AN INVESTIGATION INTO THE EFFICACY OF MECHANICAL MOLE SCARERS

M Gorman[†] **and A Lamb**

University of Aberdeen, Department of Zoology, Culterty Field Station, Newburgh,
Grampian AB41 0AA, UK

[†] Contact for correspondence and requests for reprints

Abstract

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This paper investigates the responses of European moles (Talpa europaea) *to mechanical mole scarers. The three devices tested emitted vibrations in the frequency range 0 to 20kHz. Vibrations of this frequency are rapidly attenuated when passing through soil. Moles fitted with radio transmitters gave no indication of being repelled by the mechanical devices.*

Keywords: *animal welfare, control, European mole, mechanical scarers*

Introduction

The burrowing habits of European moles, *Talpa europaea*, and the consequent raising of molehills and surface runs, inevitably bring them into conflict with humans who want to use the land for productive purposes. It is difficult to put a precise figure on the financial losses that are caused by moles, but the Ministry of Agriculture, Fisheries and Food estimates that the annual cost to British agriculture in the late 1980's was of the order of £2.5 million. This sum, which includes not only the financial loss but also the cost of control measures, might seem trifling in an industry with an annual turnover reckoned in billions of pounds per annum. However, national figures such as these ignore the patchy nature of the problem. Moles can have a serious impact at a local level, particularly in marginal areas where farmers may already be struggling to survive. For those faced with a large-scale problem, the only practical form of control is to destroy the moles by trapping or by poisoning them with strychnine. Unfortunately, both methods can cause a great deal of suffering and the use of strychnine is additionally problematical in that dying moles may come to the surface and bring about secondary deaths in carnivores and birds of prey.

In addition to agricultural damage, moles also cause a varying degree of consternation, but little monetary loss, among amateur gardeners and keepers of greens. Where the damage is on a small scale, for example in a domestic garden, an alternative to killing moles is to attempt to scare them away. The methods used involve crude assaults on one or other of the moles' sensory systems. In one ancient form of retaliation, beer or lemonade bottles are buried up to their necks in the ground. The wind, blowing across the open mouths of the bottles, is said to set up vibrations which permeate through the soil and so upset the moles that they move on. A number of mechanical devices are now commercially available, which, their manufacturers claim, perform the same task, but more efficiently. These scarers consist of a probe that is pushed into the mole-infested ground, and which periodically transmits vibrations of varying frequency depending upon the model in question. If they work, then they would represent a valuable, humane alternative to the use of poisons and traps.

The aims of this work were to test the efficacy of three of these relatively expensive devices in expelling moles from the areas in which they are living.

Background information

Our studies were carried out on wild, free-living moles. To help the reader understand our method of approach it is necessary to present information on the general behaviour of the European mole, particularly concerning its social organization and patterns of activity.

Moles appear to enjoy a relatively simple and straightforward social order. For most of the year adults are solitary and sedentary creatures which occupy a mosaic of subterranean home ranges. The areas occupied by different individuals are largely exclusive and used by only one animal, although there is a small, varying degree of overlap between the ranges of some neighbours (Figure 1).

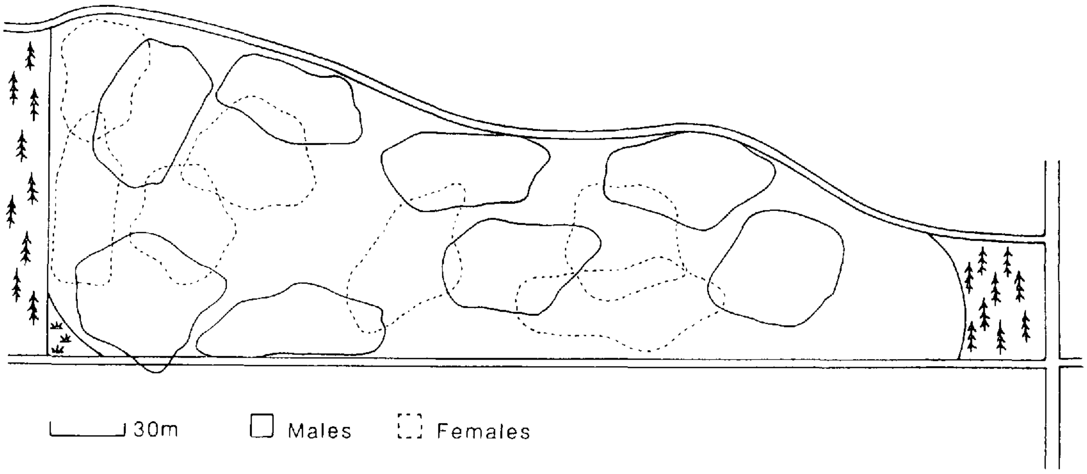


Figure 1 **A map of the home ranges of all the moles living in a pasture. The ranges are shown as the harmonic mean isopleth including 95% of fixes.** *(after Gorman & Stone 1990)*

