Applied Animal Behaviour Science xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

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

# Both feather peckers and victims are more asymmetrical than control hens

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ARTICLE INFO

*Keywords:*
Fluctuating asymmetry
Feather pecking
Skeletal traits
Laying hen
Development

ABSTRACT

Feather pecking is the major welfare issue facing the egg farming industry worldwide. Previous research has found a relationship between cannibalistic behaviour, fluctuating asymmetry of bilateral traits (FA) and body weight in laying hens. As cannibalism is linked to severe feather pecking, it could be suggested that a relationship between feather pecking, FA and body weight also exists. The purpose of this study was to analyse the association between feather pecking behaviour and a) FA, b) body weight and c) comb size in laying hens. Sixty-four laying hens were categorised as feather peckers, victims or control hens based on weekly performance of feather pecking behaviour from age 0–23 weeks and plumage condition at age 23 weeks. After culling at 23 weeks of age, the lengths of ulna, tarsus and middle toe as well as the widths of tarsus and hock were measured twice in each side. Each trait was tested for repeatability, directional asymmetry and antisymmetry. Only the three lengths were considered appropriate for analyses of composite and single-trait FA. Control hens displayed less composite FA ($P = 0.0005$) and less FA of ulna ($P = 0.0001$) than feather peckers and victims. Tarsus asymmetry differed between all categories with victims displaying most, control hens least and feather peckers intermediate levels of asymmetry ($P < 0.0001$). Victims were also lighter in body weight compared to control hens and feather peckers ($P = 0.043$). No difference was found in comb size between the three categories ($P = 0.1$). The results suggest that feather peckers and victims were exposed to similar levels of negative experiences, causing developmental instability, whereas control hens were less negatively affected than both feather peckers and victims during early life.

## 1. Introduction

Feather pecking, the forceful pulling of feathers from conspecifics, is one of the major welfare issues faced by the egg-farming industry worldwide. It has been associated with pain (Gentle and Hunter, 1990), increased fear (Vestergaard et al., 1993; Jones et al., 1995) and cannibalism (Schaible et al., 1947; Savory and Mann, 1997). Furthermore, feather pecking may result in economic disadvantages due to the decrease in the feed conversion ratio of the flock as the damage to feathers reduces the insulation power of the plumage (Herremans et al., 1989; Blokhuis and van der Haar, 1992). Performance of feather pecking behaviour has been shown to vary between individuals of the flock with some hens being predominantly peckers and others predominantly victims (McAdie and Keeling, 2000). Cloutier and Newberry (2002) found that the victims of cannibalism tended to have lower body weight and were more asymmetrical in bilateral traits than the rest of the flock. In addition, both victims and cannibals had more asymmetrical wing lengths compared to control hens (Yngvesson and Keeling, 2001). As cannibalism is linked to severe feather pecking (Schaible et al., 1947; Savory and Mann, 1997; Lambton et al., 2015), it seems likely that the relationship between feather pecking behaviour and asymmetry could be similar to the relationship between cannibalistic behaviour and asymmetry.

Deviation from perfect symmetry in bilateral traits can be a result of developmental instability which is influenced by both genetic and environmental stress (Klingenberg, 2003; Tuyttens, 2003). The most commonly used method for measuring developmental instability is fluctuating asymmetry (FA), which can be defined as the randomly directed deviations (difference between left and right side) from perfect symmetry in bilateral traits that would have been expected if a perfect control of the morphological development had occurred (van Dongen et al., 1999a; Tuyttens, 2003; Knierim et al., 2007).

FA has been suggested as a potential integrated welfare indicator reflecting the animal's ability to cope with the sum of challenges that have affected the individual during its development and can, therefore, be used as a measure of welfare and stress (Møller and Swaddle, 1997; Tuyttens, 2003; Knierim et al., 2007). Fertilised eggs from hens injected with corticosterone have elevated embryonic mortality and resulting

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http://dx.doi.org/10.1016/j.applanim.2017.05.022
Received 22 March 2017; Received in revised form 19 May 2017; Accepted 28 May 2017

chicks present increased FA in tarsus length (Eriksen et al., 2003). Also, eight-week-old chicks that are introduced to an unfamiliar group once a week have larger FA of the middle toe length compared to chicks not exposed to regrouping (Prieto et al., 2014). Hens laying eggs with shell colour abnormalities or internal inclusion present larger degree of FA compared to hens laying normal eggs (Campo and Prieto, 2010). Similarly, hens with poor plumage condition have larger FA of the tarsus width compared to hens with good plumage (Campo and Prieto, 2009), and victims of vent pecking have larger FA of the middle toe length (Campo et al., 2008). In addition, hens reared with classical music as auditory enrichment showed indicators of reduced stress as seen by reduced H/L ratio and present lower FA of the wing and tarsus (Davila et al., 2011). Thus, FA can be a good indicator of stress during early life. However, despite the wide relevance of feather pecking to both economy and laying hen welfare, no previous research has investigated the relationship between FA and laying hens' individual feather pecking profile as feather peckers, victims or control hens.

The aim of this study was to test the hypothesis that feather peckers, victims of feather pecking and control hens present differences in FA, body weight and comb size. We predicted that feather peckers would be more asymmetrical than victims and control hens and that victims would have lower body weight and smaller comb size compared to feather peckers and control hens.

