

RED FOX PREDATION ON YOUNG RABBITS IN BREEDING BURROWS

by

J. L. MULDER and J. M. WALLAGE-DREES

(Department of Ecology, University of Leiden, The Netherlands)

INTRODUCTION

The wild rabbit, *Oryctolagus cuniculus* (L.), gives birth to its young either in nests inside the main warren or in special breeding burrows separate from it. Such a special breeding burrow or "stop" is a short blind tunnel excavated by the female rabbit (doe) for the birth and subsequent nursing of its young during their first three weeks of life. The tunnel ends in a chamber lined with grass by the doe a few days before the birth of the litter. When the young are born they are embedded in a considerable quantity of fur within the grass nest, which the doe plucks from her belly. Stops are visited by the doe for a short time only—about 15 minutes—once or twice nightly to suckle the young (LLOYD & McCOWAN, 1968). On leaving the stop the doe plugs the entrance of the burrow with soil and smoothes over the surface thus making it very inconspicuous (fig. 1).

It is known that the red fox, *Vulpes vulpes* (L.), and the badger, *Meles meles* (L.), predate on nestling rabbits in stops (TINBERGEN, 1970) but there is little detailed observation on this kind of rabbit predation.

Investigations on the ecology of wild rabbits begun in 1977 by J. M. WALLAGE-DREES in the Dune Reserve in the North Holland Province (52°32' N, 4°38' E) revealed a conspicuous predation of young rabbits in stops, by foxes, in the spring of 1978. Though the main aims of the ecological investigations are the effect of winter food and predation on the size of the pre-breeding population, the opportunity to examine fox predation on rabbit stops was grasped.

OBSERVATIONS

Sixty stops were kept under observation most of which were located in the flat recreation meadows in the centre of the reserve where they were most easily detected by us. The tunnel length of the stops varied from 32 to 250 cm, averaging 85 cm ($n = 40$), and the mean height and width of the chambers were 23 cm ($n = 15$) and 18 cm ($n = 19$), respectively. Not every stop was measured completely.

Twenty-four cases of interference to stops by foxes were investigated. In some places concentrations of predated stops were found, while elsewhere none could be detected. A predated stop is usually very conspicuous because of the considerable evidence of digging. Nearly always the nest is pulled out (fig. 2). All such pillaged nests contained fur, a strong indication that young had been present. Of the stops discovered by us about a third, which contained grass nests only, were not used to give birth to young. LLOYD & McCOWAN (1968) found that 11% of the stops on Skokholm were unused.

In most cases the fox reached the rabbit kittens not by excavating from the tunnel entrance but by digging directly down or slightly to one side of the nesting chamber (table 1). The entrances to six stops opened in this way were untouched by the doe and by the fox, but the entrances to seven others had been disturbed, apparently mostly by a fox. No significant difference was found in tunnel length (distance from entrance to chamber) between these two categories (Mann-Whitney U-test, one-sided, $P = 0.391$). The holes dug by the fox into the nest were oval or more or less rectangular, measuring 15×20 cm on average.

TABLE I
Interference to stops by foxes.

	<i>number of stops</i>	<i>number with evidence of pinpointing nests with living young</i>
Nests reached by digging downwards into the chamber	15	15
entrance untouched	6	
entrance opened	7	
uncertain	2	
Stop excavated along the tunnel	4	2
Digging abandoned by the fox	2	1
Fox dug up dead young	3	
Total	24	18

Four examples of the complete excavation of the entire length of the tunnel were observed. Three of these stops were situated in flat ground, and their depth and length did not differ significantly from those which had been opened from above by the fox (Mann-Whitney U-test, one-sided, $P > 0.05$). Depth was measured as the perpendicular distance between ground level and the floor of the tunnel just before the cham-

ber. There was a little evidence of digging directly above the chamber in two of these three cases. The fourth stop was built in the steep slope of an earth dike, which made it nearly impossible for the fox to reach the nesting chamber other than from the burrow entrance.

The length and depth of predated and unpredated stops containing live young (table 2) were not significantly different (Mann-Whitney U - test, one-sided, $P > 0.05$).

