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Use of perches and nestboxes by laying hens in relation to social status, based on examination of consistency of ranking orders and frequency of interaction

L.S. Cordiner, C.J. Savory*

Avian Science Research Centre, Scottish Agricultural College, Auchincruive, Ayr KA6 5HW, UK

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Abstract

Four groups of 15–19 adult ISA Brown hens were studied in pens to assess the relationship between social status and use of perches and nestboxes. This was to test the hypothesis that subordinate hens use these resources more by day, for avoiding dominants, but that dominants use perches more at night, for roosting. The experiment consisted of a 5-week pre-treatment period, when no perches were present, and a 4-week treatment period, when each group was tested with different perch treatments (No, Low, Medium, High). All groups were observed systematically in each week, when all interactions of three types (aggressive peck, non-aggressive peck, approach/avoidance) in a group were recorded by noting the instigator and recipient (from numbered wing tags) onto a matrix. Proportions of time that each bird spent using perches and nestboxes, by day and at night, were also recorded. The results indicate that social status of individual laying hens is relatively stable across time and can be based reliably on counts of either aggressive pecks or approach/avoidances, but not non-aggressive pecks. Aggressive pecks were the most frequent type of interaction observed, and were reduced by the presence of perches. Use of nestboxes, but not perches, was greater at night than by day. There were weak tendencies for perches, and to a lesser extent nestboxes, to be used more by lower ranking birds by day, but not at night. There was some evidence of increased use of these resources by higher ranking birds at night. It is concluded that provision of perches reduces bird density on the floor (where nearly all interactions occurred), allows subordinates a means of avoiding dominants by day, reduces frequency of agonistic interactions, and should thus benefit laying hen welfare.

Keywords: Chicken–social behaviour; Ranking orders; Resource use; Perch; Nestbox; Agonistic interactions; Welfare

* Corresponding author. Tel.: +44-1292-525115; fax: +44-1292-525098.
E-mail address: j.savory@au.sac.ac.uk (C.J. Savory).

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1. Introduction

At present, less than 25% of eggs sold in the UK come from laying hens kept in non-cage housing systems (FAWC, 1997; NFU, 2000). However, the importance of such ''alternative'' systems is likely to increase greatly because the recent European Union Protection of Laying Hens Directive (EU, 1999) proposes a complete ban on conventional battery cages as from 1 January 2012. The commonest non-cage system in the UK is the so-called ''perchery/barn'', used either on its own or in combination with free-range. According to special marketing terms (e.g. SERAD, 1999), in perchery/barn housing, the interior of the building should be ''fitted with perches of a length sufficient to ensure at least 15 cm of perch space for each hen''. A similar requirement is in the UK Codes of Recommendations for the Welfare of Livestock–Domestic Fowls (MAFF, 1987) and the RSPCA's (1997) ''Freedom Food'' Welfare Standards for Laying Hens.

This standard has been interpreted in different ways. Some egg producing companies using the ''raised slatted floor'' type of perchery/barn regard the slats in the floor as ''equivalent perch space'', while others using the same type of system provide 15 cm of additional elevated perch space per bird. There appears to be disagreement among companies about perceived advantages and disadvantages of elevated perches. Some feel they increase the incidence of bone injury, red mite infestation, egg breakage and aggression, and are awkward for stockworkers. Other work indicates they increase bone strength through facilitating natural perching behaviour (Hughes and Appleby, 1989; Knowles and Broom, 1990), and may reduce aggressive encounters by allowing subordinate hens a means of avoiding dominant ones (McLean et al., 1986; Gibson et al., 1988).

In the work reported here, which was part of a larger investigation of the importance of elevated perches for laying hen welfare, small groups of adult hens were studied to assess the relationship between social status and use of perches and nestboxes. This was to test the hypothesis that perches and nestboxes are used more by subordinate hens by day, for avoiding dominant ones (McLean et al., 1986; Gibson et al., 1988), but that perches are used more by dominant birds at night, for roosting (Swingland, 1977; Weatherhead and Hoysak, 1984). There have been anecdotal reports of social disturbance amongst hens at lights off (F.H., Griffiths; N.G., Gregory, unpublished observations), when dominant birds may displace subordinate ones from preferred perches (see also Blokhuis, 1984; Olsson and Keeling, 2000), and this may be when there is increased risk of bone injury.

The present experiment consisted of a pre-treatment period, when no elevated perches were present, and a treatment period, when each group of birds was tested with different perch treatments. It had four main aims: (i) to determine the most consistent index of social status (ranking orders can be measured in different ways, and the comparability of these methods has been questioned (Rushen, 1984)); (ii) to determine the effect of different perch treatments (No, Low, Medium, High) on frequencies of interaction between birds; (iii) to determine levels of perch and nestbox use, by day and by night and (iv) to determine relationships between social status and perch and nestbox use, by day and by night. This is the first investigation of resource use in relation to social status to be done over an extended period (cf. Banks et al., 1979).

