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PROPOSAL OF A NEST BOX FOR THE REPRODUCTION OF WILD RABBITS (*Oryctolagus cuniculus*) IN CAGES

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Abstract: This paper reports on the design of a nest box consisting of two compartments for the breeding in cages of wild rabbits (*Oryctolagus cuniculus*). The first compartment was a chamber measuring on the inside 17 × 23 × 20 cm (base and height), conforming to the small body size of the wild rabbit and similar to its breeding burrows. A plastic tray was placed inside the chamber, in which the doe could build her nest. The other part of the nest box was a tunnel with an inner cross-section of 9 × 8 cm leading to the nesting chamber and designed to make the doe enter the nest slowly. The does made considerable use of the boxes as nesting places since, out of a total number of 41 births, 85.4% of the does gave birth to all of their kits inside the nest box, and in 71.4% of these cases the does suckled their litters there. No differences were found in the use of the nest box between does born in breeding burrows and those born in the nest boxes tested here. It was concluded that this nest box is appropriate for breeding captive wild rabbits.

Key words: captivity, game farming, nest box, *Oryctolagus cuniculus,* wild rabbit.

INTRODUCTION

In a colony of wild rabbits (*Oryctolagus cuniculus*) the dominant females give birth and suckle their kits either in the chambers of the common warren or, as in the case of the subordinate females, in independent burrows (known as stops) that they excavate specifically for this purpose (Mykytowycz, 1960; Lloyd and McCowan, 1968; Gibb, 1993). In domesticated breeds used for meat production, the stop is replaced with a nest box in which the doe builds a nest with the material provided to her and with hair that she pulls from her abdomen (Lebas *et al.*, 1996). In countries such as Spain, France and Portugal the decline in wild rabbit populations caused by myxomatosis and rabbit viral haemorrhagic disease led to the implementation of restocking programmes, some of which use rabbits bred in captivity. Due to the fact that there are no cages designed specifically for the wild rabbit, when breeding takes place in cages it occurs in equipment and cages designed for domesticated rabbits (González-Redondo, 1998; 2001). However, the differences in size and behaviour between the wild and domesticated breeds often mean that such equipment is inappropriate for use with the wild rabbit. In this article we describe an experimental prototype of a nest box developed from previous experiments (González-Redondo, 1998; 2000) and adapted to the wild rabbit's morphological and ethological characteristics and subsequently analyse the suitability of its design.

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MATERIALS AND METHODS

General design criteria

To make the experimental nest box prototype we used chipboard panels. This material is easy to work with, low cost, compared to metal or plastic, has good thermal insulation (Vignote and Jiménez-Peris, 1996), thus ensuring a higher survival rate among kits.

Several criteria were used when choosing the shape and dimensions of the nest box prototype: on the one hand we sought to emulate as far as possible the shape and dimensions of a natural stop and, on the other, we adapted the shape and dimensions of commercial nest boxes for domesticated meat breeds to the body size and ethological requirements of the wild rabbit. Natural stops are usually small, blind burrows consisting of a short (about one metre long) entry gallery (Lloyd and McCowan, 1968; Gibb, 1993), ending in a spherical chamber of about 25 cm in diameter (Lloyd and McCowan, 1968), with a volume of about eight litres. The commercial nest boxes used for domesticated breeds are usually at least 25 × 40 cm at the base by 25 to 35 cm in height, with a volume of at least 30 litres, about four times that of wild rabbits' breeding burrows.

In principle, when endeavouring to make a warm nest in a volume four times bigger than that of a breeding burrow, this larger dimension would hamper the wild does, which are smaller than domesticated meat breed females. Furthermore, the volume of the nest box should correspond to the wild rabbit's body size. The animals used in the trial belonged to the subspecies *O. c. algirus,* from the south of the Iberian Peninsula. These wild rabbits are characterised by being the smallest in the world (Soriguer, 1980; 1983) with a weight of 1100 g in wild-born rabbits (Soriguer, 1980) and 910 g for those born in cages (González-Redondo, 2003). In contrast, the domesticated meat breeds and the lines currently exploited in industrial rabbit breeding and for which the commercialised nest boxes are designed have an average weight of 4-4.5 kg (Lebas *et al.*, 1996), approximately four times that of the wild rabbits used in this trial.

Moreover, the litter size of wild rabbits bred in cages (an average of 3.3 and a maximum of six kits – González-Redondo, 2003–) is lower than that of meat breeds (average of nine kits –Lebas *et al.*, 1996–) and, since the size of the wild subspecies used here is small, the volume of the inner chamber does not need to be so large. For all of the above reasons, we reduced the nest box size for breeding wild rabbits to one quarter of the volume of those used for domesticated breeds, so that it would be approximately the volume of their breeding burrows.