The home range contains a complex network of semi-permanent tunnels which the mole regularly patrols, eating any soil-dwelling invertebrates, such as earthworms and insect larvae, that happen to be present when it passes (Gorman & Stone 1990). It is important to appreciate that most of a mole's food comes from what is present in these tunnels and that the mole does not need to dig every time it feeds. Indeed, rich permanent pastures may show no signs whatsoever of excavation and yet support high densities of moles. When extensive digging does take place, it is usually in the winter and early spring when the soil is damp and easily worked: this is also the time when tunnels are most likely to be damaged by frost and flooding and consequently in need of repair. There are further outbursts of digging in the late spring, when males start to search for receptive females, and in the summer when newly weaned moles are evicted from their mother's range and start to establish a network of tunnels of their own.

Each mole normally has a single underground nest. Individual moles exhibit a regular rhythm of behaviour in which periods of rest, spent in the nest, alternate with bouts of activity out in the tunnels. In European moles there are usually three sessions of activity and three periods of rest, each lasting for 3-4 hours, during the course of each 24 hours.

Materials and methods

The scarers

We used three types of scarers in our trials: the 'Eco Gardenboy' imported from West Germany by Sim and Coventry of Chester; the 'Gopher-it' imported from the USA by Automarine, Crestbury of Holt and marketed in the UK as the 'Sentinel', and the 'Kestrel Molemover' from PAL Electronics of Leicester.

All three devices were of similar construction, and consisted of a box containing the electronics and batteries and a vibrating probe which is pushed into the ground. The manufacturers claim that the devices are effective over a circle of radius 23 metres (Eco Gardenboy), 16 metres (Sentinel) and 15-19 metres (Kestrel). The instructions state that the device should be placed to one side of a centre of activity, as revealed by fresh molehills, and repositioned at regular intervals so as to drive the moles away from the affected property.

In order to investigate the nature of the vibrations emitted by each scarer, we used a signal analyser to obtain its sound spectrum, a trace of the relative proportions of different frequencies of sound in the signal. The measurements were made in a soundproof box with the scarer placed 2-5cm from a Bruel and Kjaer sound level meter (Type 22331) equipped with a standard microphone (Type 4155). The output from the meter was passed to a Spectral Dynamics Signal Analyser (Type SD380).

A signal enhancement seismograph (Model ES-1210F) was used to determine the extent to which the vibrations produced by the scarers passed through the soil. Twelve electromagnetic geophones (Model SM-4B) numbered from 1-12 were laid out in a straight line, 20cm apart in the centre of a grass field. A scarer was then inserted into the ground midway between geophones 6 and 7. The signals detected by the geophones were recorded onto magnetic tape and analysed by computer, producing a seismogram of the response of each geophone to the vibrations in the ground.

The responses of moles to the scarers

We used radiotelemetry to allow us to follow the movements of individual moles and to assess their responses to the scarers. Using this technique, it is possible to map the boundaries of each radio-tagged mole's home range and to find out how it apportions its time within this range. We predicted that, if the scarers were effective, this would be reflected by a shift in the mole's use of its range so as to avoid the vibrations from the scarer.

Moles were caught in a rough grass meadow in North-East Scotland (57°N; 2°W), using Friesian live-traps: these are wooden tunnels, which are inserted into a section of the mole's tunnel, and which incorporate a nestbox in which bedding and food (earthworms) are placed for the captive. When a mole enters the trap, the wooden tunnel is closed off at both ends by the fall of a pair of shutters. A radio package weighing under two grams was fitted with 'superglue' to the dorsal surface of the tail of each mole (moles weigh from 90-120g). The radios, which transmitted at around 173.2MHz, allowed us to detect a mole from a distance of around 20m and to locate its position to an accuracy of ±0.5m. The radio-tagged moles were released at their point of capture.