2. Methods

2.1. Subjects and husbandry

At 43 weeks of age, four groups of 20 ISA Brown hens were placed in adjacent pens in a house where ambient temperature was maintained at ca. 21°C, lights were on from 05.00 to 21.00 h, and light intensity at bird level was ca. 100 lux. Each pen measured 1.9 m wide × 2.0 m deep and contained (wood shavings) floor litter, six nestboxes (27 cm wide × 30 cm deep × 28 cm high), and ad libitum supplies of a standard layers' mash diet and water in one food hopper and one bell drinker. Initial stocking density was 6.2 birds/m^2 of usable floor area (3.23 m^2). The birds weighed ca. 1.8 kg, had been beak-trimmed early in life, and were individually marked with a conspicuous numbered tag attached to one wing. They had been kept in cages and were unfamiliar with each other. This may have caused levels of aggression to be relatively high (McBride, 1958; King, 1965; Hughes et al., 1997), and 13/80 birds either died or were removed because of aggressive pecking damage, mostly in the first few weeks and mainly in groups 1 and 4 (see sample sizes in Tables 1–4). Eggs were collected daily at ca. 0900 h, and overall mean production during the experiment was 0.73 egg per hen per day.

2.2. Pre-treatment period (weeks 1–5)

Commencing at 45 weeks of age, each group was observed for 30 min in the morning and 30 min in the afternoon, on 4 days in weeks 1–3 of the experiment and on 4 days per week in weeks 4 and 5. Three types of bird to bird interaction were recorded: aggressive peck (overt, rapid, forceful, mainly at head, recipient usually withdraws immediately); non-aggressive peck (furtive, deliberate, gentle or vigorous, peck or pull, mainly at body, recipient may withdraw eventually); approach/avoidance (no contact, one bird moving out of the path of another, includes occasional threat). During the 30-min observation periods, all such (spontaneous) interactions in a group were recorded by noting the instigator and recipient (from the numbered wing tags) onto a matrix. From the total numbers of interactions recorded in 4 days (in weeks 1–3, 4 and 5) were calculated ratios for each bird — the number of (aggressive or non-aggressive) pecks given divided by the number received and the number of approaches divided by the number of avoidances (one was added to each bird's count to avoid zeros). For all three types of interaction each bird's ratio was used to determine its position in a ranking order.

Insufficient spontaneous interactions were recorded in 4 days' observations to allow each bird's status to be assessed relative to each of its group mates. This is the usual method for measuring ''peck order'' (Rushen, 1984), but its success tends to rely on use of small groups (typically <10) or even paired contests. The ranking method used in the present study is similar to ''dominance ratio'' and ''social tension index'', which appear suitable for characterising agonistic behaviour of individual birds in flocks, without working out the peck order (Biswas and Craig, 1971). The social tension index was found to be highly correlated with peck order in one study with laying hens (Lee et al., 1982), but not in another with cockerels (Syme and Syme, 1974). It is assumed that the ranking orders in the present study reflect relative propensities of individual hens to give or receive different

sorts of peck, and to approach or avoid other birds, and hence indicate their status in different contexts.

2.3. Treatment period (weeks 6–9)

During each of four consecutive treatment weeks (weeks 6–9), commencing at 50 weeks of age, each group received a different perch treatment according to a Latin Square design. The four treatments were: No perch; Low perch (three parallel perches 26 cm apart, all 17.5 cm high); Medium perch (three parallel perches in a 45° A frame, one 35 cm and two 17.5 cm high); High perch (three parallel perches in a 45° A frame, one 70 cm and two 35 cm high). Each (4.5 cm × 4.5 cm) perch was 1 m long, so there was 15 cm perch space per bird in the treatments with perches.

During each treatment week, every group was again observed on 4 days, for 30 min in the morning and 30 min in the afternoon. In the first 15 min of each such session, all spontaneous interactions were recorded onto a matrix, as in the pre-treatment period, to determine each bird's position in the hierarchy according to each type of interaction. In the second 15 min, the identities of all birds using perches and all birds using nestboxes were recorded every 30 s. This allowed each bird to be ranked according to the amount of time it spent using perches or nestboxes, and it also provided a measure of proportions of time that perches and nestboxes were used during each treatment.

Measurements of perch and nestbox use were also made at night during each treatment week, using a video recorder, camera and infra-red light source. Each group was video recorded continuously from lights off (21.00 h) to lights on (05.00 h) on one night per week. From the recordings, in which all perches and nestboxes were visible, the identities of birds using perches or nestboxes were noted once every 15 min (i.e. 32 such scans during the 8-h dark period). As with the daytime observations, each bird was ranked according to the time it spent using perches or nestboxes, and proportions of time that perches and nestboxes were used were also obtained. Sometimes a bird using a perch or nestbox at night could not be identified because its wing tag was not visible in the video recording. Such observations could therefore, not be used for the ranking (based on bird identity), but they were used for the measurement of perch and nestbox use (based on bird presence).