## 2. Materials and methods

### 2.1. Subjects and housing

The present study included 90 non-beak trimmed Lohmann Tradition laying hens (*Gallus gallus domesticus*). These hens were also part of a larger study on the effects of brooders on injurious pecking (Jensen et al., 2006). The day-old chicks were randomly assigned to six pens of 15 birds each and reared with access to conventional heating lamps during the first five weeks of age. The pens had a floor area of 150 cm × 170 cm and a stocking density of 5.9 hens/$m^2$. Litter was provided as wood shavings, and the pens were fitted with two perches, 170 cm long each, at a height of 40 cm. The hens had *ad libitum* access to feed and water, according to recommendations from suppliers of commercial layers, i.e. starter feed from 0 to 6 weeks, grower feed from 6 to 15 weeks and finally layer feed from week 15 onwards. In addition to the feed, the birds were provided with *ad libitum* supplement of whole grain barley and crushed shells. The hens were also given access to grit from week 14. Each pen contained three adjacent nest boxes measuring 30 cm × 28 cm with wood shavings as nesting material. The light schedule was kept constant at 14 h of light (06:00–20:00 h) with a light intensity of 70 lx. The temperature was kept at 18 °C ( ± 1). Each hen was marked with a coloured ring on the leg making the unique identification of each hen per pen possible.

### 2.2. Feather pecking profiling

Feather pecking activity was observed continuously for 30 min per pen once a week from week 0–23 using all occurrence sampling (Jensen et al., 2006). Only non-aggressive pecks directed at feathered parts of the body were recorded. Pecking was classified as gentle feather pecking: without the removal of target feathers and no reactions of the target bird; and severe feather pecking: feathers removed by pulling and/or target bird reacted to the peck by abruptly moving away (Bilcik and Keeling 2000). Bouts of feather pecking were classified as repeated pecks to the same individual with an interval of < 5 s between each peck. At the end of the experiment, on week 23, the level of plumage damage per hen was determined using the detailed scoring method described in Bilcik and Keeling (1999). This method scores the plumage condition in 11 body parts with each body part being given a score from 0 (no damage) to 5 (worst damage). Thus, the maximum total plumage damage score is 55, corresponding to a completely naked hen. The feather pecking profile of each hen, either a performer of feather pecking (feather pecker), a victim of feather pecking or a control hen (neither pecker nor victim), was categorised based on the feather pecking activity and total plumage scores of each hen. The classification of hens in these three categories was done according to the following criteria:

- Feather peckers were hens that performed a total of ≥19 severe feather pecking bouts, had a total plumage damage score of ≤4 and a maximum plumage damage score of 1 in each single body part.
- Victims were hens that performed ≤6 severe feather pecking bouts, had a total plumage damage score of ≥7 and a minimum of one body part with plumage damage score 3 or higher.
- Control birds were hens that performed ≤6 severe feather pecking bouts, had a total plumage damage score of ≤4 and a maximum plumage damage score of 1 in each single body part.

**Table 1**
Mean (min-max) score for plumage damage condition and number of feather pecking bouts observed for each of the feather pecking categories.

| | Number of birds | Plumage condition | Feather pecking bouts |
|---|---|---|---|
| Feather peckers | 21 | 3.0 (0–4) | 68.3 (19–197) |
| Victims | 23 | 10.8 (7–16) | 2.8 (0–6) |
| Control | 20 | 1.5 (0–4) | 1.7 (0–4) |

These criteria resulted in 21 feather peckers, 23 victims and 20 control hens, giving a total of 64 profiled hens (Table 1). Of the remaining 26 of the original 90 hens, 24 were excluded due to mortality or pecking injury and two hens did not fit the criteria for any of the three categories and were, therefore, also excluded. The 64 profiled hens included in the study were culled by cervical dislocation at 23 weeks of age and stored at −18 °C until later examination.

### 2.3. Anatomical measurements

All anatomical measurements were taken by the same researcher after each carcass was defrosted. The researcher was blinded to the feather pecking category of the carcasses. Body weight was recorded to the nearest 1 g using a digital scale, while comb height and comb length were measured to the nearest 0.01 mm using a digital caliper. Both the left and right side of the following five presumed bilateral symmetric traits were measured twice to the nearest 0.01 mm using a digital caliper: length of ulna, length of tarsus, width of tarsus, width of hock and length of the middle toe. The definition and methods of measuring these traits were based on the description by Yngvesson and Keeling (2001). One control hen was excluded from the hock data due to increased thickness of the soft tissue around the hock. Five other hens were excluded in the analyses of a single trait due to inaccuracy in the data: one feather pecker in the ulna data, one control and two victims in the tarsus length data and one victim in the middle toe data.

### 2.4. Statistical analysis

Repeatability of the trait measurements between the two rounds of measurements was assessed using the Tukey mean-difference plot (Bland-Altman type plot) (Bland and Altman, 1986 Ersbøll et al., 2004). The repeatability coefficient, i.e. the expected maximum difference between measurements of the same trait, was calculated using the criteria that 95% of the difference should be less than two standard deviations (Bland and Altman, 1986). The presumed bilateral symmetric traits (length of ulna, length of tarsus, width of tarsus, width of hock and length of the middle toe) underwent the following series of checks to identify true FA (Knierim et al., 2007): A mixed regression analysis with restricted maximum likelihood (REML) parameter