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Applied Animal Behaviour Science 58 (1998) 131–141

APPLIED ANIMAL BEHAVIOUR SCIENCE

The effect of foraging material and perch height on feather pecking and feather damage in laying hens

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Accepted 30 September 1997

Abstract

Feather pecking in laying hens (*Gallus gallus* domesticus) may not only cause welfare problems, but also result in economic losses due to feather damage and increased mortality. The present study aimed at testing whether foraging material and perch height have significant effects on feather pecking and feather damage. From week 19 to week 30 after hatching, groups of 14 hens (white 'Lohman Selected Leghorn' hybrids) were kept in pens with or without access to polystyrene blocks as foraging material and with low or high perches (45 cm or 70 cm above floor level; 2×2 factorial design; four pens each per housing condition). Time since introduction of the hens into the experimental pens ($P < 0.0001$) and provision of foraging material ($P < 0.002$), but not perch height, had significant effects on the rate of feather pecking interactions. Feather pecking was less frequent in pens with than without polystyrene blocks. On the other hand, feather damage in week 30 was significantly more pronounced in pens with low than with high perches ($P < 0.05$), but not significantly influenced by the provision of foraging material. Hens sitting or standing on the floor were especially likely to elicit feather pecking. Individuals characterised by relatively high rates of feather pecking showed more severe forms of this behaviour. It is concluded that hens should be provided with foraging material and high perches during the laying period to reduce feather pecking and feather damage.

Keywords: Chicken; Feather pecking; Feather damage; Housing

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0168-1591/98/$19.00
PII S0168-1591(97)00137-8

1. Introduction

Over the last years, there has been much debate as to whether feather pecking in laying hens is related to the motivational system for dustbathing behaviour (Vestergaard and Lisborg, 1993; Vestergaard et al., 1993; Vestergaard, 1994) or to that for feeding behaviour (Blokhuis and Arkes, 1984; Blokhuis, 1986, 1989; Martin, 1986; Baum, 1995). Recently, we have shown that providing chicks with a sand area for dustbathing does not prevent them from developing high rates of feather pecking (Huber-Eicher and Wechsler, 1997), and Nørgaard-Nielsen (1997) reported that chicks reared with or without access to sand do not differ in the number of feather pecks received or performed during dustbathing. On the other hand, we found that provision of foraging material is efficient in reducing feather pecking in chicks (Huber-Eicher and Wechsler, 1997, in press). In a series of experiments we demonstrated that the time the chicks spend on exploratory and manipulative foraging behaviour away from the feeder is inversely related to the rate of feather pecking. We therefore concluded that feather pecking should be considered as redirected foraging behaviour (Huber-Eicher and Wechsler, in press).

The present study aimed to verify whether adult laying hens also show less feather pecking when provided with foraging material. As with previous experiments with chicks (Huber-Eicher and Wechsler, in press), groups of hens were kept in pens with or without polystyrene blocks as foraging material. Polystyrene blocks were chosen, as they elicit foraging behaviour but do not have nutritive value and, unlike wood-shavings or straw, do not elicit dustbathing behaviour. In addition, we tested whether perch height (45 cm or 70 cm above floor level) has an effect on feather pecking and feather damage. It was expected that feather damage would be more pronounced in hens that can not withdraw to high perches and are hence continuously available to feather pecking groupmates.

In a study with laying hen chicks (Wechsler et al., in press) we also found that there were qualitative differences in feather pecking between individuals characterised by high and lower rates of this behaviour. The percentage of feather pecking interactions classified as 'plucking' (severe pecks) was significantly higher in chicks defined as 'high rate peckers'. In the present study, we examined whether adult hens with high rates of feather pecking also show more severe forms of this behaviour. In addition, we tested whether the two factors varied between the pens (provision of foraging material, perch height) had significant effects on the quality of feather pecks. Finally, we investigated whether hens situated at specific locations within the pen or engaged in specific activities were especially likely to receive feather pecks.