2.4. Statistical analysis

To determine consistencies (across time) of ranking orders based on the three types of interaction, Spearman correlation coefficients were calculated for each group, comparing individual birds' rankings among different time periods (weeks 1–3, 4, 5, 1–5, and 6–9). Ranking orders for each group were also compared among the different types of interaction, by Spearman correlation in pre-treatment (weeks 1–5) and treatment (weeks 6–9) periods. Mean frequencies of each type of interaction in each group (per bird/h) were compared between pre-treatment and treatment periods, and among perch treatments during the treatment period, by two-way ANOVAs (to assess period/treatment and group effects). Mean proportions of time spent using perches or nestboxes in each group, by day and at night, were also compared among perch treatments by two-way ANOVAs. To

determine relationships between social status and perch and nestbox use, by day and at night, Spearman correlation coefficients were calculated for each group, comparing individual birds' dominance rankings in weeks 6–9 based on aggressive pecking and approach/avoidances with their rankings for perch and nestbox use.

3. Results

3.1. Consistencies of ranking orders

Observed ranking orders based on aggressive pecks and approach/avoidances were very consistent from week to week and between pre-treatment and treatment periods, in all groups, judging from the (100%) significant ($P < 0.05$) correlation coefficients in Table 1. With the exception of one comparison, rankings based on non-aggressive pecks were always relatively inconsistent.

When rankings based on the different types of interaction were compared with each other, those based on aggressive pecks were always consistent with approach/avoidances, but neither of these were consistent with those based on non-aggressive pecks (Table 2). It is concluded that rankings based on non-aggressive pecks are not related to social status, so these were not used for the comparisons with resource use (Section 3.4).

3.2. Frequencies of interaction

Across all 9 weeks of the experiment, overall mean frequencies of interaction (per bird/h) were 1.99 aggressive pecks, 0.41 non-aggressive pecks, and 1.22 approach/avoidances.

Table 1
Consistency of ranking orders based on each type of interaction across weeks 1–5 (pre-treatment period) and weeks 6–9 (treatment period), as indicated by Spearman correlation coefficients*

Type of interaction	Period (weeks)	Group 1 ($n = 15$[a])	Group 2 ($n = 19$)	Group 3 ($n = 19$)	Group 4 ($n = 16$)
Aggressive pecking	1–3 vs. 4	**0.64**	**0.77**	**0.88**	**0.81**
	1–3 vs. 5	**0.63**	**0.72**	**0.76**	**0.68**
	4 vs. 5	**0.55**	**0.73**	**0.77**	**0.76**
	1–5 vs. 6–9	**0.56**	**0.64**	**0.94**	**0.85**
Non-aggressive pecking	1–3 vs. 4	0.42	0.22	0.06	−0.17
	1–3 vs. 5	**0.54**	0.23	0.29	0.10
	4 vs. 5	0.28	0.12	0.28	−0.23
	1–5 vs. 6–9	0.01	0.39	0.27	0.41
Approach/avoidance	1–3 vs. 4	**0.62**	**0.74**	**0.85**	**0.81**
	1–3 vs. 5	**0.70**	**0.80**	**0.64**	**0.74**
	4 vs. 5	**0.85**	**0.63**	**0.65**	**0.69**
	1–5 vs. 6–9	**0.55**	**0.58**	**0.85**	**0.69**

* Significant ($P < 0.05$) correlations are in bold type.
[a] Group 1, $n = 13$ in weeks 6–9.

Table 2
Consistency of ranking orders across types of interaction, in weeks 1–5 (pre-treatment period) and weeks 6–9 (treatment period), as indicated by Spearman correlation coefficients*

Period (weeks)	Types of interaction	Group 1 ($n = 15$[a])	Group 2 ($n = 19$)	Group 3 ($n = 19$)	Group 4 ($n = 16$)
1–5	Aggressive vs. non-aggressive	−0.12	−0.30	0.30	0.13
	Approach/avoidance vs. non-aggressive	−0.07	−0.33	0.13	−0.12
	Aggressive vs. approach/avoidance	**0.81**	**0.83**	**0.94**	**0.81**
6–9	Aggressive vs. non-aggressive	0.13	−0.17	0.16	0.32
	Approach/avoidance vs. non-aggressive	0.25	0.03	−0.01	0.28
	Aggressive vs. approach/avoidance	**0.71**	**0.75**	**0.84**	**0.89**

* Significant ($P < 0.05$) correlations are in bold type.
[a] Group 1, $n = 13$ in weeks 6–9.

The only significant difference between pre-treatment and treatment periods was with aggressive pecks, which were reduced in frequency during the treatment period (Fig. 1).

During the treatment period, frequencies of aggressive pecks were reduced during treatments with perches compared with the No perch treatment, but only with the High perch was this effect significant (Fig. 2). Similar effects of perches were seen with frequencies of approach/avoidances and non-aggressive pecks, but only with the former interaction did this approach significance ($P = 0.057$).

