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Night-time roosting in laying hens and the effect of thwarting access to perches

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Abstract

Free-living hens roost on branches in trees at night, and laying hens in aviary systems or cages provided with perches also make extensive use of these for night-time roosting. It is therefore suggested that roosting on perches is important to the hens and that domestic hens should be provided with perches in order to promote welfare. However, no study has addressed the question of motivation for roosting. In the present experiment, we studied undisturbed roosting behaviour and the reaction of commercial laying hens when roosting on perches was thwarted. Fifty-two adult hens (Lohmann Selected Leghorn, LSL) were kept in two groups of 26 hens in litter pens with perches at heights of 23, 43 and 63 cm. Behaviour was observed for 60 min starting at lights-off, registering the number of hens on each perch level. The hens started to get onto the perch immediately and within 10 min after lights-off, more than 90% of the hens were on the perch. All hens roosted close together on the top perch. In a second experiment, 24 hens were kept in eight groups of three birds each in experimental pens equipped with perches. Birds were tested in four different situations: (1) the pen unchanged (Base), (2) the perch covered with plexiglass (PCov), (3) the perch removed (PRem) and (4) the unchanged pen (Post). The order of PCov and PRem alternated between groups in a balanced manner and all groups of birds experienced all four treatments. The hens were observed for 60 min from lights-off using focal sampling. For comparisons, the Post treatment served as the control. In the treatments where perching was not possible, the hens spent less time sitting ($p = 0.042$), and also tended to spend more time standing ($p = 0.06$), than in the control. Furthermore, the hens moved more ($p = 0.042$) when the perch was inaccessible, and when the perch was visible but inaccessible they also showed more attempts to take off ($p = 0.042$). These findings can be interpreted as increased frustration and/or exploration, probably to find an alternative roosting site. Together with the high use of perches for night-time roosting under undisturbed conditions, these results indicate that laying hens are

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motivated to perch and imply that hens kept under conditions where perching is not possible may experience reduced welfare.

Keywords: Laying hens; Perching; Motivation; Frustration; Thwarting

1. Introduction

Under feral conditions, domestic hens roost on branches in trees at night, seeking out these places well before dark (Wood-Gush et al., 1978). The cue for going to roost, as Kent et al. (1997) have shown for free-ranging domestic hens in the Gambia, is the afternoon light decreasing below a certain intensity. Groups of hens have preferred roosting sites within their home ranges, and at night, group members move there for roosting (Collias and Collias, 1967; McBride et al., 1969; Wood-Gush et al., 1978). Young chicks are brooded by the mother hen on the ground, but at about 6 weeks of age, the hen starts to take them to lower branches for roosting (McBride et al., 1969).

Under natural conditions, birds that choose elevated locations for their night rest run a lower risk of predator attacks, and it seems reasonable to assume that there has been selection towards roosting. Dawkins (1990) has suggested that causal mechanisms initiating a behaviour that under natural conditions maximizes fitness, will continue to motivate the same behaviour in domestic animals, although they are kept in a protected environment where the fitness effects have been eliminated. Blokhuis (1984) found that whereas during the day birds often rested in a standing position and not always on the perch, at night all hens rested on the perch and most on the highest perches available. In commercial systems with access to perches, the majority of birds use the perches for roosting at night and make extensive use of the perches also during the day (Tauson, 1984; Braastad, 1990; Duncan et al., 1992; Appleby, 1995; Appleby et al., 1992, 1993; Abrahamsson, 1996; Newberry et al., 1997, Lambe and Scott, 1998), although variation between strains has been reported (Faure and Jones, 1982a,b). The high percentage of night-time perching in domestic hens kept in cages or aviaries, when given access to perches, has been taken as an indicator that hens are motivated to roost also when housed under commercial conditions. However, the motivation to perch has not been experimentally studied.

It has been argued that if an animal cannot perform a behaviour it is motivated to show, then its welfare will be reduced (Hughes and Duncan, 1988; Dawkins, 1990; Jensen and Toates, 1993) There are several methods for studying motivation (see Fraser and Matthews (1997) for a review of preference and motivation testing). One of these is to deprive the animal of the possibility to perform a particular behaviour sequence and then record what the animal does. If it is a behaviour for which the animal is motivated, the animal will respond to the deprivation with behavioural changes, such as the performance of vacuum activities or signs of frustration. Frustration in domestic fowl has been investigated by thwarting feeding, nesting, incubating, brooding and sexual activity (Duncan, 1970; Duncan and Wood-Gush, 1971, 1972). When feeding was thwarted, hens showed an increase in preening (hereafter referred to as displacement preening) when hunger/feed expectancy was low, and an increase in escape attempts

developing into stereotyped pacing, at higher levels of hunger/feed expectancy (Duncan and Wood-Gush, 1972). This was accompanied by an increase in aggression when in the presence of a subordinate companion bird (Duncan and Wood-Gush, 1971). An increase of exploratory behaviour, suggesting that the hens are searching for the missing resource, may also be seen as a response to thwarting (Nicol and Guilford, 1991).

