

THE DIET OF TAWNY OWLS (*STRIX ALUCO*) AND KESTRELS (*FALCO TINNUNCULUS*) IN THE NEW FOREST, HAMPSHIRE

By GRAHAM HIRONS

ABSTRACT

The diet of kestrels and tawny owls in the New Forest was studied by identifying prey remains in their pellets. Of 190 kestrel pellets examined in 1982-83, 137 (72%) contained small mammals of which short-tailed voles occurred most frequently (24% of pellets). Lizards were found in 45% of pellets and were taken especially in spring. Small rodents contributed 66% by weight to the prey taken by tawny owls. Wood mice were the most important dietary component (57% of vertebrate prey items). In comparison bank voles and short-tailed voles together made up only 19% of vertebrate prey items. The scarcity of voles in the diets of these two predators in the New Forest compared with other areas of Britain probably reflects the removal of vegetation cover by the large numbers of domestic herbivores depastured there.

INTRODUCTION

The New Forest embraces the most extensive tracts of heath and ancient pasture woodland remaining in the lowlands of western Europe. The area comprises a mosaic of woodland (13000 ha), secondary heaths and acid grasslands (11740 ha), and valley mires (2384 ha). The woodlands include 8100 ha of statutory silvicultural Inclosures, principally even-aged plantations of oaks (dating from the eighteenth and nineteenth centuries) and conifers (planted this century), and 3878 ha of beech and oak woodland with an understory of holly. The latter areas are unenclosed and open to grazing by the ponies and cattle of New Forest commoners.

The patchwork of habitats which characterises the New Forest today has arisen largely from the grazing and browsing of the domestic herbivores and deer. However, two recent developments threaten to alter fundamentally the

ecology of the Forest. First, the number of ponies depastured has trebled since 1955, and second, animals have increasingly been permitted to graze inside the fenced Inclosures from which they had previously been excluded (Tubbs 1982).

These two factors have resulted in further reduction of shrub and herb layers which were already impoverished due to the long history of grazing and browsing.

The consequences of overgrazing are not confined to the removal of vegetation. Loss of cover has probably resulted in the absence of bank voles (*Clethrionomys glareolus*) and short-tailed voles (*Microtus agrestis*) from large areas of the Forest (S D Hill and G Hiron, unpublished data). This is significant because in Britain many predators, including stoats (*Mustela erminea*), weasels (*Mustela nivalis*), foxes (*Vulpes vulpes*), most owls and some diurnal birds of prey include these two species in their diet. Clearly the activities of the large grazers will affect the ecology of these predators in the New Forest and, indeed, Tubbs (1982) has attributed the 45% decline in the buzzard *Buteo buteo* population since 1973 to the increase in grazing pressure over this period causing a reduction in the numbers of small rodents.

The two commonest avian predators in Britain are the tawny owl and kestrel. Tawny owls are most abundant in deciduous woodland where they capture prey at night by dropping onto it from a perch. In some areas of Britain just two small rodent species, the bank vole and the wood mouse (*Apodemus sylvaticus*) sometimes constitute 60% of the owls' diet in winter and early spring (Southern 1954). Kestrels occur in most types of open habitat where they capture prey by day by swooping down onto it, either

from a perch or after a bout of hovering. All previous studies in Britain have found short-tailed voles to be the most important component of the kestrel's diet (Brown 1976, Yalden and Warburton 1979).

The aim of this paper is to make a preliminary comparison between the diets of kestrels and tawny owls in the New Forest, where voles are uncommon, and elsewhere in Britain. Diets were assessed by the identification of prey remains in pellets cast by the predators. The study forms part of a wider investigation into the effects of grazing by large herbivores on small rodent populations and their avian predators in the New Forest.

METHODS

Collection and analysis of pellets

Pellets cast by kestrels were collected from beneath roost sites or hunting perches from various places in the New Forest in 1982 and 1983. Regularly used sites were visited at two week intervals. As few kestrels winter in the New Forest only pellets collected in the period April–September are considered here.

Tawny owl pellets were collected by systematically searching three territories in Matley Wood (SU 078 335), Studley Wood (SU 160 225) and Stubby Inclosure (SU 044 326) respectively, during the period October 1982 – September 1983. Pellets were analysed by the methods described by Yalden and Warburton (1979) for kestrels and Southern (1954) for tawny owls. Not all the pellets which were collected have yet been analysed.

