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THE EFFECTS OF RELEASING CAPTIVE HEDGEHOGS *(ERINACEUS EUROPAEUS)* INTO THE WILD

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ABSTRACT

Four 'rehabilitated' hedgehogs from an animal hospital were taken to Yorkshire and radio tracked for two weeks to determine their fate after reintroduction to the wild. One died for reasons not apparently related to the study. The other three (1 male and 2 females) successfully built natural nests, and soon learned the geography of their new environment. They integrated well with the wild resident hedgehogs and developed home ranges similar to what would be expected of wild hedgehogs in the same habitat. However, only one managed to maintain its body weight, the others lost significant mass. A longer study, with more animals is needed to confirm the success of hedgehogs released into the wild after a period of veterinary care.

INTRODUCTION

Hedgehogs *(Erinaceus europaeus)*, are regarded with affection and many individuals and organisations are concerned about their welfare. Some spend considerable time and effort treating sick or injured hedgehogs for release back into the wild, in both urban and rural areas. However, little attempt seems to have been made to establish how, or even whether, these rehabilitated hedgehogs survive after release.

In the summer of 1989 four captive hedgehogs were obtained from the Wildlife Hospitals Trust, Aylesbury and were released (after treatment for injury) into an area with an existing population of wild hedgehogs at Malham Tarn, Yorkshire. They were radio tracked over the subsequent three weeks and their body weights monitored. The aim was to establish if they could find enough food to maintain their body weights, whether they could build daytime nests and then find them again and whether they integrated into the local population of wild hedgehogs.

THE STUDY SITE

The study site was adjacent to Malham Tarn Field Centre, bounded by the Tarn to the south and by Highfolds Scar and stone walls on the other three sides. Mixed deciduous woodland, mostly beech *(Fagus sylvatica)* and sycamore *(Acer pseudoplatanus)*, with some patches of conifers, dominates the site. It stands on sloping ground with moss-covered scree and limestone rocks covering large areas. The dominant ground flora is dog's mercury *(Mercurialis perennis)*, often used by the hedgehogs for nest building. A grassy clearing extends to the water's edge from the Field Centre and there are also patches of grass around the cottages.

METHODS

The captive hedgehogs were anaesthetised with halothane to enable a patch of spines to be clipped. Radio transmitters (from 'Biotrack', Wareham, Dorset) were glued on before they were released. A luminous tag attached to the transmitter enabled

hedgehogs to be easily located in the dark without approaching them too closely.

The two females were released on the evening of 20 June 1989, the two males 24 hours later. Fieldwork continued until 2 July 1989, giving 13 consecutive nights of tracking in the woodland. A further two nights observation (4 and 5 July) took place on open, tightly-grazed grassland adjacent to the main woodland study site to the east.

The hedgehogs were tracked throughout each night until they nested. It was intended to locate each animal at least once every half hour (with a minimum time lapse of 20 minutes), but during the study period the time intervals increased as the hedgehogs became more dispersed. Nest sites were confirmed during the day while still occupied, so the exact point of the start and end of a night's activity could be recorded, but the exact time of entering and leaving nests was often not known.

Each time an animal was located, its position 'fix' was recorded as a pair of X, Y co-ordinates, accurate to about 10 metres, taken from an Ordnance Survey map (1:10,000) divided into hectare squares. The time at which the fixes were taken and the habitat type in which the animals were found were also noted. The hedgehogs were weighed every night at the first recorded fix.

It was decided that a minimum of six fixes (including start and end nest sites) taken over a minimum of six hours per night, was needed to provide a representative indication of home range size and the distance travelled each night (Morris, 1987). Applying these criteria during data analysis resulted in only three nights of information being available for male 235. He died soon after release, for reasons not obviously related to the study. Thus, the results presented here relate to released captive females 225 and 255 and male 275. Eliminating the few nights where the number of fixes or the number of hours of study fell below six, provided 27 hedgehog/nights of acceptable data, plus two nights of close-tracking on the grassland for 225 and 255.