2. Methods

2.1. Animals and housing conditions

A total of 224 white laying hens ('Lohman Selected Leghorn' hybrids) were used in this experiment. They were not beak-trimmed and had been reared in a flock of 700

birds on a farm at a density of 10.8 birds/m^2. The room in which the hens were kept for the first 18 weeks of life was illuminated by both artificial light and daylight. The floor was covered with wood-shavings. In addition, the birds had access to a sand area (200×200 cm) and two bales of straw that were replaced now and then. There were several perches at different heights (60, 100, 120 and 180 cm above ground level). The flock was checked daily by stockmen for injuries caused by feather pecking. There were no such injuries. Behavioural observations made for 2 h each when the birds were 5, 10 and 18 weeks old revealed that feather pecking was at a very low level (B. Huber-Eicher, unpublished data). By the end of week 18, on arrival from the farm, the hens' plumage condition was perfect.

The hens were randomly assigned to groups of 14 individuals and distributed among 16 pens of identical size (265×90 cm, height 235 cm; 5.9 hens/m^2). The pens were built side by side along a corridor in a stable. Hens in adjacent pens had no visual contact, as the pens were separated by plywood walls. These walls were 190 cm high and allowed auditory contact between all groups in the stable. Fresh air was introduced above the plywood walls. Spent air was removed from each pen by a separate pipe. Each pen was illuminated by an incandescent light bulb (75 W). In addition, there was a fluorescent tube (36 W) per two pens. Light intensity at the height of the animals was about 60 lux. Day length was kept constant at 16 h (between 05:00 and 21:00) with a 15 min twilight phase at the start and end of the day. On the narrow side of each pen there was a glass door (72×142 cm) opening on to the corridor from where behavioural observations were made.

The pen floor was made of slats (width 1 cm, 2.5 cm apart). There were two cup drinkers and a suspended feeder (diameter 30 cm) in each pen. The feeder was automatically refilled, and the animals had ad libitum access to a commercial layer food (pellets). In the rear of the pens and 80 cm above the slatted floor a nest box (50×40 cm, height 40 cm) containing chaff was fixed to the wall. The opening of the nest box was covered with a plastic curtain to promote its use as an egg-laying place. In front of the nest box there was a small board (53×10 cm) to facilitate landing. A perch (210 cm long, 22 cm away from the side wall) was provided at 45 cm (8 pens) or 70 cm (8 pens) above the slatted floor. In 8 pens two blocks (60×8 cm, height 15 cm) of polystyrene (density 38 kg/m^3) were fixed to the slatted floor along the side wall opposite to the perch and along the rear wall, respectively. In a pilot study (unpublished data) we had observed that this material is attractive for laying hens and elicits elements of foraging behaviour (pecking, tearing, striking). The other 8 pens contained no such foraging material. Perch height and provision of foraging material were varied independently (2×2 factorial design), resulting in 4 housing conditions which were randomly assigned to 4 pens each.

2.2. Procedures

Three days after introduction into the experimental pens, all hens were marked individually with wing tags (4×2.5 cm) on each wing. The wing tags were fixed around the upper wings by means of a crêpe rubber tape (width 1.5 cm).

Eggs were collected daily between 14:00 and 18:00. To do so a person had to enter the pen. The number of eggs collected in each pen was noted.

All blocks of foraging material were replaced whenever one of the two blocks in any pen was largely destroyed by the hens (on average every 11 days). The weight of both the removed and the newly fixed blocks was noted for each pen.

To avoid unnecessary pain, all injuries caused by feather pecking were treated with tar or a commercial anti-pecking spray. This effectively prevented other hens from pecking at the wounds. The experiment was subjected to the authorisation procedure prescribed by Swiss animal welfare legislation (application No. 91/96).