The only significant group effect ($P = 0.036$) from the ANOVAs was with non-aggressive pecks during the treatment period, which occurred at a higher frequency in group 4 (0.75 per bird/h) than in groups 1–3 (0.24–0.35). However, levels of aggression had

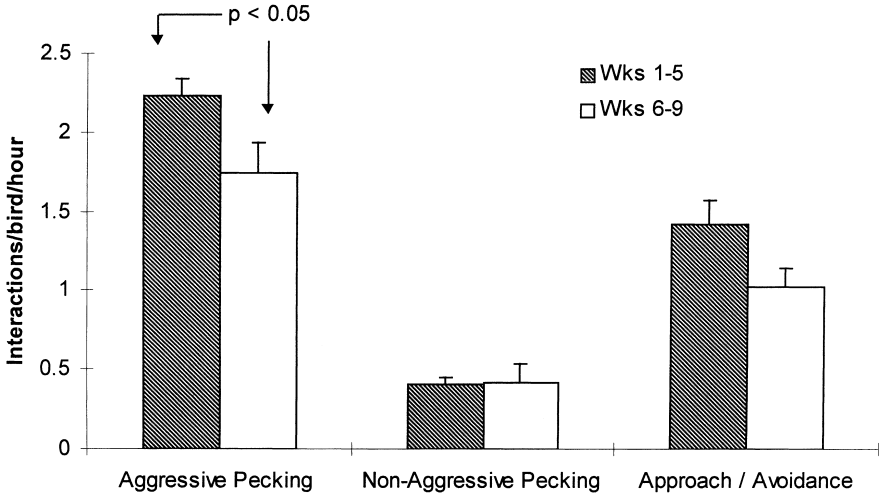

Fig. 1. Mean frequency of interactions (per bird/h ± S.E.) for aggressive pecks, non-aggressive pecks and approach/avoidance encounters across pre-treatment (weeks 1–5) and treatment (weeks 6–9) periods. Comparisons by ANOVA (Section 2.4).

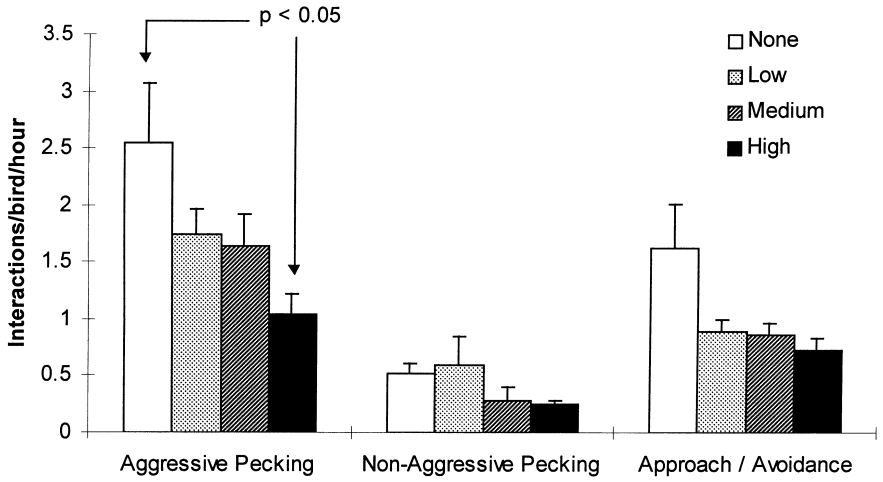

Fig. 2. Mean frequency of interactions (per bird/h ± S.E.) for aggressive pecks, non-aggressive pecks and approach/avoidance encounters during each perch treatment in the treatment period (weeks 6–9). Comparisons by ANOVA (Section 2.4).

been higher in groups 1 and 4 than in groups 2 and 3 at the start of the trial (see Section 2.1), and this is reflected by the variation in sample size shown in Tables 1–4.

3.3. Perch and nestbox use

During the treatment period, overall mean proportions of time spent using (all) perches were 24.0% by day and 18.4% at night, and overall mean proportions of time spent using nestboxes were 2.0% by day and 22.4% at night (Fig. 3). The only effect of perch treatment that was nearly significant ($P = 0.071$) was at night, when nestboxes were used most with the No perch treatment. The only significant group effect ($P = 0.012$) was with nestbox use by day, which was higher in group 1 (4.1%) than in groups 2–4 (1.1–1.5%).

3.4. Relationships between social status and perch and nestbox use

Out of 44 Spearman rank correlations calculated between social status and perch use, 11 (25%) were significant (Table 3). In groups 2 and 4, there was evidence from (four out of a possible six) significant negative correlations that (all) perches tended to be used more by lower ranking birds by day, regardless of treatment. There was only weak evidence of this in group 1, and none in group 3. The only significant (positive) correlations at night were with group 3, indicating that perches tended to be used more by higher ranking birds then, with the Low perch treatment only.