TABLE II
Measurements (in cm) of predated and unpredated stops containing live young.
(All measurements were not taken in every case)

	<i>predated</i>				<i>unpredated</i>			
	<i>n</i>	<i>range</i>	<i>mean</i>	<i>st.dev.</i>	<i>n</i>	<i>range</i>	<i>mean</i>	<i>st.dev.</i>
length	16	32-243	85	60	15	43-250	87	58
depth	11	20- 67	36	15	12	28- 62	39	10

In addition to the examples of successfully predated nests described, two tentative attempts were observed. In the one only the entrance to a deep and curved breeding burrow was opened by a fox, while in the other our attention was drawn to a shallow hole (10 cm deep) dug in a meadow, which when excavated further revealed a nest with a 24-days-old rabbit kitten, probably situated in a warren.

In an attempt to assess the sensitivity of does to disturbance to their breeding burrows a number of stops were opened through the entrance and young from 1 to 4 days old were handled. In most cases this caused the does to desert their stops resulting in the death of the young, which confirms the results of MYERS (1958). Three out of four such stops containing dead young were detected by a fox and dug out from above. The young in one nest must have been very recently dead, while those in another nest had died approximately two weeks before. The third stop dug out by a fox contained young which had died three days before, but these young were left untouched in the nest.

Little information is available on the proportion of stops containing live young discovered by foxes because it is much easier for the observer to find predated stops. The total number of stops at risk of being predated could not be known. Of five inhabited stops known and checked frequently three were dug out by foxes.

DISCUSSION

Predation on rabbit nests by foxes is mentioned by several authors, but few make more than a passing reference to the phenomenon. In the

literature on the diet of the fox seldom a distinction is made between adult, juvenile and nestling rabbits eaten by foxes. F. J. J. Niewold (pers. comm.) and N. Tinbergen (*in litt.*) think the predation on stops to be a speciality of some individual foxes, and not a general habit of all members of the population. The low frequency of occurrence of unweaned rabbit kittens found in fox stomach analyses, referred to by McINTOSH (1963) and RYAN & CROFT (1974), tends to support this view, just like the local concentrations of predated stops in our study area.

The fact that in 18 out of 21 cases foxes dug directly above the nesting chambers (though the chamber is variably positioned in relation to the stopped burrow entrance) is striking evidence of the ability of the fox to perceive the young rabbits in the nest. LLOYD & McCOWAN (1968) and MYERS & PARKER (1965) also state that nearly always foxes dig right into the nesting chamber of breeding burrows.

TINBERGEN (1970) when following tracks of foxes in sanddunes observed that the disturbed sand of the closed entrances of 15 stops were detected by foxes. Only three had been dug out however, and he suggested that only when the fox comes across a doe opening her stop it is able to find the young. Unfortunately he did not check the presence of young in the 12 stops unopened by the fox (*in litt.*). The high proportion of undisturbed entrances to predated stops in this study indicates that foxes can discover stops with young in the absence of the doe, but it does not imply that they did not detect the entrances. However, apparently not always foxes can connect stop entrances with the possible presence of young rabbits, and conversely.

It is not clear how foxes pinpoint the location of the young in the nest, but it must be by ear, nose or, possibly, by temperature differences between the ground directly above the nest and its surroundings. Clearly if the young are dead smell provides the stimulus. Interestingly in one of the cases described here the young had died only shortly before the fox found the nest and thus would have produced only a weak smell of putrefaction, which nevertheless was a sufficient clue for the fox. Consequently smell cannot be dismissed as the clue leading to the predation of the live young also. MYERS & PARKER (1965) however suppose that it is by ear that the fox locates the young, and indeed it is easier to appreciate that sound or vibrations due to the movements of the young might penetrate through 40 cm of earth more readily than odours. It is likely that the ability of the fox to find nests by either smell or hearing depends more or less upon the soil type, vegetation and weather conditions like humidity of the air. It is not known whether or not foxes can perceive the slight temperature differences that might obtain above a nest containing live young.

Temperature measurements will be made during the next breeding season, when a tame fox will also be used for experimental work in nest detection.