In industrial rabbit breeding, the use of open nest boxes is common since they are usually located in controlled environments (Lebas *et al.*, 1996). However, wild rabbit farming often takes place in outdoor facilities (González-Redondo, 2001) and therefore nest boxes must be enclosed receptacles in order to maintain a constant temperature, at least during the first weeks of life. Therefore we designed the nest box with an entry tunnel leading to an inner nest chamber to provide thermal insulation. This nest box layout would also lead to a higher acceptance rate among the does since it is similar to their breeding burrows. In fact, it is better adapted to the species' ethology by replicating an underground burrow correlating to the doe's excavating behaviour prior to kindling (Myers, 1958; Gibb, 1993). This design also allows the doe to display her natural behaviour of closing up the entry tunnel with nesting material, as occurs in the wild, using earth to plug the breeding burrow entrance (Myers, 1958; Lloyd and McCowan, 1968). Since the does can be easily frightened in captivity and since they would systematically use the nest box as a refuge, we designed the entry tunnel to be sufficiently small to physically constrain the doe when she is inside it. This was done to prevent her from crushing the kits by bolting into the nest. It was also decided that the entry tunnel should be flush with the cage wall since in earlier prototypes in which the tunnel protruded into the cage we observed that 90% were damaged by gnawing (González-Redondo, 2000).

Nest box design and construction

Figure 1 shows the experimental nest box and its dimensions. We used 16-mm thick chipboard panels with no protective treatment, cut into the component parts and then screwed together. The nest consisted of one compact body structure with two compartments, the main part being a chamber. A removable plastic tray with eight drainage holes, each measuring 0.5 cm in diameter, was placed inside the chamber and it was here that the doe built the nest, littered and suckled. The other compartment of the nest box formed an access tunnel leading to the inner chamber. This tunnel had two functions: to shelter the inside of the nest box from the effects of low outside temperatures and cold draughts and, as mentioned above, to prevent the does from crushing their kits when bolting into the nest when alarmed. The nest box had a removable chipboard cover designed to facilitate inspection of the interior when monitoring and handling the litter.

The nest boxes were placed outside the cages, with the tunnel floor at the same level as the cage floor. The inner tray thus lay below the floor level of the cage, making it easier for the kits to return to the nest if they strayed outside.

Use of the nest box

In industrial rabbit breeding for meat production, nest boxes are supplied to the does 28 days after mating and they are withdrawn when the kits are three weeks old (Lebas *et al.*, 1996). In our case, the nest boxes were placed in the cages at the beginning of each mating season (mid January), so that