In order to describe the movements of moles, to locate their nests, and to delimit their home ranges, we radio-tracked individuals for up to eight hours at a time. At five-minute intervals, we recorded their positions as Cartesian coordinates, in relation to two rows of regularly spaced bamboo canes standing on the northern border (the x axis) and the eastern border (the y axis) of the field.

Our approach was to radio-track an individual for several days, and then to place one of the scarers at the point where the mole was spending most of its time: this might be the site of its nest, or it might be a place where it habitually foraged. We then continued to radio-track the mole in order to detect any changes in its patterns of movement. Two moles were used in the trials, and each of the three scarers was tested on each mole.

Results

The nature of the vibrations produced by the scarers

None of the three scarers was designed to operate continuously but instead, presumably to extend their battery life, they all emitted short bursts of vibrations at regular intervals. When active they each produced a rapid series of vibrations; the Kestrel, for example, generated about 25 discrete pulses of sound per second.

The sound spectra of the vibrations produced by the three devices are shown in Figure 2. The major frequencies produced by all three devices lay in the range 0-20kHz.

Passage of vibrations through the soil

The seismograph results were essentially similar for each of the three devices; as an example, a seismogram produced by the Kestrel is shown in Figure 3. This diagram consists of a plot of response against time for each of the 12 geophones, with the scarer placed midway between geophones 6 and 7. Before analysis, low frequency background vibrations, mainly from passing traffic, were eliminated from the seismic data by means of a 300Hz low pass filter. It is clear from the seismogram that vibrations from the scarer were picked up only by geophones 6 and 7, each situated just 10cm from the scarer. The vibrations picked up by the other geophones are from vehicular traffic on a road some 100m distant and were similar in form when the scarer was inactive.

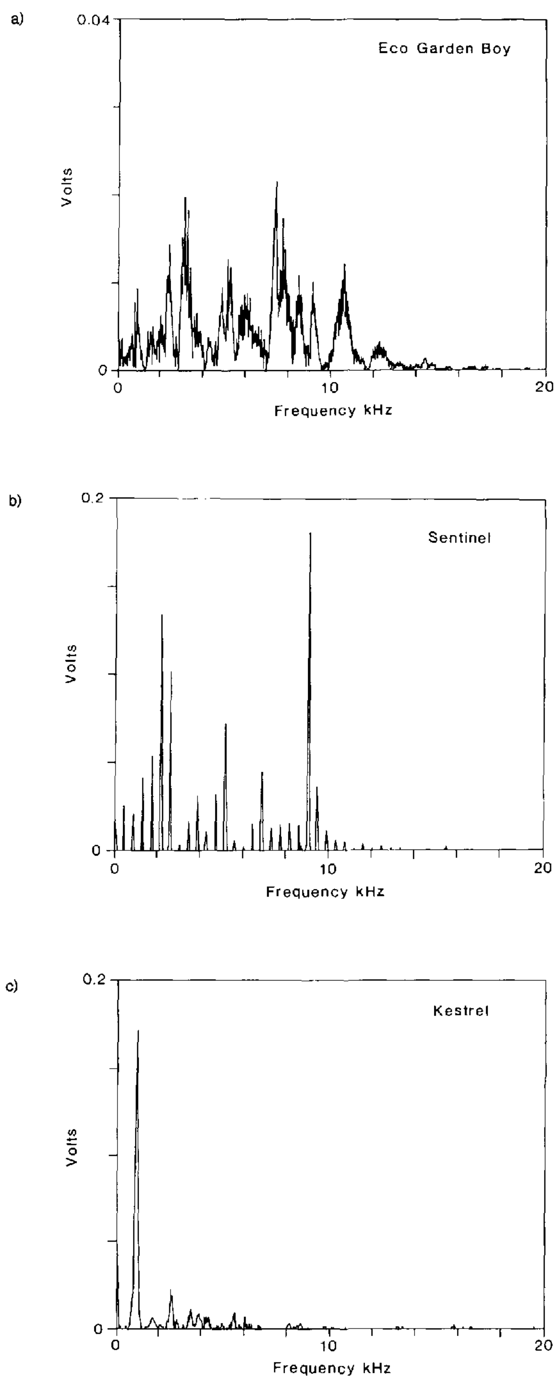


Figure 2 **The sound spectra of the vibrations produced by the scarers: a) the Eco Gardenboy; b) the Sentinel, and c) the Kestrel.**