Identification and enumeration of prey

Kestrel pellets. Both identification and enumeration of mammals were based on skulls, jaws or sometimes isolated cheek teeth. When skeletal remains were inadequate, fur was used for identification by reference to Day (1966). No attempt was made to distinguish between wood-mice and yellow-necked mice (*Apodemus flavicollis*). The presence of a bird was indicated by a powdery matrix to the pellet and the length of the humerus was used to assess its size (Yalden 1977). Lizard remains were signified by the

presence of keratinous scales and limb bones. Mean weights for each species were taken from Yalden (1977).

Many pellets contained the remains of beetles and caterpillars and the identification of these has not yet been completed. The presence of earthworms was indicated by the occurrence of sand grains in the pellet matrix and confirmed by the presence of chaetae. The contributions made to the diet by lizards, arthropods and earthworms have not yet been quantified.

Tawny owl pellets. For the most part prey remains were identified in the same manner as those in kestrel pellets. Beetles were quantified on the basis of head and leg counts. Biases inherent in tawny owl pellet analyses have been discussed by Southern (1954) and Lowe (1980). In this study, to facilitate comparison with published information from elsewhere, no correction has been made for differences in the proportion of different rodent species which fail to appear in the pellets. This loss is of the order of 40% for wood mice, 33% for bank voles and 15% for short-tailed voles (Lowe 1980).

RESULTS

Prey items in kestrel pellets

The frequency of occurrence of different prey items in kestrel pellets by month of collection is given in Table 1. Of the 190 pellets examined 72% contained small mammals. The species which occurred most frequently was the short-tailed vole which was found in 24% of pellets; common shrews (*Sorex araneus*) occurred in 17% and harvest mice (*Micromys minutus*) in 13%. The other major groups represented in pellets were beetles (*Coleoptera*) which occurred in 60%, lizards (*Lacerta vivipara*; 45%) and birds (19%). Earthworms were found in only one pellet (0.5%).

Some marked seasonal trends are also apparent from Table 1. Lizards occurred in 59% of pellets collected in April/May but in only 29% of those collected in the period June – September ($\chi^2 = 15.46$; $P = <0.01$). Lepidopteran caterpillars, mainly those of the emperor moth (*Saturnia pavonia*), were present in 83% of the

Table 1. The frequency of occurrence of different prey in Kestrel pellets collected in the New Forest in 1982 - 83.

Month of collection:	April-May	June-July	August-September	OVERALL
No. of pellets examined	104	57	29	190
PREY	No. (%)	No. (%)	No. (%)	No. (%)
Wood mice spp.	2 (1.9)	3 (5.3)	1 (3.4)	6 (3.2)
Bank vole	2 (1.9)	3 (5.3)	—	5 (2.6)
Short-tailed vole	28 (2.7)	16 (28.1)	1 (3.4)	45 (23.7)
Harvest mouse	19 (18.3)	1 (1.8)	5 (17.2)	25 (13.2)
Pygmy shrew	7 (6.7)	6 (10.5)	—	13 (6.8)
Common shrew	22 (21.1)	8 (14.0)	3 (10.3)	33 (17.4)
Small mammals				137* (72.1)
Birds	27 (26.0)	8 (14.0)	2 (6.9)	37 (19.5)
Lizard	61 (58.6)	17 (29.8)	8 (27.6)	86 (45.3)
Earthworms	1 (1.0)	—	—	1 (0.5)
Lepidoptera	—	—	24 (82.8)	24 (12.6)
Coleoptera	69 (66.3)	26 (45.6)	20 (69.0)	115 (60.5)

* This figure includes unidentified mammals indicated by counts of upper incisors or fur.

Table 2: The frequency of occurrence of different prey in 33 Kestrel pellets collected elsewhere in Hampshire in 1982 - 83.