Out of 60 correlations between social status and nestbox use, only seven (12%) were significant (Table 4). In group 3, there was a tendency for nestboxes to be used more by lower ranking birds by day, judging from the significant negative correlations with the Low and Medium perch treatments. In group 4, on the other hand, there was a tendency for

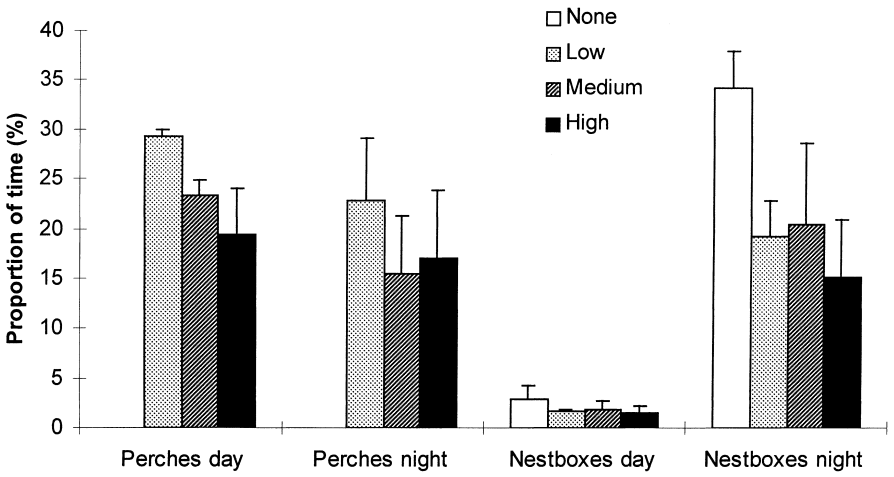

Fig. 3. Mean proportions of time spent using perches and nestboxes (±S.E.), by day and by night, during each perch treatment in the treatment period (weeks 6–9). Comparisons by ANOVA (Section 2.4).

nestboxes to be used more by higher ranking birds (significant positive correlations), by day with the High perch treatment and at night with the Medium perch treatment. The only other significant correlation was in group 2 (Medium perch treatment, night, positive).

Of the 18 significant correlations in Tables 3 and 4, 11 were with rankings based on aggressive pecks and 7 were with rankings based on approach/avoidances.

Table 3
Spearman correlation coefficients between social ranking orders in weeks 6–9 based on aggressive pecking and approach/avoidance interactions and ranking orders based on total times spent using (all) perches, by day and night, during the three treatments with perches*

Treatment	Type of interaction		Group 1 ($n = 13$)	Group 2 ($n = 19$)	Group 3 ($n = 19$)	Group 4 ($n = 16$)
Low perch	Aggressive pecking	Day	−0.43	**−0.47**	−0.39	**−0.59**
		Night	−0.11	−0.16	**0.50**	−0.31
	Approach/avoidance	Day	**−0.73**	−0.39	−0.16	−0.46
		Night	−0.44	−0.34	**0.49**	−0.14
Medium perch	Aggressive pecking	Day	−0.06	**−0.46**	−0.05	**−0.48**
		Night	−0.11	−0.34	–[b]	−0.46
	Approach/avoidance	Day	−0.14	**−0.43**	−0.01	**−0.53**
		Night	−0.05	−0.17	–[b]	−0.29
High perch	Aggressive pecking	Day	0.26	**−0.46**	−0.25	**−0.55**
		Night	–[a]	0.04	0.06	−0.34
	Approach/avoidance	Day	0.09	−0.18	0.01	−0.43
		Night	–[a]	−0.16	−0.06	−0.29

* Significant ($P < 0.05$) correlations are in bold type.
[a] No birds used perches during this observation period.
[b] No data were obtained for this observation period.

Table 4
Spearman correlation coefficients between social ranking orders in weeks 6–9 based on aggressive pecking and approach/avoidance interactions and ranking orders based on total times spent using (all) nestboxes, by day and night, during the four perch treatments*

Treatment	Type of interaction		Group 1 ($n = 13$)	Group 2 ($n = 19$)	Group 3 ($n = 19$)	Group 4 ($n = 16$)
No perch	Aggressive pecking	Day	0.06	−0.07	−0.16	−0.29
		Night	−0.05	0.14	−0.20	0.14
	Approach/avoidance	Day	0.12	−0.14	−0.19	−0.12
		Night	−0.19	0.13	−0.24	0.10
Low perch	Aggressive pecking	Day	−0.17	−0.12	**−0.59**	0.06
		Night	0.22	0.21	−0.03	−0.25
	Approach/avoidance	Day	0.22	−0.07	0.06	0.45
		Night	0.11	0.21	−0.08	−0.27
Medium perch	Aggressive pecking	Day	0.05	−0.14	**−0.63**	0.08
		Night	0.01	**0.43**	–[b]	**0.48**
	Approach/avoidance	Day	0.00	−0.05	**−0.66**	0.30
		Night	−0.01	0.39	–[b]	**0.49**
High perch	Aggressive pecking	Day	0.23	0.26	0.08	0.39
		Night	0.22	−0.09	−0.19	–[a]
	Approach/avoidance	Day	0.46	0.08	−0.02	**0.51**
		Night	0.11	0.15	0.12	–[a]

* Significant ($P < 0.05$) correlations are in bold type.
[a] Birds using nestboxes were not identifiable during this observation period.
[b] No data were obtained for this observation period.