Hedgehogs 225 and 255 were released next to a bowl of dog food placed under a tree. Female 225 ignored the food and began exploring northwards immediately after release. Female 255 displayed foraging behaviour around the base of the tree for an hour but fed only once from the food bowl for three minutes even though she was never more than 1 metre from it. The food was left in place for three more nights, but the animals did not return to it.

Following the released animals had priority, so only intermittent observations were made of wild hedgehogs. Twenty-five of these were found during the study (15 males, 10 females) representing a density of approximately 1 hedgehog per 1.5 hectares on the study area. They were weighed, sexed, and marked with spray paint enabling individual recognition of each.

After 13 nights in the woodland, females 225 and 255 were translocated into an area of open grassland east of the wood for two nights. Each observer tracked one female hedgehog continuously, recording position fixes every 20 minutes when possible, from the time the hedgehogs were released, until they ceased to be active at the place where they spend the subsequent day. Male 275 remained in the wood and was not tracked, although his weight and nest sites were recorded.

A computer program ('RANGE' by A. Wroot, 1983) analysed the pairs of x, y co-ordinates, calculated the distances between successive fixes and cumulated them to give the minimum distances travelled each night. The program then selected the

outermost points at which each hedgehog had been found and calculated the area of the convex polygon enclosed, giving a measure of the 'range area' used each night by each animal. The areas could then be summated to provide a 'cumulative home-range', *i.e* the total range area used by the animal over the duration of the study period.

RESULTS

The original aim was to locate the animals at least once every hour, and at least 6 times per night. In practice, individual hedgehogs were often located nine or more times per night and 93% of the fixes used to calculate range areas and distances travelled were made at intervals of less than one hour. There were a few unfortunate time gaps of more than two hours due either to equipment failure or unexpected bursts of hedgehog activity (usually male 275). If a hedgehog could not be found the search was abandoned and the other animals located so that their fixes were not too affected by long time intervals between them. The search was then resumed for the missing hedgehog. The average time lapse between fixes was 42 minutes (SD = 14.58). A total of 626 fixes were made during the study. This constitutes 140-160 per animal, representative of their activity in that time.

Table 1. *The minimum distances per night travelled by the four radio-tagged hedgehogs in woodland habitat (the means are calculated excluding inactive night).*

Night. No.	Distance Travelled (metres) Male 275	Female 225	Female 255	Male 235
1		269	701	338
2	576	597	139	490
3	840	524	583	200
4	810	710	355	– inactive –
5	647	672	342	— died —
6	745	411	319	
7		inactive		
8	947	479	173	
9	777	395	642	
10	887	493	707	
11	699	438	— inactive —	
12	921	613	502	
13	899	738	708	
Mean	795	528	470	343
Range	576-947	269-738	139-708	200-490
SD	114	135	204	

Tables 1 & 2 show the distances travelled and the range areas used per night for all four released hedgehogs. The calculated distance travelled is a minimal measurement because hedgehogs make frequent deviations from their path, often wandering in circles, adding considerably to the apparent distance covered. The females were fairly erratic, animal 255 being more so with travel distances ranging from 140m to 710m per night. The male was consistently more active, travelling more than 800m on

half the nights he was studied. His average distance travelled (795m) was at least 50% greater than those of 225 and 255 (528m and 470m respectively). This is a normal feature of hedgehog ecology (Morris, 1986, 1987). Male 235 weighed less than the other three and was far less active. His weight and movements declined rapidly after release; on night 4 he was inactive the whole night and he died the following day.

Home Range Area

Each night the females used an area of about 0.3-3.5ha, the male wandered more widely, covering 1.5-6.0ha per night. Although Table 2 shows the range areas used each night, it does not indicate the size of the total area familiar to the animal, i.e. the 'home range' in the conventional sense. To do this, cumulative range areas were calculated by adding each night's radio fixes to those of previous nights (Morris, 1987).