PREY	No.	(%)
Wood mice spp.	2	(6.1)
Bank vole	3	(9.1)
Short-tailed vole	12	(36.4)
House mouse	1	(3.0)
Harvest mouse	4	(12.1)
Common shrew	2	(6.1)
Small mammals	26	(78.8)
Birds	3	(9.1)
Lizard	4	(12.1)
Earthworms	12	(36.4)
Coleoptera	10	(30.3)
Lepidoptera	—	—

pellets collected in August and September but in none of the pellets from the period April - July.

During the study period 33 pellets were analysed from two sites outside the New Forest; at Hamptworth, 3 km north of the Forest (SU 178 229), and in the Itchen valley 3 km northeast of Southampton (SU 170 460). The results of this analysis are presented in Table 2. In contrast to those from the New Forest, earthworms were found in 36% of the pellets from these areas ($\chi^2 = 59.41$; $P = <0.001$) but lizards were found in only 12% ($\chi^2 = 11.49$; $P = <0.01$). Short-tailed

voles and bank voles occurred significantly more often than in pellets from the New Forest. These two species accounted for 55.6% of the vertebrate prey items (excluding lizards) outside the Forest but only 30.5% within it ($\chi^2 = 5.42$; $P = <0.05$).

As vertebrate and invertebrate prey differ in size by two orders of magnitude, assessment of the kestrel's diet on a numerical basis alone is clearly insufficient. Unfortunately invertebrate prey have yet to be quantified but the contributions of the various vertebrate prey (excluding lizards) can be determined on a weight basis. The results of this analysis are presented in Table 3. The short-tailed vole contributes 40.6% to the weight of vertebrate prey. Apart from common shrews (12.2%), all other mammal species contribute 5% or less and are much less important in the diet than birds (31.7%).

Prey items in tawny owl pellets

Table 4 gives the frequency of occurrence and percentage weight of prey recovered from 65 tawny owl pellets from the New Forest. Small rodents comprised 41.7% of the prey items and 66.3% of the total weight of prey taken. Small rodents were most important in winter (defined as November - April) when they formed 88.0% of prey by weight compared with 52.1% in summer. The most frequent vertebrate prey was

Table 3. *The percentage weight of vertebrate prey (other than lizards) in the summer diet (April – September) of Kestrels in the New Forest.*

PREY	No.	wt. (g)	% wt.
Wood mice spp.	6	108	4.6
Bank vole	5	80	3.4
Short-tailed vole	45	945	40.6
Harvest mouse	25	125	5.4
Common shrew	33	280	12.0
Pygmy shrew	13	52	2.2
Birds	37	740	31.7

Apodemus (probably mainly *A. sylvaticus*) which comprised 56.6% of the vertebrate prey items. By contrast the voles (*Clethrionomys* and *Microtus*) both constituted only 9.6% of vertebrate items.

Dor beetles (*Geotrupes* and *Typhoeus*) contributed a surprisingly high proportion of the prey, particularly in winter when they accounted for over 50% of items taken and formed 6.0% by weight of the total diet. It is notable that no moles (*Talpa europea*) or earthworms were found in the pellets.

DISCUSSION

The diet of kestrels in the New Forest compared with elsewhere in Britain

The importance of mammalian prey, particularly short-tailed voles in the diet of kestrels is in agreement with previous studies in Britain (Ellis 1946; Davis 1960 and 1975; Simms 1961; Yalden and Warburton 1979). The most complete

study is that of Yalden and Warburton (1979) who collected 219 pellets over four years in the period April – September from a site in the Lake District. Their study area contained a mixture of habitats including coastal marshes, sand dunes, pasture, deciduous and coniferous woodland, arable farmland and rough hill grazing. In this area short-tailed voles contributed a significantly higher proportion of the vertebrate prey items recovered in the pellets than in the New Forest (45.0% as against 27.4% in the New Forest; $P = <0.01$) and together the two vole species accounted for 73% of the weight of vertebrate prey. The comparable figure for the New Forest is 44%. In the New Forest this shortfall is made good by a greater reliance on birds (22.6% of vertebrate prey items (excluding lizards)) and lizards. The latter are taken mainly in the spring when they spend much time basking. In the Lake District study only 12 lizards were recovered in the 219 pellets examined.

The absence of earthworms in the New Forest pellets presumably reflects the low densities at which worms occur in open habitats in the New Forest (Packham 1983); 26% of the Lake District pellets contained earthworms.