4. Discussion

In this experiment, ranking orders in groups of laying hens were consistent across time when based on individual birds' observed frequencies of giving and receiving aggressive pecks, and of approaching and avoiding other birds, but not when based on frequencies of giving and receiving non-aggressive pecks (Table 1). Ranking orders based on aggressive pecks and approach/avoidances were also consistent with each other, but neither were consistent with those based on non-aggressive pecks (Table 2). These results indicate that social status of individual laying hens is relatively stable and can be based reliably on counts of either aggressive pecks or approach/avoidances. It was probably not stable to begin with, in the 2 weeks before the experiment started, when presumably the social hierarchy in each group of (20) newly assembled (adult and unfamiliar) birds was being established, and when much of the observed aggressive pecking damage (see Section 2.1) occurred (cf. McBride, 1958; King, 1965; Hughes et al., 1997). The fact that approach/avoidances, which involved no contact and minimal overt aggression, produced ranking orders that were very like those based on aggressive pecks suggests that both types may have reflected underlying social dominance, or peck orders, in all groups. Reservations concerning the ranking method in the present study are outlined in Section 2.2, and problems involved in measuring peck orders were reviewed in detail by Rushen (1984).

The present results also indicate that propensities to give and receive non-aggressive pecks are relatively inconsistent across time, and are not related to social status. This agrees with previous reports that allopreening, allopecking and feather pecking are not related to dominance (Hoffmeyer, 1969; Wood-Gush and Rowland, 1973; Leonard et al., 1995). However, in two studies with small groups of (four) fowls, one found feather pecking damage scores to be related negatively to social rank (Hughes and Duncan, 1972), and the other concluded that lower ranking birds show more allopreening (social grooming) while higher ranking birds show more feather pecking (Vestergaard et al., 1993). Perhaps non-aggressive pecking is linked to dominance more closely in small groups than in larger ones. No attempt was made here to distinguish between different types of non-aggressive pecking/pulling (as defined in Section 2.2); only the vigorous type is associated with feather loss and injury (Savory, 1995; Bilcik and Keeling, 1999).

During the present experiment, aggressive pecks were the most frequent (1.99 per bird/h) and non-aggressive pecks the least frequent (0.41 per bird/h) types of interaction observed (Fig. 1). Presumably this was because of the recent mixing of unfamiliar adult hens (cf. McBride, 1958; King, 1965). In a study by Hughes et al. (1997), rates of ''all agonistic interactions'' increased from 2.74 to 13.75 per bird/h in the first 49 h after new groups of 12 adult ISA hens were formed, but were lower (<1 per bird/h) in larger groups of (300 and 700) familiar ISA hens. In another experiment following the present one, where groups of 16 ISA hens formed at 17 weeks of age were observed to 44 weeks, the overall mean frequency of aggressive pecks was lower (0.47 per bird/h) and that of non-aggressive pecks was higher (1.45 per bird/h) than those reported here (C.J., Savory and L.S., Cordiner, unpublished data). Similarly, in the study of Hughes et al. (1997), the increase in frequency of agonistic interactions in the 49 h after new groups were formed, referred to above, coincided with a decline in mean frequency of ''non-agonistic interactions'' from 7.21 to 2.75 per bird/h.

The significant reduction in frequency of aggressive pecking during the treatment period (1.74 per bird/h), compared to the pre-treatment period (2.24 per bird/h, Fig. 1), can presumably be accounted for by the effect that presence of perches had in reducing aggressive pecking. This effect was greatest, and significant, with the High perch treatment (Fig. 2), despite the fact that perch use was greatest (though not significantly so) with the Low perch treatment (Fig. 3). Similarly, in other work with laying hens, significantly less feather pecking damage was found in pens with high (70 cm) than with low (45 cm) perches (Wechsler and Huber-Eicher, 1998). Such damage is usually due to non-aggressive pecking (Savory, 1995), which was not affected by perch treatment in the present study.

In the daytime during the treatment period, about 2% of time (overall mean) was spent in nestboxes, regardless of treatment, and 24% was spent on perches when they were present (Fig. 3). Hence, about 74% of birds in a group would have been on the (usable) pen floor at any one time during Low, Medium and High perch treatments, compared with 98% during the No perch treatment. This 24% reduction in bird density on the floor (where nearly all interactions occurred) suggests that the mathematical probability of an interaction between two birds happening by chance would have been reduced accordingly during treatments with perches. It probably cannot account for all the observed reduction in aggressive pecking, because the mean frequency of aggressive pecks during treatments with perches (1.48 per bird/h) was 42% lower than that during the No perch treatment (2.55 per bird/h).

The overall mean value of 24% of time spent perching by day agrees closely with some comparable values obtained with adult hens kept in non-cage systems (Savory and Cordiner, 1999; Bilcik and Keeling, 2000), but not with others which varied from <10 to 47% (Blokhuis, 1984; Appleby and Duncan, 1989; Carmichael et al., 1999). In layer cages with perches, mean proportions of time spent perching by day have varied from 25% (Braastad, 1990; Appleby et al., 1992, 1993) to 44% (Duncan et al., 1992). Factors like the length, height, design and positioning of perches, ability to feed or drink from them, presence of other resources, and early experience, all contribute to such variation.