Table 2. *The range area used per night by four radio-tagged hedgehogs in the woodland.*

Night. No.	Range Area (hectares) Male 275	Female 225	Female 255	Male 235
1		0.54	1.39	0.40
2	1.48	0.84	0.05	1.47
3	1.87	0.76	0.79	0.23
4	1.99	1.19	0.29	– inactive –
5	1.70	1.96	0.26	— died —
6	1.96	1.71	0.19	
7	———	inactive	———	
8	2.58	0.61	0.12	
9	4.43	0.35	3.37	
10	5.69	0.59	1.08	
11	1.56	0.24	— inactive —	
12	2.76	0.65	1.34	
13	5.62	1.87	2.50	
Mean	2.877	0.943	1.035	0.526
Range	1.48-5.69	0.24-1.96	0.05-3.37	0.23-1.47
SD	1.528	0.570	1.025	

Fig. 1 shows that each successive night's observations added a considerable amount to the cumulative range for the first 6-9 nights. Thereafter, continued observation rarely found the animal far outside the area within which it had already been recorded.

After 12 nights female 225 had used a total cumulative area of 6ha; female 255, 9.6ha. Male 275 had nearly double the cumulative area of 255 and, in 12 nights reached an asymptote of over 17ha. These cumulative home-range figures are about six times larger than the range areas used per night given in Table 2.

Social Behaviour

The cumulative home range of male 275 enclosed most of the home range of females 225 and 255. It also included at least part of the home ranges of the wild females he was found courting. This demonstrates that hedgehogs do not defend mutually exclusive territories (Reeve, 1982; Morris, 1985) and suggests that introductions into an existing wild population will probably not result in social disruption. Male 275 was seen with 5 wild females. He spent 45 minutes with no.3, and 2 hours 15 mins with no.4. He was also found with 16, 17, 21 and the released female 225 (for 2 hours) and

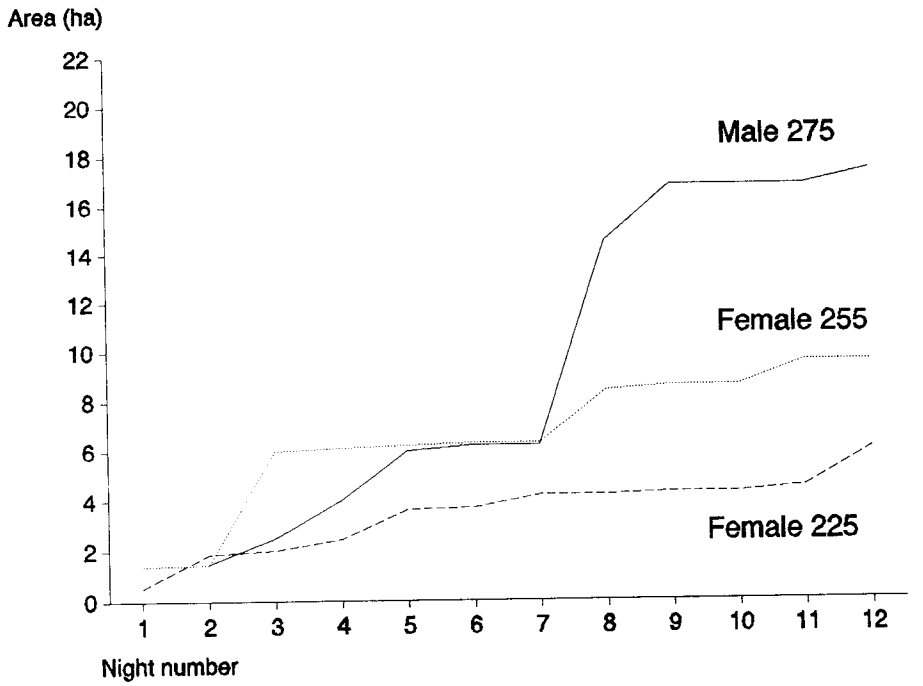

FIG. 1

Approximate cumulative Home Range area after each successive night. Actual areas used will be larger than shown as periodic position fixes only sample activity: the animals were not monitored continuously. The abrupt increse for male 275 after night 7 was due to his moving to the far side of the study area thereby increasing his home range.

with wild male 14. However no matings were observed nor any aggresive interactions, even when male 275 was found courting a female in the presence of a wild male.

Duration of Activity

Male 275 had a cumulative range area greater than that of 255 or 225, and his mean period of nightly activity (370 mins, SD=114.43) was also longer than that of the two females (313mins, SD=154.08; and 361mins, SD=114.5 respectively). The females' activity periods were very erratic compared with 275; female 255 stayed out for 530 minutes on the first night but only for 160 minutes the next night.

