Applied Animal Behaviour Science xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

journal homepage: www.elsevier.com/locate/applanim

Curtained nests facilitate settled nesting behaviour of laying hens in furnished cages

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ARTICLE INFO

Keywords:
Furnished cage
Nesting behaviour
Laying hen
Enclosure
Welfare

ABSTRACT

Egg location can be used to determine the nests that hens prefer, but it does not indicate whether the design of that nest satisfies a hen's nesting motivation. Hens that are satisfied with the nest resources exhibit characteristic settled nesting behaviour including less activity and longer sitting phases during the hour pre-lay. The current experiment compared the nesting behaviour of hens housed in large furnished cages given two surfaces either enclosed with plastic curtains or open. We hypothesized that hens with curtained nests would be more settled in their pre-laying behaviour than hens only provided with plastic nest surfaces. Furthermore, we hypothesized nest-naïve hens would benefit from having an enclosed nest added, demonstrating more settled nesting behaviour. After being conventionally reared, 996 pullets were placed in 24 furnished cages at week 15 (large: 41,296 cm^2; small: 20,880 cm^2). Each FC had two nests, one with a plastic mesh surface and one with a smooth plastic surface (3368 cm^2). Half of the FC had both nest surfaces enclosed with plastic red curtains (ENCL, n = 12) and half had two open surfaces (OPEN, n = 12). All FC were subsequently modified at week 28 to have one enclosed and one open surface. Egg location was recorded from the first egg to week 36. Focal hens were marked at week 20 and observed from week 22–24 and 31–33. Oviposition times were recorded during week 21, 27, 30, 36. Scan samples of sitting and aggressive behaviour were conducted during weeks 25–26 and 34–35. Hens with two curtained nests were less active ($P = 0.0219$), less aggressive ($P = 0.0055$), displaced less ($P = 0.0269$), and sat more ($P < 0.0001$) than hens with two OPEN nest surfaces. When hens from OPEN FCs were subsequently given an enclosed nest, the percentage of hens sitting increased ($P < 0.0001$) and the proportion of time spent active decreased ($P = 0.02$). Therefore, nest areas enclosed with simple plastic curtains facilitate the expression of more settled nesting behaviour, even for hens that had laid for three months without access to enclosed sites.

1. Introduction

Nesting has been widely established as a highly motivated behaviour pattern (Nicol, 2015; Weeks and Nicol, 2006). As such, the EU directive (European Commission, 1999), the New Zealand Code of Practice (National Animal Welfare Advisory Committee, 2012), and now the new Canadian Code of Practice for laying hens (National Farm Animal Care Council, 2017), have made it mandatory to provide a nest in all new laying hen housing systems. Furnished cages (FC) are designed to capitalize on the health and hygiene benefits of a conventional cage in addition to supporting motivated behaviour patterns by providing more space and furnishings. However, furnished cages have been criticized because they only include the bare minimum of resources: "objects that often bear a distant resemblance to the things that matter to hens, such as a place to nest, a perch and a place to dustbathe" (Compassion in World Farming, 2010). The nests in many designs of furnished cages are simply comprised of a surface that is different from the wire floor and surrounded by strips of plastic that form a curtained enclosure. Although nest use has been used as an indicator of welfare in furnished cages (Welfare Quality®, 2009), the suitability of nest resources may not only be judged on whether they are utilized by hens, but also on whether they allow a hen to express a fuller nesting behaviour repertoire (Hunniford et al., 2014).

One important attribute of nest sites is enclosure. Most hens prefer to lay their eggs in enclosed nests over open nests (Appleby and McRae, 1986), and will overcome obstacles to reach and enter enclosed nest "boxes" (e.g. Cooper and Appleby, 1996, 1997). Hens also show more signs of behavioural satisfaction – more "settled" forms of nesting behaviour – when entrances to nest boxes are screened with plastic curtains (Struelens et al., 2008). Most previous studies that have used pre-laying behaviour to investigate nest design have generally focused on small groups within pen environments (Ringgenberg et al., 2015a,b;

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https://doi.org/10.1016/j.applanim.2018.01.016
Received 22 September 2017; Received in revised form 4 January 2018; Accepted 19 January 2018
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Struelens et al., 2008). In contrast, the present experiment uses fully stocked furnished cages to explore the effect of providing curtained nests on satisfying nesting motivation.

In this experiment, we measured the behaviour of hens initially provided with two enclosed nests or open nests, and finally provided with one open and one enclosed nest. We assessed the extent to which hens showed "settled" pre-laying and nesting behaviour, which has been argued by many researchers to indicate that hens are motivationally satisfied by the design of their nest resources (Appleby, 1990; Appleby et al., 1993, Freire et al., 1996, Struelens et al., 2008, Nicol, 2015). Pre-laying behaviour is described as "settled" when hens perform fewer nest inspections in the searching phase (Freire et al., 1996; Nicol, 2015) and exhibit less exploratory behaviour (Zupan et al., 2008). Settled layers also perform fewer, but longer, bouts of sitting (e.g. Cronin et al., 2012) and spend more time at the final nest site (e.g. spending a longer duration in the nest; Freire et al., 1996) during the sitting phase that precedes oviposition. Hens experiencing frustration have been shown to be aggressive to each other (Duncan and Wood-Gush, 1971), so intra-specific aggression may be a supplementary indicator of nest space and quality. Additionally, the timing of oviposition may be delayed if hens are interrupted during nesting (Freire et al., 1997; Hughes et al., 1986) or prevented from accessing a nest (Reynard and Savory, 1999; Yue and Duncan, 2003).