2.3. Behavioural observations

Data collection started in week 19 and ended in week 30. The hens of each pen were directly observed once a week for a period of 15 min between 09:30 and 12:00 (8 pens) or between 14:00 and 16:30 (8 pens). All groups were observed within one day, at regular intervals of 7 days and in a fixed order throughout the study. Data collection in the 4 pens of a given housing condition was evenly distributed throughout the day.

Sampling methods were similar to the methods used in previous studies with laying hen chicks (Huber-Eicher and Wechsler, 1997, in press; Wechsler et al., in press). During the observations 'all occurrences' (Altmann, 1974) of feather pecking interactions in a group were recorded for three periods of 4.5 min. Aggressive pecks were not included. Feather pecks that were successively directed at the same receiver were recorded as one interaction. An interaction ended when there were no more pecks during a period of 4 s. It was differentiated whether the interaction was composed of 1–4, 5–9 or ≥ 10 single feather pecks. This categorisation allowed us to limit the amount of time we paid attention to interactions that were composed of more than 10 single pecks in favour of recording all occurrences of feather pecking interactions. Only pecks at feathered parts of conspecifics were classified as feather pecking. Pecks at legs, beaks, combs or wattles were neglected, as such pecks may be under the control of another behaviour system and not be linked to feather pecking. Every feather pecking interaction was attributed (with increasing intensity) to one of the following 4 types of behaviour: (1) 'pecking' at a feather without pinching, (2) 'pinching' a feather and pulling slightly, (3) 'pulling' at a feather with a vigorous backward movement of the head, (4) 'plucking' a feather. Interactions that were composed of repeated pecks were classified according to the most intense type of behaviour observed. For each feather pecking interaction the identity of the actor and the receiver, the area of the body (head, neck, breast, wing, back, rump, tail, vent) that was pecked, the location of the receiver (on the floor, on the perch, in front of the nest box, in the nest box, on the nest box) and its activity during the interaction (sitting, standing, foraging, feeding, drinking, dustbathing, preening, moving, feather pecking) were recorded. 'Foraging' was defined as follows: The hen pecks at the floor, at the foraging blocks or at other parts of the pen (but not at the feed) or stands/moves with its head in a lower position than the rump. Hens situated next to the feeder with the head above the food were recorded as 'feeding'.

During the 30 s following each period of 4.5 min of data collection on feather pecking (see above) the activity (sitting, standing, foraging, feeding, drinking, dust-

bathing, preening, moving, feather pecking) and the location (on the floor, on the perch, in front of the nest box, in the nest box, on the nest box) of all hens of a pen were recorded ('scan' sample; Altmann, 1974).

2.4. Feather damage

The plumage was scored for damage when the hens were 30 weeks old, using a scoring system of 1 (perfect plumage), 2 (feathers damaged, no skin area denuded), 3 (denuded area up to 3×3 cm) or 4 (denuded area greater than 3×3 cm) points for six individual parts of the body: breast, legs, vent, back, rump, wings. In addition, the tail and the primaries were given a score of 1 (perfect) or 2 (damaged). In the analysis, a total 'feather loss' score (range 6 to 24) was calculated for each hen by adding the scores of breast, legs, vent, back, rump and wings.

2.5. Statistical analysis

The pens were treated as independent observational units. The analyses were performed using Systat (Wilkinson, 1992) or Microsoft Excel. All statistical tests are two-tailed with an alpha level of 0.05. As 11 hens from 8 pens died during the study and hens in the nest boxes were not visible, the rate of feather pecking interactions for a given pen and week was divided by the average number of hens visible in the three 'scan' samples for that pen and week. These data were analysed using a two-way ANOVA with 'foraging material' and 'perch height' as main factors and 'week' as a repeated measures. In accordance with a study on feather pecking in laying hen chicks (Wechsler et al., in press), individuals with a feather pecking rate (data of all weeks

Table 1
Effects of foraging material and perch height on plumage condition in week 30