Nests

In 14 days, female 225 used two different daytime resting places (Fig. 2). Her main nest site (A), used on 13 days, was under a woodpile near three similar ones. She returned here without appearing unsure of which woodpile her nest was in. Her other nest was in a stone wall. She took an hour to build nest A, a major investment of time and energy. In 14 days, female 255 used four different daytime resting places in the woodland. All were self-constructed, using mainly dead leaves and dog's

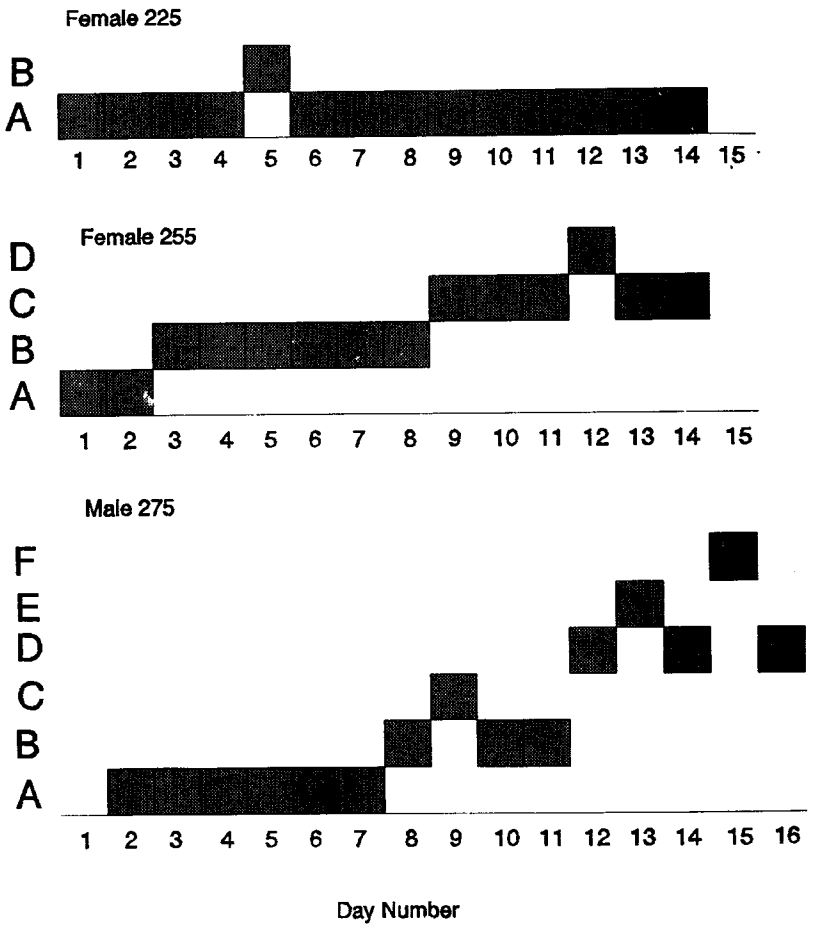

FIG. 2
Successive daytime nest positions were designated (A,B,C . . .) in sequence for each animal. Changes are shown here. The male 275 used 6 different nests, changed 8 times in 16 days. The females used fewer nests and changed less frequently.

mercury. They took approximately an hour to build, except for the grass lair (D) she used during day 12. The lair was probably used instead of a proper next because of the high daytime temperature (Dimelow, 1963), not because the hedgehog was lost.

