Applied Animal Behaviour Science xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

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

Location tracking of individual laying hens housed in aviaries with different litter substrates

Dana L.M. Campbell*,[1], Darrin M. Karcher, Janice M. Siegford

Department of Animal Science, Michigan State University, East Lansing, MI, USA

ARTICLE INFO

Article history:
Received 8 December 2015
Received in revised form 31 August 2016
Accepted 1 September 2016
Available online xxx

Keywords:
Behavior
Welfare
Aviary
Hen
Individual
Litter

ABSTRACT

The laying hen industry is phasing out conventional cages in favor of other housing systems such as the aviary – designed to improve hen welfare by providing additional space and resources including a litter area. However, we do not know whether individual hens significantly vary in the time they spend in different areas of these aviaries throughout the day, which may affect individual welfare. Further we do not know if providing different types of litter substrates affects hen use of the litter area. Using direct observations, the locations of 35 individual color-marked hens were tracked across a period of 3 days during mid lay of the production cycle. Hens were housed in 6 separate aviary pens (n = 144 hens/pen), each with one of 3 litter substrates on the open floor area (n = 2 pens/substrate: AstroTurf®, straw or wood shavings). Hens spent less time on AstroTurf® litter than on other types of litter ($P = 0.01$). Regardless of litter type, individual hens differed in time spent on litter with some hens never observed in the litter area (all $P < 0.02$). Individual hens spent different ($P < 0.05$) proportions of time in some other locations within the aviary, but these differences were not consistent across the 6 pens. No difference was seen in amount of time individual hens spent in the nest box (all $P \geq 0.15$). These results indicate resources such as the nest box may be a fixed demand for all hens but the extent of utilization for other aviary resources depends on the individual hen. These results have implications for individual hen welfare and add to understanding of individual system-use patterns, which can inform optimal system design and management practices.

1. Introduction

The laying hen industry, within North America and on a global scale, is gradually implementing new housing systems in response to consumer demands. One of these alternative systems is the aviary, which typically consists of a tiered cage structure containing perches, nest boxes, water, and feed on varying levels, and an open litter area on the floor. This system is designed to encourage behavior such as foraging and dust bathing, and thus meet hens' ethological needs (Cooper and Albentosa, 2003). Current aviary system design and management is based on the assumption all hens respond equally to the provided resources with similar impacts on welfare status between individuals. But studies are beginning to demonstrate individual differences in coping style in relation to environmental challenge, which are reflected in behavioral expression and underlying physiology (Ohl and Putman, 2014). Thus, to accurately evaluate whether the aviary system adequately provides resources that improve the welfare of all hens, we must consider hen behavior at the individual level (Siegford et al., 2016).

Early research of hens in indoor non-cage systems (aviaries and percheries) showed differences in behavioral time budgets and distribution of individual hens corresponding with differences in individual welfare status (Hansen, 1994). Highly aggressive birds had better plumage, and both drank and food-pecked more than those birds identified as more submissive, who in turn spent more time either fleeing from aggressive birds or resting (Hansen, 1994). In a further study observing hens in a large perchery system, 66.2% of observed individual hens used approximately 85% of the vertical space and 80% of the pen length available to them (Carmichael et al., 1999). About 70% of these focal hens were observed on the litter area although they only used 50% of the total litter space available to them (Carmichael et al., 1999). Similarly, studies using radio-frequency identification (RFID) tracking technology with outdoor free-range systems, have shown individual hens vary significantly

* Corresponding author at: School of Environmental and Rural Science, The Woolshed, University of New England, Armidale, NSW 2351, Australia.
E-mail addresses: danaleigh.m.campbell@gmail.com, dana.campbell@csiro.au (D.L.M. Campbell).
[1] Now at: School of Environmental and Rural Science, University of New England, and CSIRO, Armidale, NSW 2351, Australia.

http://dx.doi.org/10.1016/j.applanim.2016.09.001
0168-1591/

in their use of the outdoor range, with hens accessing this resource frequently, infrequently, or not at all (Campbell et al., 2016a; Richards et al., 2011). Laboratory behavioral tests showed hens that chose to spend less or no time outdoors also presented higher fear levels and elevated stress responses than hens regularly using the range (Hartcher et al., 2016; Hernandez et al., 2014). But to date, there are no studies that have tracked individual-level hen placement throughout the day within current commercial-style aviaries to determine whether individuals use all areas of the aviary equally, including the litter resource.

A suitable litter substrate for dust bathing and foraging needs to be friable, of adequate depth, and comprise small particles for tossing onto feathers during bathing (Scholz et al., 2010; Moesta et al., 2008). Recent laboratory-based research has shown that depending on the type of litter substrate available in cages, hens varied in expression of dust bathing and foraging (Alvino et al., 2013; Scholz et al., 2010). Hens preferred to dust bathe in sand over new wood shavings (van Liere et al., 1990), lignocellulose (soft wood pellets) over wood shavings, food pellets and artificial plastic turf – 'Astroturf' (Scholz et al., 2010) and sand over Astroturf® (Alvino et al., 2013), but preferred Astroturf over wire floor, specifically for dust bathing though overall use of the floor area did not differ (Merrill et al., 2006). Hens preferred foraging in food particles over wood shavings, lignocellulose (soft wood pellets) and Astroturf (Scholz et al., 2010). Comparisons between commercial furnished and barn or aviary floor-litter based systems, showed a suitable aviary or barn litter substrate can encourage complete dust bathing bouts (de Jong et al., 2005), and lower feather lipid levels were found on the harder-to-reach back feathers (Blatchford et al., 2013). However, there has been no research investigating the impacts of different litter substrates on visitation rates of individual hens to the floor litter areas in aviary systems.

