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OWL PELLET AVOIDANCE IN YELLOW-NECKED MICE *APODEMUS FLAVICOLLIS AND HOUSE MICE MUS MUSCULUS*

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Owls feed mainly on rodents, which may harbour a diverse set of pathogen species. Their pellets often contain undigested body parts of the prey that may also contain viable rodent pathogens. Therefore, avoiding pellets may serve to reduce pathogen transmission in rodents. Alternatively, rodents may also avoid pellets as a form of predator avoidance, since pellets are likely to indicate owl presence in the vicinity. These alternative hypotheses both lead to the prediction that the behavioural repertoire of rodents should include owl-pellet avoidance, an adaptive behaviour to reduce the chance of infection or predation. The present study tested whether rodents avoid pellets by live-trapping yellow-necked mice *Apodemus flavicollis* using traps with and without pellets, and in house mice *Mus musculus* in Y-maze experiments. We show that both the yellow-necked mice in the field and the house mice in the laboratory exhibit conspicuous owl-pellet avoidance. We argue that this behaviour is an adaptive way to reduce either the transmission of unspecified rodent pathogens or predation pressure.

Key words: pellet avoidance, rodent, barn owl

INTRODUCTION

Owls feed mainly on rodents, and the hair and bones of the prey items are eliminated as pellets (MIKKOLA 1984). These pellets often contain large undigested pieces of rodent bodies, such as skin fragments, ears, legs, tails etc. (CRAMP 1985). It is possible that viable pathogens such as viruses and bacteria are present in pellets. Students of owls often argue that pellets may represent a potential risk for human health and recommend to disinfect pellets before analysis. However, a very few cases of owl pellet-transmitted diseases have been documented up to the present day. Recently, SMITH *et al.* (2005) described two pellet-borne outbreaks of *Salmonella typhimurium* in public schools.

Presuming that owl pellets may contain viable pathogens we hypothesise that the behavioural repertoire of rodents should include owl-pellet avoidance. This behaviour could be adaptive if capable to reduce the chance of infection. Other mechanisms to avoid sources of pathogens (carried by faeces or corpse) are well-known in some mammal species, such as cattle (*Bos taurus*) avoiding the faeces of badgers

(*Meles meles*) (HUTCHINGS & HARRIS 1997), or sheep (*Ovis aries*) avoiding faeces of the conspecifics (HUTCHINGS *et al.* 1999). Other animals are known to avoid the dead conspecifics to reduce pathogen pressure (see MOORE 2002 for examples).

Pellets might also signal of the presence of owls to the rodents, thus – at least theoretically – pellet avoidance may also decrease predation risk. Previous studies indicated that rodents' foraging behaviour and movements are influenced by the threat of owl predation (ABRAMSKY *et al.* 1996, HENDRIE 1998), and that they avoid the scents, odours or faeces of their predators (EPPLE *et al.* 1993, PILLAY *et al.* 2003).

Both the pathogen avoidance and the predator avoidance hypothesis predicts that rodents should gain an adaptive benefit by avoiding pellets, however, this type of rodent behaviour has not been described yet. The present study aims to investigate the owl-pellet avoidance in rodents by live-trapping in the field using traps with and without pellets situated at the trap entrances, and under laboratory conditions using Y-maze experiment.

MATERIALS AND METHODS

1. The field experiment was carried between the 20th and 25th of July 2002, in a desolate area of the New Public Cemetery of Budapest. The study site is covered with bush and horse-chestnut *(Aesculus hippocastaneum)* trees. The area was abandoned for more than 40 years and offers a suitable habitat for the yellow-necked mouse *Apodemus flavicollis*.

We used 66 wooden live-traps (as described in GURNELL and FLOWERDEW 1990), placed cca 8 m one from another, along a horse-chestnut alley. All traps were frequently used previously and had similar trap histories. Each trap was allocated to the experimental (with pellets) or to the control (without pellets) groups randomly. During the experimental period traps were not exchanged between the two groups (those with or without pellets) to avoid the rise of pellet smell on the traps without pellets. We used bread fried in vegetable oil as bait (1×1 cm cubes, 2 pieces in each). Half of the traps were also supplied by cca 10 pieces of barn owl (*Tyto alba*) pellets each. These were relatively fresh, not older than 1 month (see RAMSDEN & RAMSDEN 1995 for ageing pellets). Pellets were collected in Satu Mare county, Romania, where *Microtus* and *Apodemus* species are the most common prey items of barn owls (SIKE *et al.* 2001). Pellets were gently pushed into the soft forest litter around the entrance of the trap, thus it was impossible for a rodent to enter without touching them directly. However, pellets did not form a mechanical barrier for rodents crossing over them. Traps were checked once daily, between 07:00 and 09:00 h. Animals trapped were soon removed from the area by car and released far away from the trapping area, thus each individual was represented by a single catch only.

2. Twenty house mice *Mus musculus* were bought in a pet shop (sold as live food for reptiles) for the purpose of Y-maze experiments. Y-mazes were made by plastic tubes (diameter 32 mm, length cca 15 cm). Following the tubes, each mouse could choose between two target boxes. One of them contained pellets while the control box contained garden soil. In the target boxes, we offered the same quantity and quality of apple and carrot pieces placed directly on the pellets or the garden soil.

Each animal, tube, box and material was used only once to ensure that mice were not influenced by former experiences or odours.

Firstly, mice tended to walk through all the available tubes and boxes apparently to explore the space, secondly, they settled in one of the target boxes to feed. Decisions were considered when they started to feed in one of the target boxes; either on the garden soil or on the owl pellets.

Spatial positions of the pellet *versus* control boxes were changed in each case. Results of the field trapping and the laboratory experiment were both compared to the binomial distribution (two-tailed binomial test).

RESULTS

1. A total of 35 yellow-necked mice were caught during the five-night trapping period. 30 of these were captured in traps without pellets and 5 were captured in traps with pellets. Mice clearly preferred traps without pellets (2-tailed binomial test, $P<0.001$). However, pellet-avoidance was not absolute, as a few individuals walked across owl pellets to get to the baits from the traps.

2. We found a similar avoidance rate in the Y-maze experiments with house mice. Out of 20 mice, 17 began started to feed in the soil box, and 3 of them did the same in the pellet box (2-tailed binomial test, $P<0.002$).

DISCUSSION

Yellow-necked mice are well-known to exhibit acrobatic capabilities to climb across the dense vegetation thus we exclude the possibility that pellets pushed into the soft forest litter could serve as mechanical barrier to influence capture results. In addition, neophobia is also unlikely to play a role in this case, since different species of owls inhabit our study site, whose pellets can be found in the territory, thus owl pellet is not a novelty here. Moreover, we used captive-bred house mice in the Y-maze experiments that have never seen either pellets, or garden soil before, and thus neophobia was also unlikely to influence our results since both substrates were equally new to the animals. In conclusion, we argue that the above data strongly support the prediction that rodents adaptively avoid owl pellets.

JEDRZEJEWSKI *et al.* (1993) assumed that the olfactory recognition of owls by rodents (voles) is not developed because aerial hunting does not leave olfactory cues on the ground. On the contrary, however, we cannot exclude the possibility that pellets may well serve as olfactory cues indicating owl roosting sites for ground-dwelling rodents. Alternatively, it also seems likely that owl pellets with undigested rodent body parts harbour infective bacteria, fungi and viruses potentially harmful for rodents. Admittedly, our present results do not allow any speculation about the nature of the adaptive value of this behaviour. We propose that this rodent behaviour may either decrease the chance of pathogen transmission, or decrease predation pressure, or both.

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