Applied Animal Behaviour Science xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

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

Use of space by domestic chicks housed in complex aviaries

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ARTICLE INFO

Article history:
Received 20 October 2015
Received in revised form 29 May 2016
Accepted 30 May 2016
Available online xxx

Keywords:
Gallus gallus domesticus
Laying hen
Chicks
Locomotion
Aviary
Incline

ABSTRACT

To improve the understanding of the development of locomotor capacity in layer hens, we measured how female laying hen chicks (n = 120) of four different strains (LSL-lite, Hyline Brown, Dekalb White, Lohmann Brown; 3 groups of 10 chicks per line) utilized the ground, the air, elevated horizontal (platforms and perches) and inclined surfaces (ramps and ladders) in an aviary until 9 weeks of age. We used infra-red video recordings to perform all-occurrences sampling of locomotive behavioural and perching events that occurred on the ground—where bedding material, food and water were provided, in the air, and on elevated horizontal and inclined surfaces within weekly 30-min sampling periods. Chicks preferred level ground during the first week of life compared to weeks 5–9 ($P < 0.0001$) and performed 52% of all behavioural events in this section. Elevated surface use began at 2 weeks of age and increased over time ($P = 0.003$), where most behaviour was performed in S2 (45% of all events). Chicks preferred horizontal to inclined surfaces, which were used from weeks 2–5 with maximum use occurring during weeks 2 and 3. Lohmann LSL chicks used the space above the ground most frequently ($P = 0.05$) and performed more aerial ascent/descent behaviour than other lines ($P < 0.0001$). Overall activity levels declined with age ($P < 0.0001$). In summary layer chicks almost exclusively locomoted on the ground but utilized elevated horizontal surfaces (perch, first platform) as early as 2 weeks. These results provide information for improving space use in rearing aviaries by introducing lower perches, platforms and ramps/ladders to accommodate age-dependent locomotor abilities.

1. Introduction

For most animals, the ability to move from one place to another is essential for survival (Higham, 2007). Precocial birds, such as the chicken, are covered in down feathers, open their eyes whilst hatching and predominantly rely on their mother for thermoregulation (Collias, 1952; King and Farner, 1961). Within hours after hatching, however, they are able to run and walk on planar (two-dimensional) and horizontal ground and display independent activity (Muir et al., 1996; Schaller and Elmen, 1962).

Locomotion in caged systems is often restricted to two-dimensional movements on horizontal and planar surfaces. However, a natural environment with complex vegetation and topography includes three-dimensional space and inclined surfaces, thereby allowing for locomotion of different types in all three dimensions (Higham and Russell, 2010). The third dimension complicates movement by making space much larger and requiring more intricate processing and interpretation of information (Birn-Jeffery and Higham, 2014). In addition, this dimension brings the added challenge of having to recruit the muscles to perform work against gravity (Roberts et al., 1997) and control motion during descent when the leg muscles actively lengthen in eccentric contractions (van Griethuijsen and Trimmer, 2009).

There is a general effect of body size upon the use of inclined surfaces in the environment. Many animals will move up slopes, climb steep branches, or navigate in the air to reach areas above the ground in order to protect themselves from predators, aggressors, and unpleasant climatic conditions or to reach a high value food resource (Hill and Hawkes, 1983; Kraft et al., 2014; Marzluff, 1988; Stewart et al., 2007). Terrestrial bipedal ground birds, such as the chicken, navigate elevated surfaces and aerial space mainly to escape predators (Drovetski, 1996; Tobalske and Dial, 2000;

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http://dx.doi.org/10.1016/j.applanim.2016.05.024
0168-1591/

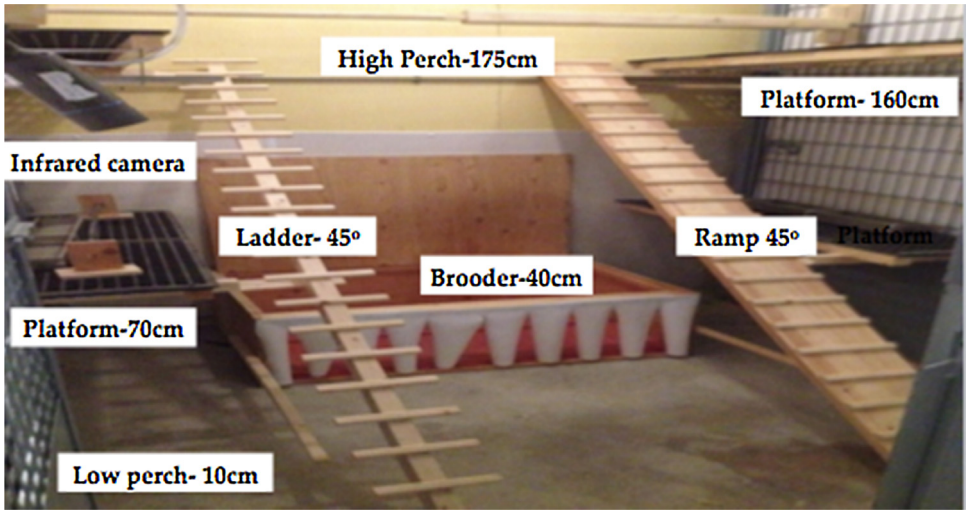

Fig. 1. Each experimental aviary provided a dark brooder, two platforms at each of two heights, a ramp and ladder between the ground and these platforms and two low perches. An infrared Samsung video camera was fixed overhead.