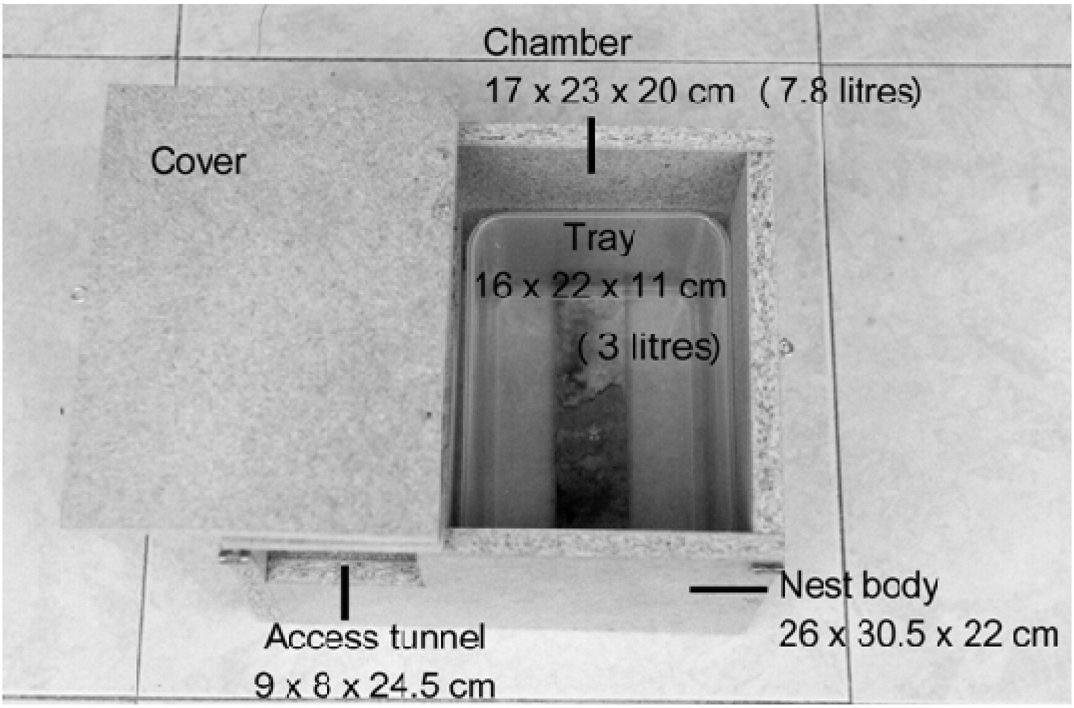

Figure 1: View and dimensions of the experimental nest box with the cover open. Inside the inner chamber can be seen the plastic tray destined to accommodate the litter.

the does could also use them as refuges to keep them stress-free and thus reduce the risk of ova losses and embryo re-absorptions, a frequent occurrence in wild rabbits especially when they are in stressful situations (Brambell and Mills, 1947; 1948). Each female stayed in the buck's cage for a period of seven days, after which she returned to her own cage until kindling. In the case of those females that gave birth, the next mating took place 30 days after kindling, when weaning occurred. Each litter stayed in the nest box for 37 days (30 days lactating and seven days in which the doe was mating in the buck's cage). Each nest box was used by the same doe during each successive breeding season.

The nesting material provided was cereal straw spread on the cage floor 28 days after mating. When the does started to display nest-making behaviour they took the straw into the nest boxes.

We used the data from 41 births obtained from three does caught in breeding burrows in the southern Iberian Peninsula when they were approximately 25 days old, and from 10 females born in cages from these wild-born females. To evaluate the degree of utilization of the nest box we recorded the number of cases in which the litter was born entirely inside the nest box, entirely outside the nest box (on the cage floor), and partly inside the nest box (some kits born inside and the rest outside the nest box). We recorded the kits' survival rate after the peribirth period, this period being regarded as the first 24 hours after the birth of the litter.

Statistical analysis

The statistical analysis was carried out with the Chi-square tests and Fisher's Exact test using the SPSS 9.0 program (SPSS Inc., 1999).

RESULTS

In 35 of the 41 litters (85.4%, $P<0.001$) the does gave birth to all of the kits inside the nest box. In four litters (9.7%) some kits were born inside the nest box and some outside, while in two litters (4.9%) all of the kits were born outside the nest box.

In 71.4% (n=25) of the births occurring with all the litter inside the nest box, one or more kits survived to lactation, whereas in the other 29.6% (n=10), they died around birth ($P<0.05$).

Table 1 shows the distribution of births according to the place chosen for littering as a function of the mother's origin: born in the wild or in cages.

During the usual handling operations at the experimental farm, it was never possible to observe the does outside the nest boxes while performing these operations. This was because the does used the nest boxes as a refuge when alarmed. Despite the intensive use of the nest boxes as a refuge, the does rarely soiled their interiors until the time of kindling. Only the tray placed in the inner chamber of the nest box became dirty during lactation, but being plastic it was easily cleaned and disinfected after each use, once the kits had been weaned.

Table 1: Distribution of frequency of birthing occurrence according to the doe's origin (born in the wild or born in cages).

Doe's origin	Birthing place		
	All the litter inside the nest box	One or more kits outside the nest box	Total
Born in the wild n (%)	18 (94.7)	1 (5.3)	19 (46.3)
Born in cages n (%)	17 (77.3)	5 (22.7)	22 (53.7)
Total n (%)	35 (85.4)	6 (14.6)	41 (100.0)

n: number of births. Fisher´s Exact test; exact bilateral probability: $P = 0.191$.

The only signs of damage observed in the nest boxes were the weathering of the wood caused by their being placed in an outdoor position and the damp stains caused by the does' urine and by the water spilled occasionally from the waterers, all of which caused the chipboard to warp.

DISCUSSION

Shape and elements of the nest box

The shape and components of the nest box under trial, with a chamber accessed by an entry tunnel emulating the shape of a breeding burrow (Mykytowycz, 1960; Lloyd and McCowan, 1968; Gibb, 1993), probably contributed to their effectiveness and to a high degree of utilization by promoting the satisfactory development of the species' typical nest-making behaviour. The lower position of the plastic tray inside the inner chamber relative to the level of the entry tunnel emulates the position of the chamber inside the breeding burrow relative to its mouth. The association between excavation and nest-making behaviour (González-Mariscal, 2001), is here supported by the observation, not quantified, that after kindling some does plugged up the entry tunnel with straw. This behaviour is similar to that of female rabbits in the wild when they block the mouth of the breeding burrow with earth (Myers, 1958).

