SEQUENTIAL STRUCTURE OF BEHAVIOR OF LAYING HENS IN AN ENRICHED ENVIRONMENT

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Introduction

Laying hen houses have changed dramatically from initially extensive and small to large-scale intensive indoor battery cage systems, producing more eggs at low cost (FAWC, 1997). Concerns over the welfare of caged hens arises in 2 general areas: first, that the barren environment within a cage prevents the performance of ethological needs of hens (Yue and Duncan, 2003) and, second, that the small amount of space in a cage imposes severe restriction to the general freedom of movement (Baxter, 1994).

It seems that a systematic approach by the translation of behavioral needs of laying hens into welfare-based design parameters for laying hen-housing systems has received modest attention (Schwabenbauer, 1999). The welfare concept has to be translated via behavioral needs into quantifiable behavioral parameters that can be used as inputs to model a housing system and to assess minimal space and facility requirements. Therefore, definition, prioritization, and measurement of behavioral needs and sequence are crucial for the design.

Quantification of sequences of events of various behaviors may yield insights as to how hens distribute their time over various resources and what their behavioral priorities are. These properties of hen behavior will be used to design hen-housing systems, based on behavioral needs, behavioral priorities, needed facilities, and space allocations. The aim of this paper was to estimate quantify sequential organization of a behavior. To assess the behavioral sequential organization the first-order transition matrix were analyzed, and percent-ages of behavioral occurrences at different places in the pen were calculated. The results of these analyses will provide the input parameters for a simulation model, which can then be used as a tool to optimize fulfillment of hen needs in interaction with environmental conditions for laying hen houses in the egg industry.

Materials and Methods

Stock, Housing, and Environment

Stock. Twenty, 18-wk-old, beak intact, commercial, ISA Brown laying pullets were acclimatized in the pen for 10 wk. All were laying at the end of the 10-wk period. ***Pen.*** A pen (Figure 1) providing nest boxes, drinkers, feeders, perches, sand, and wood shavings was designed. The dimension of the pen was 6 ×4 ×3 m (length, width, and height). The pen was divided into 12 floor segments of 1 ×1.75 m each so that each commodity was provided in 2 diagonally located segments and a corridor. ***Environment.*** The hens were on a light-dark cycle of 10L:14D (light from 0800 to 1800 h; dark from 1800 to 0800 h) with a 60-lx (at bulb level) white lamp. A light length of 10 h was provided to simulate natural day length for hens. A 15-lx (at bulb level) lamp was used in the dark period to support the video recording. The temperature was maintained at 19 ±2^{o}C throughout the experiment.

Feed and Feeding

Hens were fed ad libitum on commercial layers pellets (protein, 16%; fat, 6.2%; energy, 2,825 kcal/kg). The feed was administered in 6 feeders once each day (0900 to 1100 h) after the cleaning and before the start of next 24 h of observation.

Data Collection and Analysis

Data Collection. Video recordings of behaviors started at 28 wk of age when hens were in full egg production. Observations were made by means of a time-lapse video recorder throughout the experimental period of 10 d. For identification purposes hens were marked with a distinct black sign on a white tag on their backs. Out of 20 hens, 5 hens were randomly selected based on recognition of a tag's sign for 5 alternate days for the purpose of behavioral analyses. Software, Observer 4.1 was used for behavioral re-cording.

Data Analysis. The start and end times of behavioral events and the location were recorded. A 14x 14 matrix of probability of frequencies of the first-order transition between behaviors was calculated. The matrix was corrected for so called structural zeroes (de Vries et al., 1993). The standardized residuals were calculated with MATMAN program. Only positive transitions with a q values greater than or equal to 2 were regarded as transition (de Vries et al., 1993). The standardized residuals were used to analyze the direction of transition of behaviors. The transition directions were visualized with the help of arrows and circles in which arrows showed the q values, and radius of the circle showed the frequency of the behavior (Schouten, 1986).

Results

Overall Time Budget of Behaviors

In designing a facility and space use, it is necessary to know how intensive given commodities or facilities are used. The major part of the time budget, around 97%, was spent on resting, nest use, perching, still, feeding, walking, preening, and drinking, and around 2% was spent on other behaviors. Approximately 1% of the time budget was covered by unobserved and not identifiable behaviors.

Behavioral Sequential Analysis

To obtain information on how to locate facilities and the corridor, the transition between behaviors must be assessed. Figure 2 shows the positive first-order transition of behaviors with standardized residuals greater than or equal to 2. Thirteen hundred transitions were observed. Fifty-three cells contained positive transitions with 33 being significant. Preferred transitions could be observed from nesting to drinking to feeding, feeding to drinking to feeding, feeding to escape to perching, or preening to resting to preening, which had residual values greater than 10. Other behavioral loops could be observed, such as resting to wing stretching to dust bathing to resting, feeding to attack to feeding/drinking, resting to preening to dust bathing to resting, or perching to wing flapping to preening, which had residual values less than 10.