Body part	High perch		Low perch		*P*-values		
	Foraging material				Foraging material	Perch height	Interaction
	Yes	No	Yes	No			
Breast	1.3	1.2	1.9	2.8	n.s.	< 0.01	n.s.
Legs	1.0	1.0	1.1	2.4	n.s.	< 0.07	n.s.
Vent	1.6	1.6	2.0	3.2	n.s.	< 0.06	n.s.
Back	1.0	1.2	1.2	1.3	n.s.	n.s.	n.s.
Rump	1.3	2.1	2.0	2.8	n.s.	n.s.	n.s.
Wings	1.0	1.3	1.1	1.1	n.s.	n.s.	n.s.
Tail	1.4	1.5	1.3	1.3	n.s.	n.s.	n.s.
Primaries	1.0	1.0	1.0	1.0	n.s.	n.s.	n.s.
Total 'feather loss'	7.2	8.4	9.2	13.5	n.s.	< 0.05	n.s.

Average feather damage scores of hens kept in 4 different housing conditions ($n = 4$ pens each) are presented. Scores have ranges from 1 to 4 for body parts, 1 or 2 for tail and primaries, 6 to 24 for total.

Table 2
Comparison of the mean (and range) percentages of laying hens engaged in different activities in the 'scan' samples (all hens) and the mean percentages of activities shown by birds receiving feather pecks

Activity	All hens	Hens receiving feather pecks	*P*
Sitting	8 (2–18)	15 (2–39)	< 0.01
Standing	24 (19–30)	29 (16–44)	< 0.05
Foraging	10 (4–16)	5 (0–10)	< 0.001
Feeding	30 (22–36)	31 (10–52)	n.s.
Drinking	8 (5–12)	7 (0–14)	n.s.
Dustbathing	0.1 (0–1)	0.2 (0–4)	n.s.
Preening	8 (4–12)	6 (1–12)	< 0.01
Moving	8 (5–13)	6 (1–12)	< 0.005
Feather pecking	3 (1–7)	2 (0–7)	n.s.

Only data of hens situated on the floor are included in the analysis ($n = 16$ pens each, Wilcoxon matched-pairs signed-ranks test).

combined) that was higher than twice the average rate for their group were defined as 'high rate peckers'.

A total of 2240 feather pecking interactions were recorded in all groups over the study period. The percentages of feather pecking interactions directed at different parts of the body and the percentages of interactions classified according to the type of behaviour (pecking, pinching, pulling, plucking) or according to the number of single pecks (1–4, 5–9, ≥ 10) were calculated for each pen combining all data of weeks 19 to 30. The effects of the housing conditions on the quality of feather pecking interactions and feather damage were assessed using two-way ANOVA with the factors 'foraging material' and 'perch height'. With the 'scan' samples the percentages of hens engaged in the defined activities and situated at the defined locations were calculated for each

Table 3
Comparison of 'high rate peckers' and other group members (means and ranges, $n = 15$ groups) with regard to the percentages of feather pecking interactions that were assigned to different types of behaviour and to different categories of numbers of pecks observed during the interaction

	'High rate peckers'	Other group members	*P*
Type of behaviour			
Pecking	23 (14–35)	40 (24–52)	< 0.001
Pinching	57 (22–72)	50 (37–65)	< 0.02
Pulling	14 (0–29)	8 (1–15)	< 0.05
Plucking	5 (0–28)	3 (0–11)	n.s.
Number of pecks			
1–4	48 (27–91)	62 (45–80)	< 0.02
5–9	21 (4–39)	17 (9–30)	n.s.
≥ 10	31 (3–45)	20 (8–30)	< 0.01

Average percentages calculated for 'high rate peckers' and other group members within each group were compared using the Wilcoxon matched-pairs signed-ranks test.