Three of the six nests used by male 275 were relatively close together under rocks and tree trunks and lined with moss and dead leaves. His other 3 nests were on the far side of his range near the Tarn; one of which seemed to be an existing nest (in

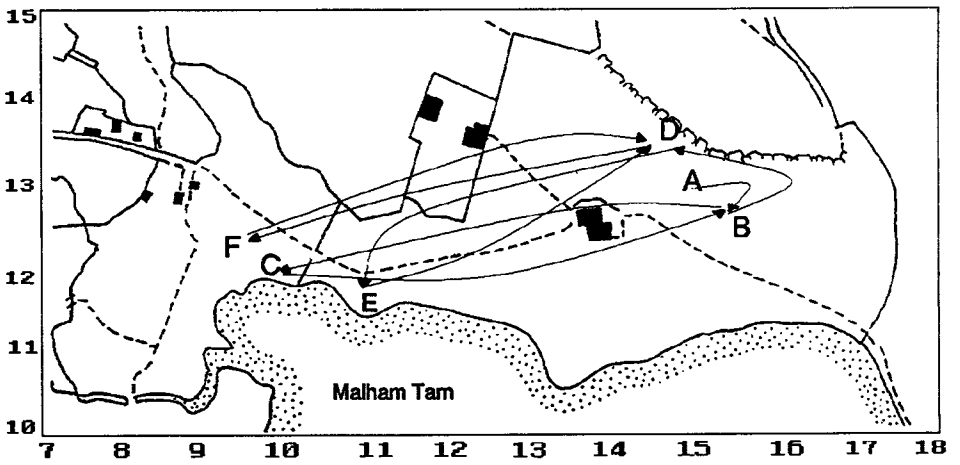

FIG. 3

Sketch map of the study area showing sequence of daytime nest sites used by male 275. He began on the east side of the study area (A,B), moved to the west (C), then back to the east (D again) then used site (F) in the west, then back to (D). The fact that he returned to nests B and D after at least one day away implies that he had learned the geography of this site fairly effectively in a short time. Black squares are buildings.

which he spent only one day), near wild female 215 and her two young. This may in fact have been non-simultaneous sharing of the wild female's nest (Reeve and Morris 1985). Male 275 spent six successive days in the same nest at the beginning of the observation period. But once he was used to his environment he began exploring further and changed his daytime resting place frequently, sometimes returning to a place used before. The direction of the arrows in Fig 3 show that he went to nests in the west of the site, then back to those in the east. He changed his daytime nests twice as often as female 255, apparently a normal part of male hedgehog behaviour (Reeve & Morris, 1985; Morris, 1987) enabling a larger range to be utilised than if the animal always returns to the same place. On the nights that 275 returned to the same nest from which he started, the mean range size was 1.8ha; on the 8 nights he ended up at a different nest, his mean range was 4.2ha.

BODY WEIGHT

The animals were expected to lose weight in the first few days after release as they explored their new surroundings, neglecting foraging. Nevertheless, female 225 managed to maintain her body weight fairly constant over the study period. Although she did lose weight (6%), this was not a statistically significant trend ($r = 0.215$, $P = 0.1$). She was often found in tall vegetation on wet ground which may have been a prime feeding area. However, Fig 4 shows significant losses for the other two.

Female 255 lost 36% of her body mass, 20% in the first 4 days. Her weight was still declining when the study ended. The male 275 lost 12% of his initial mass. Weight losses for both were statistically significant ($r = 0.903$, $P = 0$; and $r = 0.717$, $P = 0.00052$ respectively).

TRANSLOCATION TO GRASSLAND HABITAT

After two weeks in the woodland, the two females were recaptured and released into nearby grassland on July 4. They responded differently to the new habitat: a summary is given in Table 3. Close-tracking of 225 and 255 meant that every point they reached on nights 15 and 16 was recorded, whereas the '6+ fixes per night' formula used in the woodland, represented only a sample of the animal's total movements and would have probably missed some of the outermost points reached. Thus, the close-tracking method gave more accuracy to the grassland data, but also increased the apparent distances travelled and range areas.