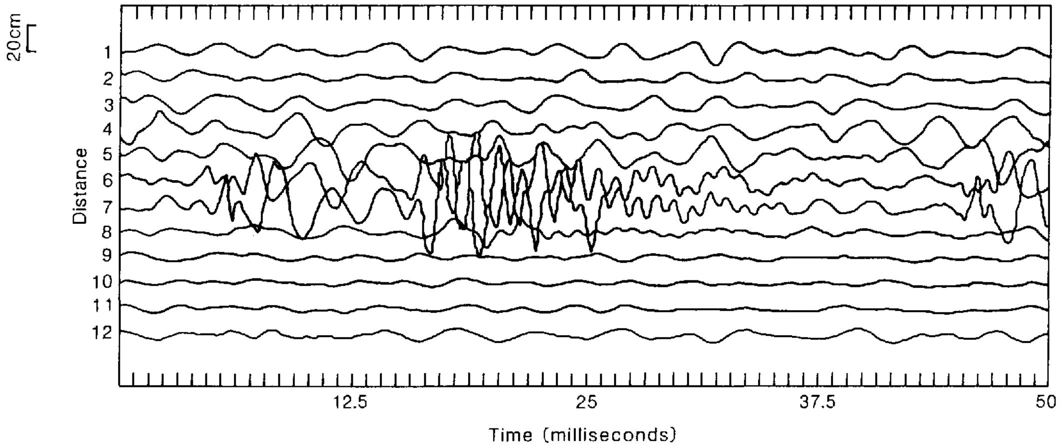


Figure 3 **The response of an array of geophones to the vibrations produced by the Kestrel scarer.**