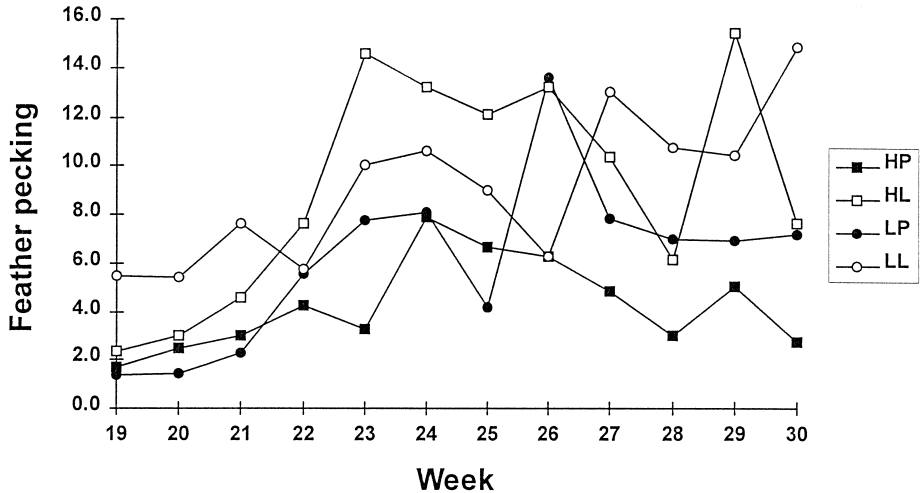

Fig. 1. Development of the rates of feather pecking interactions (per 14 hens per 30 min) from week 19 to week 30. Average values of 4 pens each of 4 housing conditions are presented. The pens contained either high (H) or low (L) perches. The second independent variable was provision (P) or lack (L) of foraging material.

pen using all data of weeks 19 to 30 (36 'scans' per pen). These data were also analysed using two-way ANOVA.

Prior to the ANOVA square-root and arcsine square-root transformations (Sokal and Rohlf, 1981) were applied to rates and percentages, respectively, to achieve a normal distribution of the residuals (Lilliefors test; Lilliefors, 1967). However, untransformed data are given in Tables 1–3 and in Fig. 1.

3. Results

The provision of foraging material had the intended effect on the behaviour of the birds. The percentage of hens that were foraging in the 'scan' samples was significantly higher in pens with than without polystyrene blocks (average values 15 and 10%, respectively; $F_{(1,12)} = 9.47,\ P = 0.01$). Perch height had no significant effect on foraging behaviour ($F_{(1,12)} = 0.00002,\ P = 0.99$), and there was no significant difference in the amount of foraging material the hens removed from the blocks between pens with perches in a high and low position (average 2017 g vs. 2095 g; $F_{(1,6)} = 0.11,\ P = 0.75$).

Perch height had no significant effect on perch use. On average 35 and 31% of the hens in pens with high and low perches, respectively, were observed on the perches in the 'scan' samples ($F_{(1,12)} = 0.78,\ P = 0.4$). Provision of foraging material also had no significant effect on perch use ($F_{(1,12)} = 0.27,\ P = 0.61$).

Fig. 1 shows the development of feather pecking separately for the four housing conditions. The 'week' had a significant effect on the rates of feather pecking interactions ($F_{(11,132)} = 8.90,\ P < 0.0001$). With all 4 housing conditions there was an increase

in feather pecking rate over the first half of the study period. In addition, feather pecking rates were significantly lower in pens with than without foraging material ($F_{(1,12)} = 16.38$, $P < 0.002$), but did not differ between pens with high and low perches ($F_{(1,12)} = 1.36$, $P = 0.27$). There was no significant interaction between these two factors ($F_{(1,12)} = 0.8$, $P = 0.39$).

The effects of foraging material and perch height on plumage condition in week 30 are presented in Table 1. 'Feather loss' (total score) was significantly more severe in hens housed in pens with low than with high perches. Provision of foraging material had no significant effects on plumage condition. With respect to different body parts the effect of perch height was significant for the breast and close to the significance level for the vent and the legs.