Dial, 2003). The safety risk associated with acquiring high valued resources above the ground could result in injuries and/or death, especially as a consequence of falling (Hewlett et al., 1986).

For chicks to successfully navigate and minimize the risks associated with using the third dimension, they must first obtain locomotor stability and equilibrium ability on the ground, a process which may take up to seven days post-hatch (Muir et al., 1996; Muir, 2000). Performing exaggerated locomotive behaviours (play) may aid in refining the chicks' locomotor abilities. However, such behaviour is best performed on a large flat surface, not in a complex three-dimensional system (Wells and Turnquist, 2001). Successful foraging abilities are similarly developed on the ground during the first week of life, a process that is highly dependent on social interactions with the mother hen or same-age chicks in commercial settings (Bourgon et al., 2014; Collias, 1952; Gajdon et al., 2001; Suboski and Bartashunas, 1984). Chicks also rely on the mother hen for thermoregulation and protection, which requires remaining in close proximity to her for the first week of life (King and Farner, 1961; McBride et al., 1969; Sherry, 1981). In the second week of life, chicks begin to increase their distance from the mother hen and to explore the third dimension (Muir et al., 1996; Wood-Gush, 1971).

When housing commercial hens for egg production, there are three common rearing systems used: cages (conventional or furnished), predominately two-dimensional non-cage floor systems, and three-dimensional aviary systems. These systems differ in their environmental complexity in ascending order, particularly in how much freedom of locomotion in the horizontal and vertical dimensions that they offer to the birds. Complex environments allow for chicks to express a full range of locomotion; however, they can also increase the risk of bone damage in adult laying hens (up to 80% in adult birds; Harlander-Matauschek et al., 2015; Wilkins et al., 2004), which may be detrimental to their welfare. One overarching goal of our research is to improve the understanding of how to better design and manage non-cage systems. The present research is the first step in revealing how chick's locomote when given full access to the third dimension from one day of age onwards. Previously it has been shown how juveniles of wild-type species utilize the third dimension to engage in escape behaviour (Jackson and Dial, 2011), however, the goal in the current study was to measure locomotive behaviour in the third dimension of non-distressed chicks.

Therefore, we measured the chicks' use of horizontal surfaces (ground floor and elevated surfaces) and inclined surfaces (ladders and ramps) within a complex three-dimensional environment (aviary) until 9 weeks of age. To examine potential differences in level and inclined locomotor performance, we hypothesized the following: (1) chicks would locomote more frequently on the ground level than on elevated surfaces because members of the phasianidae family are typically terrestrial (Tobalske and Dial, 2000), (2) chicks would locomote more frequently on horizontal surfaces than on inclined surfaces due to being initially top heavy (Berger et al., 2007), and (3) there would be age and strain dependent differences in the chicks' preferences for (a) locomotion on horizontal ground versus horizontal elevated surfaces and (b) for level versus incline locomotion. Based on Jackson et al. (2009), we expected that with increasing age and experience there would be an increase in three-dimensional use (air, horizontal elevated and inclined surfaces) due to maturation of morphological characteristics required to properly utilize the third-dimension.

2. Materials and methods

2.1. Ethical approval

This study was approved by the University of Guelph Animal Care Committee (Animal User Protocol Number 2501) prior to the chicks being hatched.

2.2. Animals and housing

This study involved the use of 30 female laying hen chicks each of Hyline Brown, Lohmann Brown, Lohmann LSL Lite, and Dekalb White (n = 120) from hatch until 9 weeks of age, whose average weights at 9 weeks were 888, 954, 815, and 776 g, respectively. The chicks were individually identified at one day of age with plastic neck-tags printed with consecutive numbers (5 × 2 cm; Ketchum, Brockville, Canada) and attached using 5-cm fasteners. They were placed into 12 identical aviary pens (10 chicks of the same line per pen) at the Arkell Research Station in Guelph Ontario, Canada. Researchers were blinded to what line of laying hen strain was in which pen to avoid biased results. Each pen (Fig. 1) (183 L × 244 W × 290 H cm) contained four elevated platforms, two on each side (122 × 31 at 70 and 160 cm above ground), with a lad-

Please cite this article in press as: Kozak, M., et al., Use of space by domestic chicks housed in complex aviaries. Appl. Anim. Behav. Sci. (2016), http://dx.doi.org/10.1016/j.applanim.2016.05.024