Table 3. *Range areas used and distances travelled in the grassland*

Night No.	No. of Fixes	Female 225 Range Area (ha)	Distance Travelled (m)
15	17	11.8	1534
16	13	2.7	676
Night No.	**No. of Fixes**	**Female 255 Range Area (ha)**	**Distance Travelled (m)**
15	19	13.2	1840
16	16	3.9	899

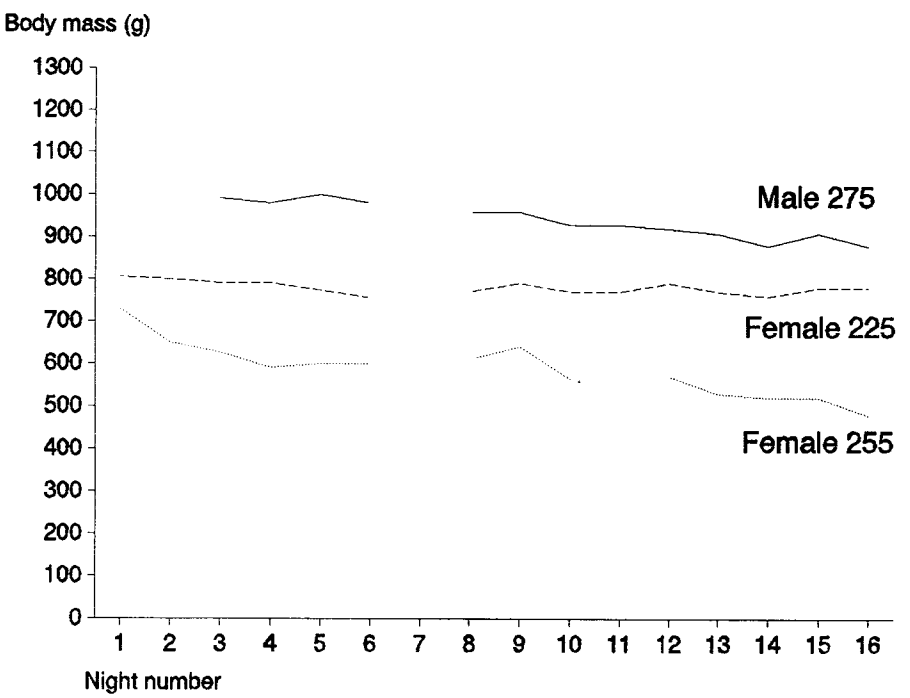

FIG. 4

Weight changes during the study period. All three hedgehogs showed progressive weight loss, suggesting inadequate feeding. In the case of female 225, the loss is minor, but for the other two it is significant. gaps indicate nights when the animals were not weighed.

Hedgehog 225 only spent 2.5 hours in the grassland before finding her way back into the wood where she returned to a point (under a tree trunk) near her original nest A. She was taken back into the grassland the subsequent night to see if her 'homing' had been intentional, or due to chance. That night she travelled to the wall bordering the woodland, found the entrance to the wood, and by the end of the night, was back in her original nest A. We did not move her again.

Female 255 appeared to be much more disturbed by the new environment. By the end of the first night out in the open grassland, she seemed very unsettled and spent over an hour searching for a suitable nest site among rocks. On the second night, she found her way into a small plantation adjacent to the Tarn. She gathered grass and dead leaves from a metre radius around her chosen nest site, but then abandoned it (possibly because we disturbed her) and constructed a nest of moss, grass and dry leaves under a bush about 4m away. When 255 was later discovered with a wild male, she was left in the plantation.

Differences between activity in the two habitats soon became evident. Both females greatly increased their speed, ranges and distance travelled. On night 15, female 255 covered a distance 4.5 times longer on the grassland compared to her woodland movements; and on night 16, travelled 200m more than her greatest distance reached in the wood. Similar pattern of activity was shown by 225 who increased her average (woodland) distance travelled by a factor of three on night 15. The distances travelled by both on night 16 dropped by half. In the grassland the areas used were also much greater than in the woodland.

Discussion

Although the sample size of three hedgehogs is obviously inadequate, the study showed that the animals rapidly developed their home range as they became familiar with the new woodland area. They used home range sizes similar to those of wild hedgehogs studied in similar habitat elsewhere (Morris, 1986). When the two females were translocated to open grassland they ranged much further than in the wood, and if studied longer, might have established similar range sizes to wild hedgehogs tracked on a golf-course (Reeve, 1982; Morris 1985). However, they quickly re-entered the wood, suggesting that, given a choice, there is a preference for sheltered habitat over open ground.