Size of the inner chamber

The dimensions chosen for the inner chamber, conforming to the size of the chambers of breeding burrows (Lloyd and McCowan, 1968), as well as the small body size of the rabbits belonging to the subspecies used here (Soriguer, 1980; González-Redondo, 2003) and their small litter size (González-Redondo, 2003) when compared with other subspecies of wild rabbits (Soriguer, 1983) and other domesticated breeds used for meat production (Lebas *et al.*, 1996), must also have contributed to the does' acceptance of the experimental nest box as place to nest, litter, and suckle. The size of the nest box chamber must therefore be adapted to the type of rabbit that is meant to use it. In fact, in experiments with Australian wild rabbits, which are the largest in the world and weigh at least 50% more (Soriguer, 1980) than those used here, Mykytowycz (1959) and Parer *et al.* (1987) used nest box designs that were much larger than our nest boxes.

Nest box entrance design and its implications

The does' frequent use of the nest box as a refuge seemed to increase their calmness, probably contributing to the success of their breeding in cages (González-Redondo, 2003). Furthermore, the wild does' habit of bolting into the nest box could cause the death of kits by crushing, if the nest box design did not prevent this behaviour. To prevent domesticated does' kits from being crushed (Delaveau, 1979), some nest box models for meat breeding have a resting platform situated immediately inside the entrance, obliging the doe to step onto the platform before placing herself over the kits to suckle them in the depression adjacent to the platform (Camps, 1993; Lebas *et al.*, 1996). In our model we designed a narrow tunnel, forcing the does to enter the nest box chamber slowly, which might possibly have played a part in reducing the risk of kits deaths by crushing, although this was not quantified. Parer *et al.* (1987), in trials of breeding Australian wild rabbits in cages, showed that nest boxes provided with a narrow entrance produced a higher number of weaned kits.

In addition, the smaller cross section of the entry tunnel and its length favoured the plugging-up behaviour, using the straw provided as nesting material, displayed by some does after kindling.

The nest box as delivery and suckling place

Although all the does in the experiment used the nest box as a refuge, not all of them chose it as a delivery place. Therefore, the provision of nest boxes in the cages did not imply that all the wild does would necessarily accept them as a suitable delivery place. This is in agreement with what has been reported among domesticated does (Lebas *et al.*, 1996). However, the fact that in 85.4% of the births the whole litter was born inside the nest box and in an additional 9.7% some kits of the litter were born inside the nest box clearly shows a high utilization rate of the experimental nest box as a kindling place. The suitability is even more apparent if we consider that in almost three quarters of all the births inside the nest box, the does suckled their kits there during the lactation period. The proposed nest box is therefore suitable for both kindling and suckling in caged wild rabbits.

The suitability of the nest box design was also confirmed by the fact that the choice of the experimental nest box as kindling place was independent of whether the does were born in the wild, in breeding burrows or in captivity in nest boxes of the type tested here.

Wood as material for the construction of the nest box

The use of wood for the construction of nest boxes for wild rabbits may lead to their deterioration by both gnawing (González-Redondo, 2000) and by damp from urine and water spillages (González-Redondo, 1998). Furthermore, wood is not easily disinfected (Lebas *et al.*, 1996). These are the main reasons for avoiding the use of wood in the construction of rabbit housing and equipment (Lebas *et al.*, 1996), even in instances such as the subject of our study, where it was observed that the nest boxes were hardly soiled. The compact design of the nest boxes tested here, without angles or protrusions and their placement outside the cage prevented the does from gnawing at them either on the outside or the inside. In the model tested here limited soiling and no gnawing were observed, which therefore indicated that it is suitable for small-scale experimental use. However, if it were to be produced commercially, we propose the use of galvanized sheet metal for the walls of the nest box and plastic for the inner tray. Such nest boxes could be cleaned and disinfected easily and would also be much longer-lasting since they would not be damaged either by gnawing, urine or water spillages. However, since the thermal insulation capacity of metal is lower than that of wood (Vignote and Jiménez-Peris, 1996), it would be necessary to ascertain if a metal nest box ensured a good kit survival rate.

CONCLUSION

In conclusion, the proposed nest box was suitable for reproduction in wild rabbits from the southern Iberian Peninsula (*O. c. algirus*) since it met the animals' morphological and ethological requirements and was extensively utilized by the does as a kindling and suckling place for their litters.

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