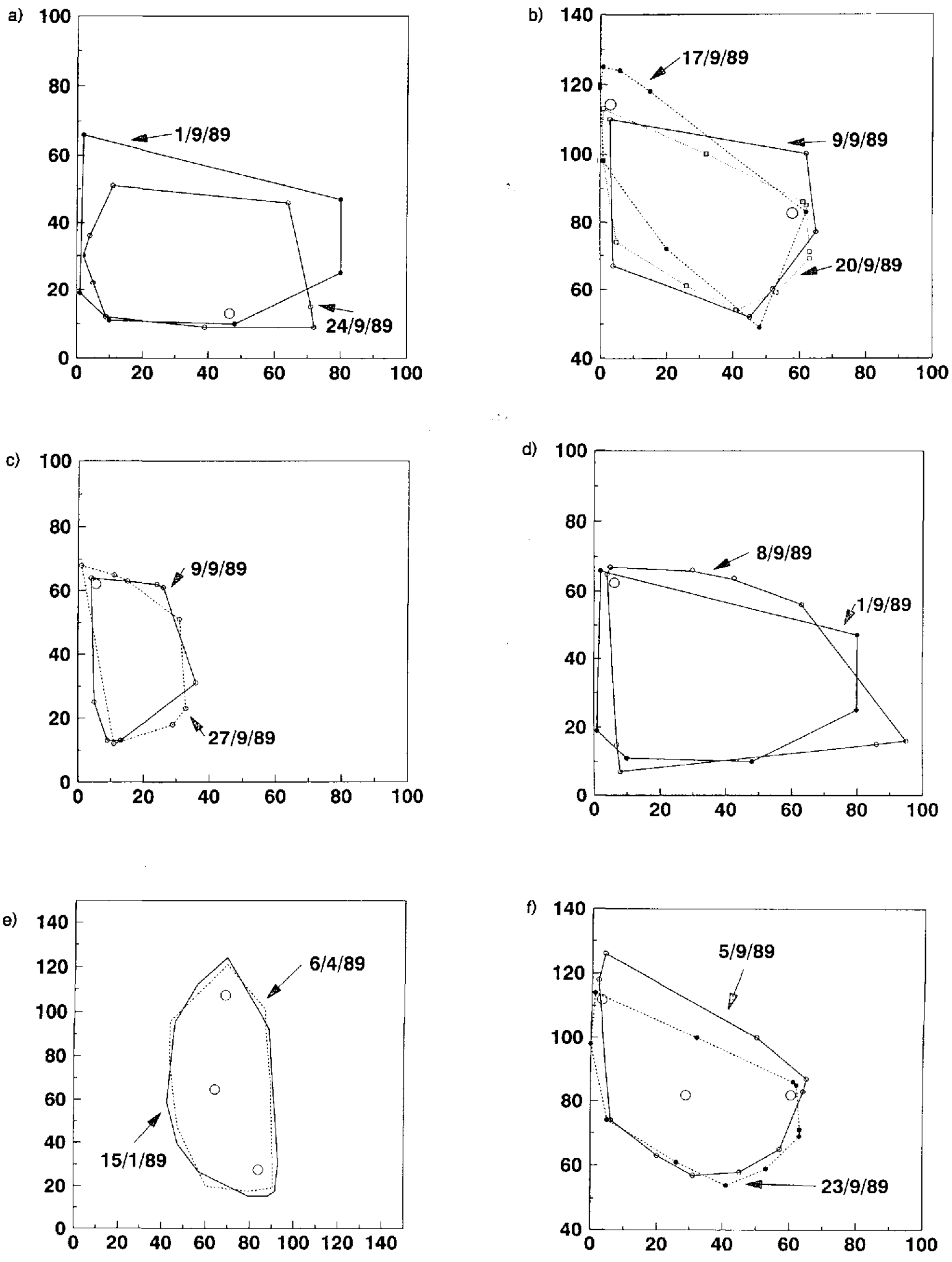
The response of moles to the scarers

The radio-tracking data were analysed to determine whether the scarers caused the moles to change their patterns of movement and/or to abandon parts of their ranges.

In order to determine the position and size of the moles' home ranges, we used the radio fixes to construct minimum convex polygons, outlines which are known to describe adequately the ranges of moles (Gorman & Stone 1990). By constructing such an outline both before and after deploying a scarer, we could detect any shift in the position or the shape of the range.

As a measure of how a particular mole used different parts of its range, we superimposed a grid on to a map of the range and counted the number of times the mole was located in each 5 by 5 metre cell. From the resulting matrix we constructed a three-dimensional surface in which the vertical dimension was a measure of the use made of different parts of the range. This operation, too, was carried out both before and after a scarer was put in place. The computation was performed by means of the SURFER suite of programs (Golden Software Ltd).

The responses of the moles to the different scarers are shown in Figure 4. In each case the range of the mole is shown as a convex polygon; the polygon of earlier date defines the range as it was immediately prior to a scarer being placed at the point shown by a large open circle. Where more than two points appear on a map this indicates that the scarer was moved during the trial, as recommended by the manufacturers. The polygon of later date shows the range after exposure to the scarer for the period between the two dates. In no case was there a shift in the range used by the animal beyond what one would expect from day-to-day differences consequent upon short-term changes in foraging patterns. There was no indication at all of moles abandoning the area around the scarer, despite the fact that this was often the nest site where a mole spends around half of each 24 hours.



Figures 4a-f The home ranges of moles before and after exposure to the three scarers (x and y axis measurements in metres).

Figure 5 shows the way in which one of the moles used different parts of its territory during the study. Part a) shows the pattern of utilization over the whole study. The major peak in the distribution of radio fixes represents the mole's nest. The other two parts of the figure show b) the pattern of range use during the first and c) the second halves of the study. The range sizes corresponding to these three time periods were 3,903m^2, 3,801m^2 and 3,785m^2 respectively. Thus all three ranges were essentially similar in terms of position, size and patterns of activity, despite the fact that the mole was exposed, at various times, to all three scarers at its nest site.

Conclusions

The results of this study must throw serious doubts on the efficacy of the three mole scarers that were tested.

The devices produced vibrations consisting of frequencies under 20kHz. These should be detectable by the European mole, which has an essentially normal pattern of hearing and shows behavioural and electro-physiological responses to sounds in the range 0.1-15.0kHz (Aitkin *et al* 1983). However, much of the output of the devices was at frequencies which are readily absorbed by solids such as soil. The seismographic analyses indicated that the attenuation was very rapid indeed and that vibrations could not be detected beyond a few centimetres. Although we do not know how sensitive moles are relative to the seismograph, we are unconvinced that the vibrations could be detected over the many metres claimed by the manufacturers. In fact, we know of no hard evidence that moles are disturbed by vibrations passing through the soil. The fact that moles are common on roadside verges, where they are exposed to intense and constant vibrations of a wide range of frequencies, would suggest that they are highly tolerant of such stimuli.