The steady decline in weight for 275 and 255 can be attributed to shortage of food due to dry soil conditions, but the hedgehogs may have been overfed whilst in captivity and so overweight at the start. This seems unlikely since the mean weights of both females were less than those recorded for the 18 wild females caught on the study area (780g; SD = 148.24). Male 275 was found to be slightly heavier than the average wild male (860g; SD = 115.16). The male's weight reduction may also have been due to him being reproductively active and thus spending more time with females than in foraging for food.

It rained on night 7 and the hedgehogs stayed in their daytime resting places, but there was little change in their weights the following night. They were also not active for longer on the subsequent night to compensate for the inactivity. In fact, female 255 was active for less time than usual and the distance she travelled was considerably reduced. Thus, although the animals were losing weight during the study, this did not stimulate extra foraging effort nor did it encourage the animals to

forage in the rain. The male also still devoted considerable time to sexual activity. Despite weight losses, supplementary food was ignored. Nevertheless, providing it can do it no harm and may be welcome in dry weather when natural food is scarce.

The greatest mean speed reached in the woodland was 2.64 m/min by 275; female 255 reached a mean speed of 4.18 m/min on the grassland during night 15. One might expect the animals to have increased their speed (along with the distances they travelled) as they became fitter and grew more familiar with their surroundings, but no evidence of this was seen.

The patterns of nest use shown by the animals were similar to those elsewhere (Reeve and Morris, 1985) with the male changing his nest more often than the females. Although the male nested on two opposite sides of the study site, he showed no evidence of being 'lost' since his movements alternated between the two areas, rather than centring around one group of nests and then the other. He also found his way back to two different nests used previously. Further evidence of navigational ability was evident as they proceeded directly to their nest at the end of the night without hesitation. Female 225 relocated her nest even when her movements took her in opposite directions on two consecutive nights. She also twice returned to her nest from the grassland, covering ground that she had never previously visited. Clearly these animals had developed a sense of local geography in less than two weeks.

Few problems are likely with the release of non-territorial and solitary animals such as the hedgehog, since factors such as scent and territory are apparently less important in their interactions with each other than in some other species. Some mammals will 'home' over long distances. For example, Phillips and Mech (1979) found an adult female fox returned 56km to its home-range in 12 days. In Suffolk, an adult female badger homed 23km in 4 weeks after being moved from her territory (Grimwade, 1988). Another badger released in Cheshire after veterinary treatment returned to its sett 2.4km away. The released hedgehogs showed no evidence of homing back towards their original source, Aylesbury. Perhaps territorial mammals 'value' their home areas more than non-territorial species like the hedgehog. However, female 225 showed a local 'homing' ability when she returned to her woodland nest from the grassland, suggesting that hedgehogs may value their nest sites rather than territories since they spend so much effort in building them.

CONCLUSIONS

This study suggests that captive hedgehogs released into good hedgehog habitat can be expected to settle quickly, expand their range, and adapt to their new surroundings. They appear able to find sufficient food, and they increase their foraging distances to match those travelled by wild hedgehogs in a similar habitat. The hedgehogs will probably integrate successfully with the wild population and show normal patterns of nest-use behaviour.

These results encourage the belief that rehabilitated hedgehogs can survive in the wild. However, it is disturbing that only one of the three animals studied was able to maintain its body weight during the two weeks observation.

However, this was only a pilot study, using only 4 animals and curtailed (for financial reasons) after less than 3 weeks. Further investigations, with more animals, are needed.

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SUMMARY

1. Four hedgehogs from an animal hospital were released into an area of woodland at Malham Tarn, Yorkshire, and their behaviour monitored for 16 nights, using radio-tracking. One died for reasons not evidently connected with the study.
2. The animals established home-ranges of normal size and travelled similar distances each night to wild hedgehogs elsewhere; the male was more active than the two females.
3. Significant declines in weight were recorded in two animals; the other maintained her body weight, with only a small loss overall.
4. Nest use patterns were similar to those recorded for wild hedgehogs elsewhere, with the male changing his nest site more often than the females.
5. The released animals were seen associating with resident wild hedgehogs and no aggressive behaviour was observed.
6. While it appears that rehabilitated hedgehogs can adjust to life in a new location, the small sample size and short duration of this study indicate the need for further investigations.

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