Perch height had a significant effect on the percentage of feather pecking interactions directed to the vent which was higher in pens with low than with high perches (average 25 vs. 10%, $F_{(1,12)} = 8.01$, $P = 0.02$). In addition, the percentage of feather pecking interactions directed to the vent was significantly lower in pens with than without foraging material (12 vs. 24%, $F_{(1,12)} = 6.53$, $P = 0.03$). No significant effects of perch height and foraging material were found when feather pecking interactions directed to the head, neck, breast, wing, back, rump or tail were analysed separately.

The location of the receivers of feather pecking interactions was compared to the location of all hens as recorded in the 'scan' samples. It was found that in each pen the percentage of hens situated on the floor when receiving feather pecks was significantly higher than the percentage of hens observed on the floor in the 'scan' samples (average 85 vs. 59%; Wilcoxon matched-pairs signed-ranks test: $z = 3.516$, $n = 16$, $P < 0.001$). On the other hand and also in each pen, the percentage of hens exposed to feather pecks on the perches was lower than the percentage of hens situated on perches in the 'scan' samples (13 vs. 33%).

To test whether specific activities are likely to elicit feather pecking interactions the activity of receivers of feather pecks was compared to the activity of all hens in the 'scan' samples. As there were major differences in the activity of the hens at different locations, the expected values calculated from the 'scan' samples were different for each location. However, the analysis was only done for hens situated on the floor while receiving feather pecks, as most feather pecking interactions (85%) occurred on the floor. The results are presented in Table 2. The percentages of receivers of feather pecking interactions recorded as sitting and standing were significantly higher than the percentages of hens sitting and standing in the 'scan' samples. On the other hand, hens engaged in foraging, preening or moving were significantly less often receiving feather pecking interactions than expected.

The percentages of feather pecking interactions classified as 'pulling' or 'plucking' were significantly higher in pens without than with foraging material (pulling: average 13 vs. 7%, $F_{(1,12)} = 5.35$, $P = 0.04$; plucking: 7 vs. 1%, $F_{(1,12)} = 18.84$, $P < 0.001$). In addition, 'plucking' accounted for a significantly larger proportion of feather pecking interactions in pens with low than with high perches (6 vs. 2%, $F_{(1,12)} = 9.56$, $P = 0.009$). Neither the provision of foraging material nor perch height had significant effects on the percentages of feather pecking interactions composed of 1–4, 5–9 or ≥ 10 single feather pecks.

Hens with a feather pecking rate that was higher than twice the average rate for their group ('high rate peckers') made up 12% (26 hens in 15 groups) of all birds observed in this experiment but initiated 34% of the recorded feather pecking interactions. These birds were not only characterised by relatively high rates of feather pecking but also by showing more severe forms of this behaviour (Table 3). Compared to the other birds of their group they had a significantly higher percentage of their feather pecking interactions classified as 'pinching' or 'pulling'. In addition, a higher percentage of their feather pecking interactions was composed of ≥ 10 single pecks.

Neither the provision of foraging material nor perch height had a significant effect on total egg production over the study period (Foraging material: $F_{(1,12)} = 0.16$, $P = 0.69$; Perch height: $F_{(1,12)} = 0.13$, $P = 0.73$). The average percentage of eggs laid per hen and per day ($n = 16$ pens) rose from 24% in weeks 19–22 to 82% in weeks 23–26 and 84% in weeks 27–30.

4. Discussion

The results of the present study with adult hens are in accordance with observations made in previous studies with laying hen chicks (Huber-Eicher and Wechsler, 1997, in press). Hens provided with polystyrene blocks showed significantly lower rates of feather pecking interactions than hens kept without such foraging material. Once again, we found an inverse relationship between foraging behaviour and feather pecking. The conclusion we had drawn from the experiments with chicks that feather pecking should be considered as redirected foraging behaviour (Huber-Eicher and Wechsler, in press) was thus confirmed in adult hens. In line with this conclusion, perch height, which had no significant effect on foraging behaviour, also had no significant influence on the rate of feather pecking interactions.