The objective of this study was to track the locations of individually-marked hens housed in aviary pens with 3 different litter substrates. Within US commercial aviary systems, wood shavings and straw are most commonly used as initial floor substrates though some producers start with bare concrete, relying on the accumulation of manure, feed and feathers to form a litter substrate. Astroturf pads are currently used in commercial aviary nest boxes and in both nest boxes and scratch areas within furnished systems but no research to date, has trialed their use as a floor litter substrate in aviaries. The research hypothesis was that individual hens would vary in their diurnal distribution throughout the tiered pens and that frequency of visits to the litter area would depend on the type of litter substrate available.

2. Materials and methods

2.1. Ethical statement

All research was approved by the Michigan State University Institutional Animal Care and Use Committee prior to the start of data collection.

2.2. Animals and housing

Subjects were 35 Bovans White laying hens selected from within groups of hens housed in commercial-style aviaries (NATURA60, Big Dutchman, Holland, MI, USA) with different litter substrates at the Michigan State University Laying Hen Facility. Cage-reared pullets were obtained from a commercial producer and at population (17 weeks of age), 144 hens were placed into each pen. As per standard commercial practice, birds were not replaced following mortality. Within the facility, there were 4 aviary rooms (each room 20 m L × 4.3 m W) that each held 4 aviary pens (343 cm L × 244 cm W × 230 cm H). Each pen contained a tiered 3-level structure with feed troughs, water nipples, perches, nest boxes on the upper level and access to an open litter area via a door on the lower level (Fig. 1). One outer perch was situated in front of the lower level door above the litter area (Fig. 1). Hens in each aviary pen were provided 1,131.88 cm^2 of useable floor area per hen, comprising of 550.69 cm^2/hen of tiered pen space (including both wire mesh flooring and metal ledges) and 305 cm^2/hen of open litter area in front of the pen. Each hen had 5.08 cm of feeder space, water access at a density of 9 hens/nipple drinker, 13.55 cm of perch space, and 83.80 cm^2 of nest box space. The aviary doors on the lower tier opened at 10:00 (time zone: EST), allowing birds access to the floor litter area after the majority of eggs were expected to have been laid. The doors closed again at 01:00. Laying hens had access to water *ad libitum* and were fed commercial diets formulated to maximize productivity *via* 3 feedings and 4 stimulations (i.e., the feed belt ran only for a few seconds to attract hens' attention) staggered throughout the day. The facility was tunnel ventilated and maintained at 21 °C. The lights within the facility (AgriShift® PL 12 W dimmable LED lights (ONCE, Inc., Plymouth, MN, USA)) came on at 05:00 beginning with a 5-min sunrise sequence and turned off with a 35-min sunset beginning at 20:30. Manure removal from the tiered pens occurred twice weekly *via* belts under the wire-mesh flooring on each level.

2.3. Target pens

Three different types of litter substrate (n = 4 pens per litter type: straw, wood shavings (hereafter shavings), and AstroTurf® NXT mats (GrassWorx™ St Louis, MO, USA)) were initially placed on the floor of the litter area prior to hens' first access to the litter area at 25 weeks (~87% production). AstroTurf® is plastic artificial turf that is often used in nest boxes and other models of the turf have previously been evaluated with laying hens in furnished cage systems (*e.g.*, Alvino et al., 2013; Scholz et al., 2010). The location of the pen within a room that was selected for a particular litter was balanced across all rooms (*i.e.*, so that each litter type was present in each end or middle pen location). The concrete floor in the open litter areas of the remaining 4 of the 16 total pens was left bare. For all litter treatments, subsequent substrate build up, occurring from deposition of feces, feathers, and feed in the open litter area, was untouched throughout the flock cycle. The six pens selected for direct observations were spread across the 4 aviary rooms, with 2 pens for each litter substrate (3 pens = nearest the door, 3 pens = furthest from the door: n = 6 total). Hens in pens located between these two end locations could not be observed, particularly in the tiered parts of the aviary, without disturbing hens in the end locations. Six pens were selected as the number of pens that could be observed within 15-min timeslots to avoid any time-of-day confounds with hen locations, thus, only those pens where an initial substrate was added were observed (*i.e.*, no pens starting with bare concrete were observed).

2.4. Focal hens and direct observations

Four days prior to the start of observation, 6 focal hens were selected from each of the target pens. Initially, 12 hens were randomly caught from each pen and a Welfare Quality® assessment (Welfare Quality®, 2009) was conducted on each hen, measuring a range of basic health parameters (*i.e.*, beak condition, comb abnormalities, comb wounds, enlarged crop, enteritis, feather condition, foot condition, keel damage, parasites, respiratory difficulties, skin lesions, toe damage, and toenail length). Following the assessment of the 12 hens/pen, 6 focal hens that were in similar physical condition were selected from that pen for individual observation. To enable visual identification of individuals, each focal bird was then

Please cite this article in press as: Campbell, D.L.M., et al., Location tracking of individual laying hens housed in aviaries with different litter substrates. Appl. Anim. Behav. Sci. (2016), http://dx.doi.org/10.1016/j.applanim.2016.09.001