The experiment had two phases. The first was used to assess the nesting behaviour of hens in two treatments: two nest surfaces (yellow mesh plastic and smooth red plastic) were either enclosed with curtains (ENCL) or left open (OPEN). We hypothesized that hens with access to curtained nests would express more settled nesting behaviour. In Phase Two, the cages were subsequently modified so that one set of curtains was removed from the ENCL FCs and one was added to the OPEN FCs, counter-balanced with nesting surface. The aim of this phase was to observe the effect of adding or removing a curtained area on nesting behaviour. We hypothesized that if providing enclosure is beneficial, then adding enclosure should increase the settled nesting behaviour of naïve birds compared with Phase 1. Hens' preferences for nest surface types in relation to enclosure determined from this experiment are reported elsewhere (Hunniford et al., 2018 *in press*).

2. Materials and methods

2.1. Animals and housing

Lohmann LSL-lite chicks were housed in conventional rearing cages (30″ × 28″ or 76.2 cm × 71.1 cm; 32 birds/cage) from one day of age (26.3 inches^2/bird or 169.3 cm^2/bird). At 15 weeks of age, pullets were randomly allocated to one of two sizes of furnished cage (n = 996) that were modified for this experiment (Farmer Automatic Enrichable; Clark Ag Systems, Caledonia, Ontario, Canada): large (41,296 cm^2; n = 12, 55 birds/cage; 750.8 cm^2/bird) and small (20,880 cm^2; n = 12, 28 birds/cage; 745.7 cm^2/bird).). The FCs were arranged in two banks of three tiers of cages in each of two rooms. Each furnished cage had white polyamide-coated wire floors and was equipped with perches that ran parallel to the feeder and nipple drinkers above a central auger (see Fig. 1). Lighting was set at 10 lx. Photoperiod was12L:12D at 18 weeks and changed to 14L:12D at 21 weeks for the remainder of the study. There was a 15-min sunrise after lights-on (07:30 h) and a 15-min sunset before lights-off (21:30 h). Animal use was approved by the University of Guelph Animal Care Committee (Animal Utilization Protocol #3387). Details of management for rearing and housing of hens are reported in Hunniford et al. (2018 *in press*).

2.2. Experimental design

Furnished cages were modified prior to housing the pullets at 15 weeks of age so that each had two nest areas (45.7 cm × 73.7 cm; 122.5 cm^2/bird in large FC, 240.6 cm^2/bird in small FC), one with a yellow plastic mesh surface and one with a red smooth plastic surface (Fig. 2). For the purposes of this experiment, there was no designated scratch area. In "Phase 1" of the experiment, half of the FC had both nest surfaces enclosed with red plastic curtains (ENCL) and half had both nest surfaces without curtains (OPEN). Each nest area was also bisected by an auger pipe and wire partition. The orientation of surface material within each cage was balanced, as was the distribution of treatments within the room and tiers (also see Hunniford et al., 2018 *in press*).

All FCs were modified when hens were 28 weeks of age. FC from the ENCL treatment had one set of curtains removed, and FC from the OPEN treatment had one set of curtains was added. Therefore, each FC had one enclosed nest and one open nest, which created a 2 × 2 factorial between previous treatment (ENCL vs. OPEN) and enclosed surface type (mesh vs. smooth). This part of the experiment is referred to as "Phase 2" where applicable. The modifications were balanced so that each enclosed surface was equally represented in each tier and cage size.

2.3. Data collection: group behaviour measures

2.3.1. Oviposition time

The afternoon before the observations began, clear plastic tubes (0.5″ or 1.27 cm diameter; polyester reinforced vinyl tubing) were installed in each cage so that the eggs that were laid on both the smooth and mesh mats were prevented from rolling onto the egg belt. This allowed identification of eggs laid on the mats versus those laid in the corner of the cage between the mat and the egg belt. The tubes were approximately 18″ (45.7 cm) in length; they were wide enough to act as an egg barrier but did not affect hen behaviour or hinder their entry into the mat area. Although it is possible that eggs stopped by the plastic tubes would have attracted hens to lay in the mat area, this same modification was made to all of the mat areas so it would not have affected the preference for a particular nest. The barriers were attached with three clear cable ties and positioned perpendicular to the solid side of the cage. Data collection began at 07:40 h when two observers, one on each side of the cage, counted and gathered the eggs laid in each of four locations (Fig. 1) every 20 min until 13:00 h. Observers collected the eggs caught by the barriers using wire hooks to avoid opening the cage, which would disturb the birds. All eggs were collected the night before data collection, and the number of cold eggs was noted in the first observation period (07:40 h) to eliminate eggs laid during the previous afternoon and over-night. Oviposition time was assessed four times (twice in Phase 1, twice in Phase 2) for a total of eight days of data collection (Table 1). The average time after lights-on that eggs were laid in each location (smooth mat and mesh mat only) within each cage was calculated to make comparisons between treatments and locations.

2.3.2. Sitting behaviour

Each FC was instantaneously scan sampled to count the number of hens sitting in different areas of the cage. Beginning when the lights were fully on (07:40 h), two trained observers (one on each side of the cage) counted the number of hens sitting in each of four locations in the cage (Fig. 1) and continued every 20 min until 13:00 h. Twelve cages were sampled during each scan, six per room. One full set of scans took two days, and was repeated the following week; this was done for both phases. Thus, there were four observation days in total per phase, and the replicates were averaged before subsequent analysis (Table 1).

2.3.3. Aggression and displacement behaviour

Similar to the instantaneous scans used to measure sitting behaviour, two observers were also trained to conduct an all-occurrences scan sample to quantify aggression and displacement behaviour. Four locations in the cage (Fig. 1) were observed, and all instances of displacements and aggressive threats/pecks (Table 2) were recorded

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