In other studies where percent time spent perching at night was measured, mean values then were all much greater (66–100%) than daytime values, in non-cage systems (Blokhuis, 1984; Savory and Cordiner, 1999; Olsson and Keeling, 2000) and cages (Duncan et al., 1992; Appleby et al., 1992, 1993). This did not happen in the present experiment, however, when use of nestboxes increased greatly at night with all treatments (Fig. 3). In commercial layer systems provided with nestboxes, access to them is often closed at night.

During the day, perches tended to be used more by subordinate birds than by dominant ones in groups 2 and 4, regardless of treatment, and there was evidence of this in group 1 with the Low perch treatment (Table 3). Nestboxes, on the other hand, tended to be used more by subordinate birds in group 3 with Low and Medium perch treatments (Table 4). Nestbox use by day was greatest in group 1, where most of the early aggressive pecking damage occurred (see Section 2.1). During the night, there were no such significant tendencies indicating greater use of perches or nestboxes by subordinate birds, but there was some evidence of increased use by dominant birds then of perches in group 3 (Low perch treatment; cf. Swingland, 1977; Weatherhead and Hoysak, 1984) and of nestboxes in groups 2 and 4 (Medium perch treatment). In general, the tendencies observed in Tables 3 and 4 are weak and inconsistent, especially in view of the possibility that some correlations were significant by chance (type 1 error). Nevertheless, they provide some support for the suggestion that perches, and nestboxes, allow subordinate hens a means of avoiding dominant ones by day (McLean et al., 1986; Gibson et al., 1988). Together with the reduction in density of birds on the floor (see above), this may explain all the observed reduction in aggressive pecking during treatments with perches.

In a study investigating priority of access to limited resources (food, water, litter, perch, nestbox) in relation to social rank, in small groups of (five) fowls observed during 10-min sessions in a test pen, only food became the focus of competitive interactions (Banks et al., 1979). Subordinate hens may thus have unhindered access to perches by day, and to nestboxes when not in use for egg laying (nearly all eggs were laid before the morning observations in the present experiment). The relatively little time spent in nestboxes by day indicates that perches were preferred (Fig. 3), as also found by Bilcik and Keeling (2000).

The fact that dominant hens used perches and nestboxes as much as, or more than, did subordinates at night indicates that these resources may not have provided a refuge from aggression then, and hence that subordinates may have been just as safe on the pen floor then. Perhaps greater use of perches at night (by all birds) was suppressed in this experiment (see above) by relatively high levels of aggression, and this may account for the increased use of nestboxes then (especially when perches were absent, Fig. 3).

In conclusion, social status in groups of laying hens was consistent when based on counts of aggressive pecks or approach/avoidances, but not non-aggressive pecks. Aggressive pecks were the most frequent type of interaction observed, and were reduced by the presence of perches. When perches were present, hens did not spend more time using them at night, but spent more time in nestboxes then (than by day). There were weak tendencies for perches, and to a lesser extent nestboxes, to be used more by subordinate birds by day, but not at night. There was some evidence of increased use of these resources by dominant birds at night. Provision of perches reduces bird density on the floor (where nearly all interactions occurred), allows subordinate birds a means of avoiding dominant ones by day, reduces frequency of agonistic interactions, and should thus benefit laying hen welfare.

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References

Appleby, M.C., Duncan, I.J.H., 1989. Development of perching in hens. Biol. Behav. 14, 157–168.

Appleby, M.C., Smith, S.F., Hughes, B.O., 1992. Individual perching behaviour of laying hens and its effects in cages. Br. Poult. Sci. 33, 227–238.

Appleby, M.C., Smith, S.F., Hughes, B.O., 1993. Nesting, dust bathing and perching by laying hens in cages: effects of design on behaviour and welfare. Br. Poult. Sci. 34, 835–847.

Banks, E.M., Wood-Gush, D.G.M., Hughes, B.O., Mankovich, N.J., 1979. Social rank and priority of access to resources in domestic fowls. Behav. Proc. 4, 197–209.

Bilcik, B., Keeling, L.J., 1999. Changes in feather condition in relation to feather pecking and aggressive behaviour in laying hens. Br. Poult. Sci. 40, 444–451.

Bilcik, B., Keeling, L.J., 2000. Relationship between feather pecking and ground pecking in laying hens and the effect of group size. Appl. Anim. Behav. Sci. 68, 55–66.

Biswas, D.K., Craig, J.V., 1971. Social tension indexes and egg production traits in chickens. Poult. Sci. 50, 1063–1065.

Blokhuis, H.J., 1984. Rest in poultry. Appl. Anim. Behav. Sci. 12, 289–303.

Braastad, B.O., 1990. Effects on behaviour and plumage of a key-stimuli floor and a perch in triple cages for laying hens. Appl. Anim. Behav. Sci. 27, 127–139.