LLOYD & McCOWAN (1968) discuss the two types of nesting behaviour of the rabbit, that is, in stops and in the main warren, and their survival value in relation to predation. Experiments with confined populations show that the social status of the doe has a strong influence upon her breeding habits. Lower ranking does tend to use stops often at the border of their home range, whereas higher ranking females litter in nests inside the main warren (MYKYTOWYCZ, 1959). In natural circumstances probably only a small minority of the litters are born in stops (LLOYD & McCOWAN, 1968; own observations). Different species of predators might have access to these two nesting sites. Foxes and badgers dig out stops, whereas the majority of nests in a main warren will be too deep to be dug out by them, at least in our area. RYAN & CROFT (1974) however mention foxes making "taps" (i.e. nest robberies) in many rabbit warrens in Australia. Especially nests in warrens in sandy soils were heavily predated by foxes (MYERS & PARKER, 1965).

Mustelids like stoats, *Mustela erminea* L., and polecats, *Mustela putorius* L., on the other hand usually do not dig out stops, but should be able to find the young inside the main warren more readily. H. G. Lloyd and P. Woudsma (pers. comm.) have observed examples of polecat predation on stops, in Wales and in the Dune Reserve, respectively. Several times adult rabbits have been seen to succeed in driving away a stoat chasing 5 to 8 weeks old rabbit kittens in the open (own observations), and once to drive a stoat out of an open burrow containing a nest (W. R. van Mourik, pers. comm.). It is not known whether does block their nesting burrows within the main warren as they do with stops. If they do, it implies another barrier to mustelids. LLOYD & McCOWAN (1968) described nesting chambers in small warrens having blocked entrances but it is not clear whether these warrens were permanently occupied by adults. On the other hand, very young rabbits (down to the age of 12 days) could be caught in traps set in the burrow entrances of main warrens in the Dune Reserve. Young of this age in stops would be locked in for another 5 to 9 days (MYERS, 1958), thus evading exposure to mustelids and predatory birds.

With respect to the presumed survival value of the dual nesting behaviour of the rabbit, it is not unlikely that the locally high proportion of fox predation on stops in our study area might be connected with the fact that in the dunes rabbits lived without the presence of foxes for at least four centuries (SWAEN, 1948). The first immigrants to the dunes settled down in our study area, only in 1968. Now, ten years

PLATE I

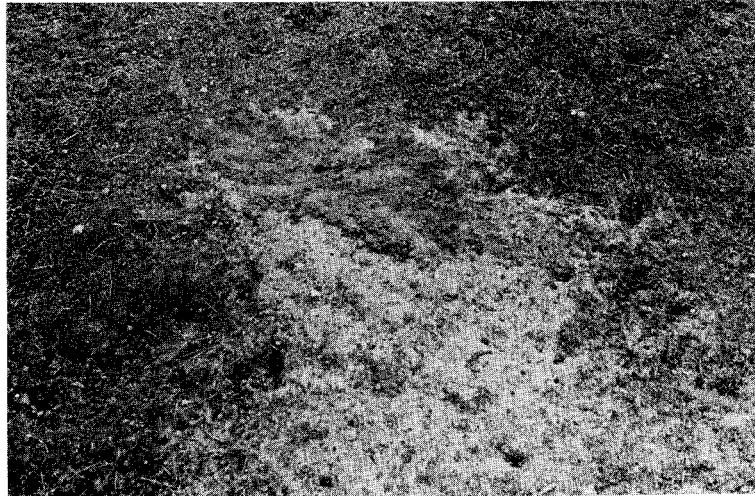


Fig. 1. Stop with freshly closed entrance. The place of the entrance is indicated by the darkcoloured, scratched sand somewhat above and left of the middle of the picture.
The light-coloured sand in the lower right part of the picture consists of the excavated earth.



Fig. 2. Stop dug out by a fox.
Scale: distance between the two holes about 45 cm. A: Hole dug to the nesting chamber. B: Some fur from the nest. C: Entrance to the stop, opened by the fox.

later, there is a population of about 35–40 foxes in the whole reserve, measuring 4800 ha. (P. Woudsma, pers. comm.).

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