There was an increase in the rate of feather pecking interactions with time, and, in accordance with other studies (Allen and Perry, 1975; Gunnarsson et al., 1993; Nørgaard-Nielsen et al., 1993), we observed a deterioration of the plumage from week 19 to week 30. By the end of the study, the total 'feather loss' score indicated a significantly worse plumage condition in hens kept in pens with low than with high perches. The effect of perch height on feather damage was especially pronounced for the lower body parts (breast, legs, vent), suggesting that hens in pens with low perches were exposed to severe feather pecks when situated on the perches. In support of this interpretation of the observed feather damages we found that the percentage of feather pecking interactions classified as 'plucking' and the percentage of feather pecking interactions directed to the vent were significantly higher in pens with low than with high perches.

Plumage condition was significantly better in pens with high than with low perches. With respect to feather pecking rates, however, we found no significant effect of perch height. As a consequence, providing hens with high perches may reduce welfare problems associated with feather damage such as pain caused by feather removal (Gentle and Hunter, 1990), but does not solve motivational problems resulting in feather pecking.

There were no significant effects of the provision of foraging material on feather damage scores in week 30. This is somewhat surprising, as the percentage of feather pecking interactions that were classified as 'plucking' was significantly higher in pens without than with polystyrene blocks. Nørgaard-Nielsen et al. (1993) reported that plumage condition was significantly better in hens given access to cut straw from a perforated plastic basket than in hens without such stimulus enrichment. It is possible that we would also have found a significant effect of foraging material on feather damage, if we had used a more attractive material than polystyrene blocks. However, as we aimed to demonstrate that the performance of foraging behaviour is crucial in reducing feather pecking, we had chosen a material that has no nutritive value and does not elicit dustbathing behaviour. It is also possible that the effect of foraging material on feather damage would be significant later in the laying year.

In accordance with a study in laying hen chicks (Wechsler et al., in press), we found that individuals characterised by relatively high rates of feather pecking performed more severe forms of this behaviour. Both feather pecking interactions classified as 'pinching' or 'pulling' and feather pecking interactions composed of ≥ 10 single pecks were relatively more frequent in hens defined as 'high rate peckers' than in the other members of their group. In contrast to the study with chicks, the percentage of feather pecking interactions classified as 'plucking' failed to be significantly higher in 'high rate peckers'. Neither the provision of foraging material nor perch height had a significant effect on the number of single pecks in a feather pecking interaction.

Hens situated on the floor received more feather pecks than expected. On the other hand, hens on perches were less often pecked than expected. When on the floor, hens that were sitting or standing were especially likely to receive feather pecks, whereas hens engaged in foraging, preening or moving were less often pecked than expected. In conclusion, hens resting (sitting or standing) on the floor were the main targets of feather peckers.

There are two practical implications of this study. First, to reduce feather pecking in laying hens, foraging material should not only be provided during the rearing period but also during the laying period. Of course, a more suitable material than polystyrene blocks should be used on farms. If straw is provided as foraging material, special attention should be paid to its form, as long-cut straw is more efficient in reducing feather pecking than straw in shredded form (Huber-Eicher and Wechsler, in press). Second, perches positioned well above the head of hens standing on the floor or on elevated platforms in aviary systems should be provided for resting hens to reduce feather damage caused by feather pecking.

Acknowledgements

We are grateful to the Federal Veterinary Office of Switzerland, the Schweizer Tierschutz STS, the Kanton Zürich, The Migros-Genossenschafts-Bund and the Meta und Willi Eichelsbacher Stiftung for their financial support of the research project (No. 014.94.1). We also would very much like to thank Rolf Eggler who constructed the experimental pens. David Nash made valuable comments on the manuscript.

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