Carmichael, N.L., Walker, A.W., Hughes, B.O., 1999. Laying hens in large flocks in a perchery system: influence of stocking density on location, use of resources and behaviour. Br. Poult. Sci. 40, 165–176.

Duncan, E.T., Appleby, M.C., Hughes, B.O., 1992. Effect of perches in laying cages on welfare and production of hens. Br. Poult. Sci. 33, 25–35.

European Union (EU), 1999. Council Directive 1999/74/EC of 19 July 1999 laying down minimum standards for the protection of laying hens.

Farm Animal Welfare Council (FAWC), 1997. Report on the Welfare of Laying Hens. FAWC, Surbiton, UK.

Gibson, S.W., Dun, P., Hughes, B.O., 1988. The performance and behaviour of laying fowls in a covered strawyard system. Res. Devel. Agric. 5, 153–163.

Hoffmeyer, I., 1969. Feather pecking in pheasants — an ethological approach to the problem. Dan. Rev. Game. Biol. 6, 1–36.

Hughes, B.O., Duncan, I.J.H., 1972. The influence of strain and environmental factors upon feather pecking and cannibalism in fowls. Br. Poult. Sci. 13, 525–547.

Hughes, B.O., Appleby, M.C., 1989. Increase in bone strength of spent laying hens housed in modified cages with perches. Vet. Rec. 124, 483–484.

Hughes, B.O., Carmichael, N.L., Walker, A.W., Grigor, P.N., 1997. Low incidence of aggression in large flocks of laying hens. Appl. Anim. Behav. Sci. 54, 215–234.

King, M.G., 1965. The effect of social context on dominance capacity of domestic hens. Anim. Behav. 13, 132–133.

Knowles, T.G., Broom, D.M., 1990. Limb bone strength and movement in laying hens from different housing systems. Vet. Rec. 126, 354–356.

Lee, Y.-P., Craig, J.V., Dayton, A.D., 1982. The social rank index as a measure of social status and its association with egg production in White Leghorn pullets. Appl. Anim. Ethol. 8, 377–390.

Leonard, M.L., Horn, A.G., Wayne Fairfull, R., 1995. Correlates and consequences of allopecking in White Leghorn chickens. Appl. Anim. Behav. Sci. 43, 17–26.

McBride, G., 1958. The measurement of aggressiveness in the domestic hen. Anim. Behav. 6, 87–91.

McLean, K.A., Baxter, M.R., Michie, W., 1986. A comparison of the welfare of laying hens in battery cages and in a perchery. Res. Devel. Agric. 3, 93–98.

Ministry of Agriculture, Fisheries and Food (MAFF), 1987. Codes of Recommendations for the Welfare of Livestock, Domestic Fowls. MAFF Publications, London.

National Farmers' Union (NFU), 2000. Poultry Bulletin, Egg Production Quarterly. NFU, Newmarket, UK, Quarterly, January 2000.

Olsson, I.A., Keeling, L.J., 2000. Night-time roosting in laying hens and the effect of thwarting access to perches. Appl. Anim. Behav. Sci. 68, 243–256.

Royal Society for the Prevention of Cruelty to Animals (RSPCA), 1997. ''Freedom Food'' Welfare Standards for Laying Hens. RSPCA, Horsham, UK.

Rushen, J., 1984. How peck orders of chickens are measured: a critical review. Appl. Anim. Ethol. 11, 255–264.

Savory, C.J., 1995. Feather pecking and cannibalism. World's Poult. Sci. J. 51, 215–219.

Savory, C.J., Cordiner, L.C., 1999. Do hens in alternative housing benefit from elevated perches? SAC Animal and Food Sciences Research Report (ISBN 1854826980), pp. 32–34.

Scottish Executive Rural Affairs Department (SERAD), 1999. Egg Marketing Regulations, explanatory leaflet on the production methods for eggs marketed under the Special Marketing Terms Free Range etc. SERAD, Edinburgh.

Swingland, I.R., 1977. The social and spatial organisation of winter communal roosting in rooks (*Corvus frugilegus*). J. Zool. Lond. 182, 509–528.

Syme, G.J., Syme, L.A., 1974. The relationship between the peck order and performance in a competitive group feeding situation by two groups of cockerel. Behav. Biol. 12, 547–550.

Vestergaard, K.S., Kruijt, J.P., Hogan, J.A., 1993. Feather pecking and chronic fear in groups of red junglefowl: their relations to dustbathing, rearing environment and social status. Anim. Behav. 45, 1127–1140.

Weatherhead, P.J., Hoysak, D.J., 1984. Dominance structuring of a red-winged blackbird roost. Auk 101, 551–555.

Wechsler, B., Huber-Eicher, B., 1998. The effect of foraging material and perch height on feather pecking and feather damage in laying hens. Appl. Anim. Behav. Sci. 58, 131–141.

Wood-Gush, D.G.M., Rowland, C.G., 1973. Allopreening in the domestic fowl. Rev. Comp. Animal 7, 83–91.