The free-living moles that we studied showed no sign of being adversely affected by any of the three scarers, and continued to use their ranges in the normal manner. In our work we were at an advantage over the normal user of these devices who has no means of knowing where the moles are living, other than by their visible excavations. We, in contrast, knew exactly where our moles were moving and we could place the scarers at sites which they regularly visited, and thus ensure maximum exposure to them. Despite this we were quite unable to induce either mole to vacate part of its range. What, then, of the claims for success? As we described earlier, moles dig relatively little for much of the year. Apparent successes with these devices are probably illusory: the result of a mole coming to the end of its current digging spell, rather than of its having decamped. In reality the offending mole is probably still living in its range, obtaining all of its needs from its existing tunnels.

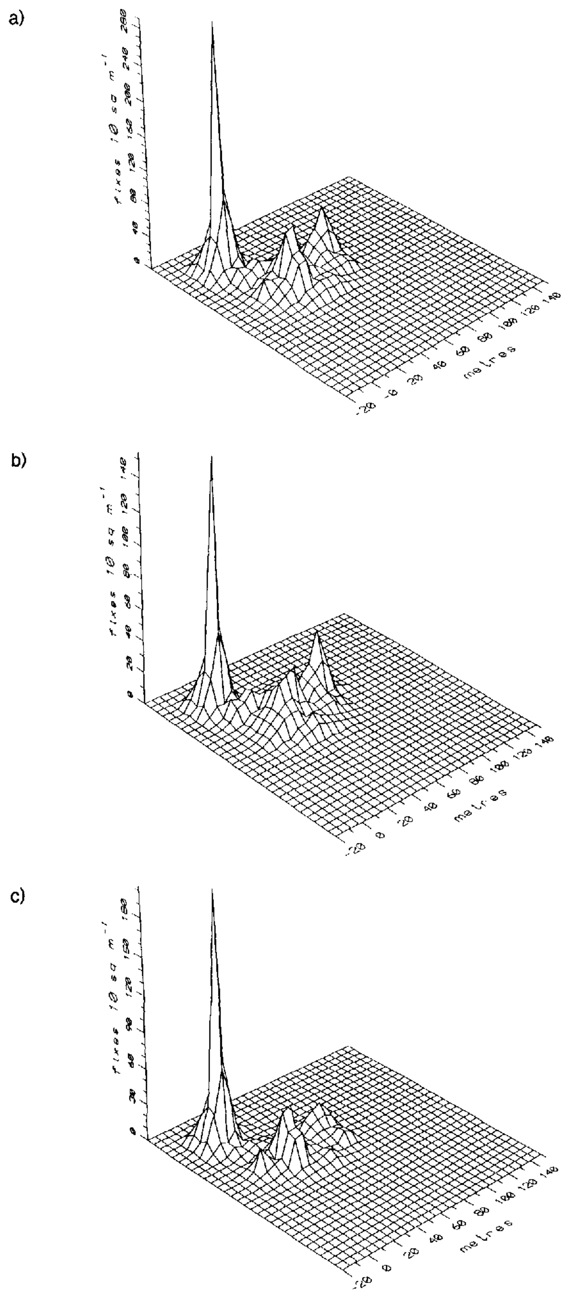


Figure 5 Three-dimensional representations of the use made by a mole of its range during a) the entire study; b) the first half of the study, and c) the second half of the study.

Animal welfare implications

Mechanical mole scarers, the present results suggest, cannot help the gardener or green-keeper to repel moles. We do not, however, recommend that the moles be removed by trapping or poison. Not only do these measures cause suffering, but they may actually increase the likelihood of mole damage in the area from which the moles are taken. This is because of the solitary and sedentary nature of moles: they tend to occupy more or less contiguous ranges beneath a given area of ground (Figure 1), and the removal of a mole often prompts its neighbour to annex its range, as we know from radio-tracking (Gorman & Stone 1990). We believe the new occupant of a system of tunnels would be only too likely to start to dig afresh, until it felt at home. It would therefore be more practical, as well as more humane, to remove molehills (which represent the spoil from one section of tunnel only) rather than moles: the task would need to be carried out only during the season of active digging.

Acknowledgements

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