Discussion

Time spent (% of the day) on different behaviors may provide an overview of facilities and space allocation in a hen house. In a well-designed housing environment, hens should be able to show a similar time budget. We demonstrated that time spent (% of the day) on behaviors, except still and walking, were lower than those reported in the literature (Rudkin and Stewart, 2003). Lack of experience in dust bathing, perching, or scratching, because they were raised in a standard hatchery environment, could be a reason for reduction in the percentage of time spent (Vestergaard and Lisborg, 1993). Feeders and drinkers provide above-normal stimuli in a cage environment and attract behavioral attention, whereas under our conditions other facilities shared the behavioral attention. This could be a primary reason for the relatively lower percentage of drinking and feeding behaviors in our study. The time spent (% of the day) on still was higher than reported by Bubier (1996). Hens spent a similar amount of time on walking, as reported by Bubier (1996). The immediate availability of single and double nest boxes in our experimental arena could be a reason for the higher percentage of nesting behavior in our findings.

Hens show a sequence and behavioral pathways in use of the given facilities. For example hens show a sequence from feeding to drinking to feeding (Figure 2), which have also been observed in other animals (Metz, 1975). This finding may suggest that in a hen housing system, drinkers and feeders should be installed closely to meet such a need of the hens. A hen house should allow hens to show the preferred behavioral pathways. Interruptions in the preferred behavioral pathways can lead to frustration and that can be a welfare issue. Highly preferred sequential ordering means little flexibility and thus such chains of behavior should be allowed with priority in the new housing environment.

In conclusion, the behavioral sequence shows how laying hens spend time in meeting their biological needs in an environment where no serious restrictions are imposed. It provides a baseline for a behavior- based design of laying hen houses.

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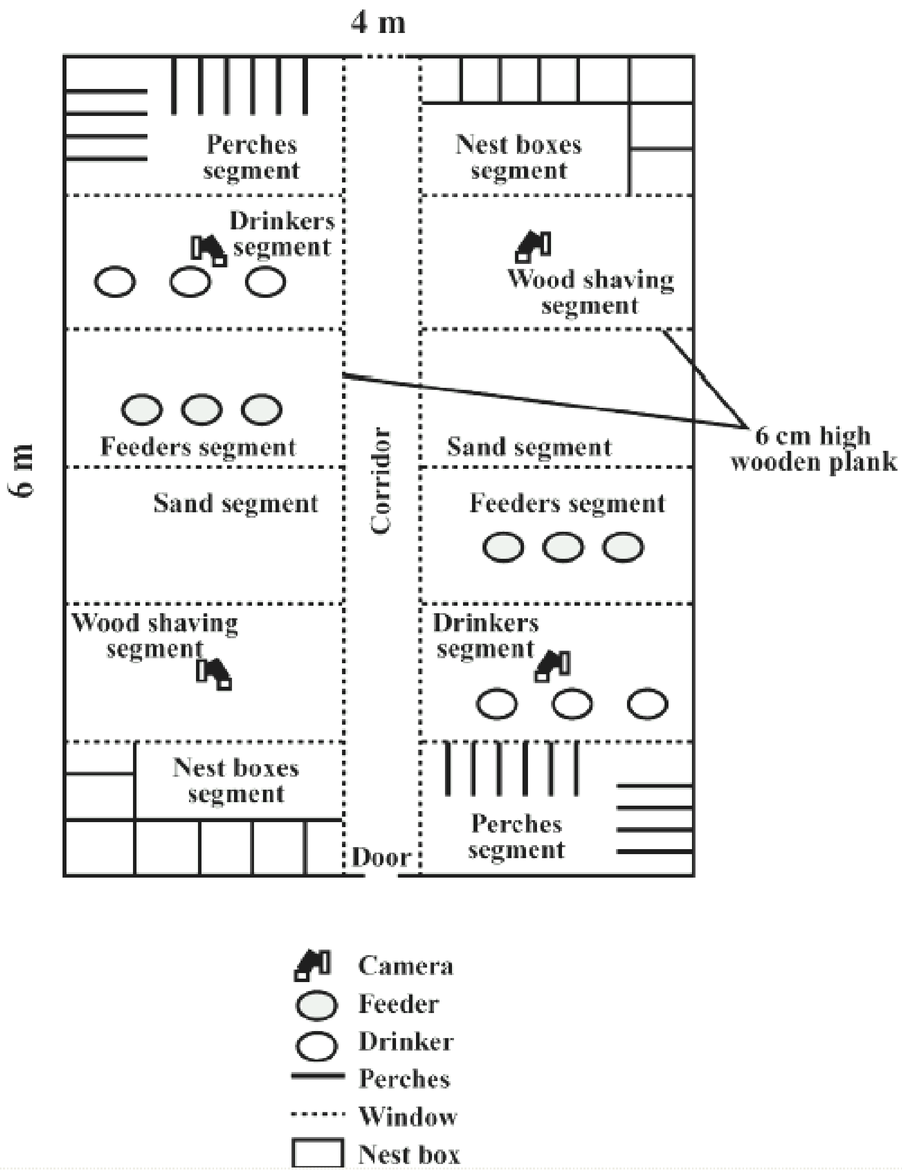

Figure 1. Layout of the pen.

Figure 2. Positive first-order transition with standardized residuals greater than or equal to 2. The radius of the circles reflects the frequency of behavior as a percentage of the total frequency. NES = nesting, PRE = preening, WFL = wing flapping, FRU = feather ruffling, WST = wing stretching, DBA = dust bathing, SCR = scratching, DRN = drinking, EAT = feeding, FLY = flying, Per = perching, ATK = attack, ESC = escape, RST = resting.