Thrush fledgling	Body (partially plucked), wings & legs remain; head missing & flight feathers missing from one wing
	Starling fledglings (2)	Body, wings & legs remain; heads missing, most feathers missing from wings, severed & flight feathers in nest
	Starling adult	Back of skull plucked clean only (interrupted while feeding)
	Chicken chick	Lower torso & legs remain; head, breast & wings missing
	Chicken chick	Body, wings & legs remain; head missing
	Chicken chick	Body, wings & legs remain; head missing
	Chicken chick	Lower torso, wings & legs remain; head & upper torso missing
	Blackbird fledgling	Body (partially plucked), one wing & legs remain; one wing & head missing
	Blackbird fledgling	Lower torso & legs remain; head, upper body & wings missing
	Blackbird fledgling	Top of head & brains missing; flight feathers removed from one wing only (the smell of ether was still detectable when remains were retrieved 6 hour after placement)
	Blackbird chicks (2)	One chick - untouched in nest; one chick - body wings & legs remain, head missing
House Sparrow adult	Body, legs & plucked feathers remain; head and wings missing	
Outdoor aviary	Blackbird fledgling	Body, wings and legs remain; head missing & feathers removed from breast, back & one wing were connected to back
	Blackbird adult	Flight feathers (plucked not severed), wing bones & pieces of breast bone (cleaned of flesh) & body feathers remain; head, body, wings & legs missing
	House Sparrow adult	Flight feathers (plucked primaries and secondaries) & body feathers (from breast?) remain; head, body, wings & legs missing
	House Sparrow adult	Flight feathers (plucked primaries and secondaries) & body feathers (from breast?) remain; head, body, wings & legs missing
	Thrush adult	Feathers plucked from the birds back only; head, body, wings & legs remained