Although the number of short-tailed voles recovered in kestrel pellets from the New Forest is lower than in pellets from elsewhere in Hampshire or in the studies mentioned above, it is still higher than expected from the results of extensive sampling of small rodent populations in the New Forest using Longworth traps (S D Hill and G Hiron unpublished data). These sug-

Table 4. *Analysis of 65 Tawny owl pellets collected in the New Forest in 1982 – 83.*

Period	May – October				November – April			OVERALL		
	No.	%	% (wt)	No.	%	% (wt)	No.	%	% (wt)	
PREY	items	(items)		items	(items)			(items)		
Wood mice	26	35.1	45.0	21	27.3	55.4	47	31.1	49.1	
Bank vole	2	2.7	3.1	6	7.8	14.1	8	5.3	7.4	
Short-tailed vole	2	2.7	4.0	6	7.8	18.5	8	5.3	9.8	
Grey Squirrel	1	1.4	6.7	–	–	–	1	0.6	4.0	
Rabbit	1	1.4	9.6	–	–	–	1	0.6	5.8	
Common shrew	4	5.4	3.1	2	2.6	2.3	6	4.0	2.8	
Birds	10	13.5	24.0	1	1.3	3.7	11	7.3	16.0	
Slow worm	1	1.4	1.9	–	–	–	1	0.6	1.2	
Coleoptera	27	36.5	26.0	41	53.2	6.6	68	45.0	3.9	

gested that short-tailed voles were absent from the closely grazed acid grasslands and woodland rides within the Forest. However, most of the kestrel ranges from which pellets were collected in the New Forest contained ungrazed roadside verges or railway embankments. These would provide areas of rough grassland preferred by the short-tailed vole. Similarly, although no harvest mice were trapped on New Forest heathlands, they are clearly present, presumably in areas of mature heather (*Calluna vulgaris*).

The diet of tawny owls in the New Forest compared with elsewhere in Britain

In deciduous woodland elsewhere in Britain the wood mouse and bank vole each comprise about 30% of identifiable prey items in tawny owl pellets and are taken especially in winter (Southern 1954; Hiron 1976). In Wytham Woods near Oxford, short-tailed voles contributed another 13% (Southern 1954). In the New Forest, small rodents were also the most important component of the diet representing 42% of the prey items identified and contributing 66% to the weight of prey. However, this was due largely to the high numbers of wood mice taken, and bank voles and short-tailed voles each constituted only 5.3% of the prey items identified.

The scarcity of voles in the owls' diet again presumably reflects the heavy grazing to which woodlands in the New Forest are subjected. Bank voles favour areas of woodland with dense brambles (Southern and Lowe 1968) and short-tailed voles prefer areas with a thick ground vegetation, especially rough grass (Hansson 1982). Both these habitats disappear under intense grazing pressure. Wood mice on the other hand show no particular preference for cover type, although they are more easily captured by owls in areas of woodland with little ground

cover (Southern and Lowe 1968). This would explain their predominance among prey taken by tawny owls in the New Forest.

In Wytham the proportion of wood mice in the diet of tawny owls declines markedly after the spring growth of ground vegetation (Southern 1969; Hiron 1976). This effect is less apparent in the New Forest, either because much of the ground vegetation is grazed back, even in summer, or because alternative prey, moles are less abundant in the Forest. In Wytham moles contribute as much as 27% by weight to the owls' summer diet (Southern 1969) but none were recorded in pellets from the New Forest.

The high frequency with which Dor beetles appeared in pellets of tawny owls in the New Forest may reflect the large amounts of dung deposited by the domestic herbivores and deer.

CONCLUSIONS

Analysis of pellets demonstrates a lower proportion of voles (*Clethrionomys* and *Microtus*) in the diet of kestrels and tawny owls in the New Forest than in other areas of Britain. As these rodents prefer habitats with a dense ground cover such as brambles (*Clethrionomys*) or grass (*Microtus*) it is reasonable to suppose that their scarcity in predator diets (and traps) is another consequence of the heavy grazing pressure inflicted by the large numbers of domestic herbivores and deer in the New Forest.

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Author: Graham Hirons, Department of Biology, Building 44, The University, Southampton SO9 5NH.

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