If perching at night is a behaviour laying hens are motivated to show, it is important that housing systems allow hens to perform that behaviour. This is not the case in conventional battery cages. Also, in alternative systems such as aviaries and percheries, the possibility of perching may be restricted due to lack of perching space. However, it is not clear which stimuli trigger the motivation to perch. It has been suggested, that 'out of sight' may be 'out of mind', i.e., in the absence of external stimuli, the hens may not be able to produce a mental representation of performing the behaviour and therefore not be motivated (Petherick et al., 1990). In this case, the hens would thus show more frustration in the presence of external stimuli than in the situation where both the resource and the stimulus are removed, which is supported by findings by Zulkifli et al. (1995) for feed-thwarting. It is possible therefore that in the complete absence of perches, such as in cages, birds would be less frustrated than hens in loose-housing systems, where birds can see other birds perching but are themselves prevented from perching due to space restrictions.

In the present study, we investigated the use of perches for night-time roosting in adult laying hens kept in groups in a litter system. In the first experiment, the use of perches in undisturbed groups of hens was studied, in order to learn more about their normal roosting behaviour prior to the further experimental study. In the second experiment, we studied behaviour when roosting was thwarted. To investigate the effect of external stimuli on motivation, we used two different thwarting situations: one where the perches were present but inaccessible, and one where the perches were removed.

2. Materials and methods

2.1. Experiment 1 — roosting behaviour in groups of hens

Experiment 1 was an observational study on the use of perches for night-time roosting in the home pens in order to find out where the hens roosted and how long it took them to go to roost under undisturbed conditions. Fifty-two laying hens of the hybrid Lohmann Selected Leghorn (LSL) aged 36 weeks at the start of the experiment were used. The hens came from a floor rearing system with access to perches and had been kept at the experimental farm in pens with litter and perches from the age of 16 weeks. Prior to the experiment, the hens were housed in two groups in adjacent litter floor pens, each pen measuring 4.0×4.5 m^2. Perches were provided at three heights: 23, 43 and 63 cm, giving 90-cm perch space in total per hen, or 30 cm/hen at each height (management recommendations are 12–16 cm/hen). The perches were of the traditional type made of hardwood, rectangular in cross-section and measuring

45×45 mm^2. Feed and water were available ad lib and hens had continuous access to nests at floor level. Eggs were collected every day. Light was controlled by a timer and gave a 12-h light period, starting at 0330 h. Daylight level was approximately 3 lx. After lights-off, a single spotlight placed outside the pens provided approximately 1 lx. All birds were wing-tagged for individual recognition.

Hens were observed from the time the light was switched off and for a further 60 min. The number of hens on each perch level was recorded, using scan sampling with 2-min intervals during the first 30 min and 4-min intervals during minutes 30–60. The two pens were observed as independent units. Observations were repeated on four consecutive days.

2.2. Experiment 2 — roosting in normal and thwarted situations

In this experiment, we studied the behaviour when night-time perching was thwarted, with and without the perch being visible. Twelve hens were randomly chosen from each of the two groups of hens in Experiment 1, giving a total of 24 hens for Experiment 2.

The 24 hens were allocated to eight groups and kept in separate experimental pens. The three hens in each group came from the same home pen. Four experimental pens were used for the observations, two located in the same room as the home pens, but visually isolated from these and two located in a different room. In order to allow observations of all four pens on the same day, the second room was on a light schedule 2 h earlier than the schedule of the home pens. The experimental pens measured 1.50×1.00 m^2 and were equipped with litter, a feeder, a drinker and perches at the same heights and space per hen as in the home pen. The perch was constructed in such a way that it could be removed from the pen or covered with a plexiglass sheet for the experimental treatments. All pens were lit with incandescent light and illumination levels were identical to those in Experiment 1. One dimmed spotlight in each pen made it possible for the observer to see the hens after the main light had been switched off. Four groups of hens were tested first, and the remaining four groups of birds were tested in the same experimental pens 2 weeks later.

Hens were moved to the experimental pens 7 days prior to the first observation and were kept there during the four observation days. Management was similar to when in the home pen and to habituate the hens to the experimental procedure and to avoid association of the arrival of the observer as a signal of a coming lights-off, we performed ‘sham observations’ (one observer stood in front of the pen in the same position as during observations for 10 min) each morning after feeding during both the adaptation and the experimental period. The four different experimental situations were: pen unchanged (Base), perch covered with plexiglass (PCov), perch removed (PRem) and again pen unchanged (Post). In PCov, the perch was covered with a sloping board of plexiglass, so that the perch could be seen, but a bird trying to perch on top of the plexiglass would immediately slide down. Base was always the first observation and Post always the last, whereas the order of PCov and PRem alternated between groups in a balanced manner, so that PCov was the second treatment for half of the birds and the third for the other half and vice versa.

A session started with the observer entering the room where the hens were kept. Five minutes before the observation period, the spotlight was switched on and perches were manipulated. In the PCov treatment, the plexiglass cover that had been present in the pen for 24 h was put on top of the perch, so that the hens could see but not get up onto the perch. In the PRem treatment, the perch was lifted out of the pen. To avoid bias resulting from manipulation of the perch, in the Base and Post treatments the perch was lifted out of the pen and re-introduced immediately. The observer then stood quietly outside the pen.

Observations were carried out during two different periods. The hens were first observed for a 15-min period when the main light was still on. There was then a 5-min break, during which the observer remained in the room, before the main light in the room was switched off. Observations then started again and continued for 60 min after lights-off. Immediately after the end of the second observation period, the perch was restored and the spotlight switched off, leaving the pen in its original state.

Both the location and the activity of the birds were recorded. The following locations were recorded: perch1 (the lowest perch), perch2, perch3, nest, floor (excluding nest) and other. 'Other' was scored when hens attempted to perch on the wooden frame of the pen wall and were balancing on the wall before falling down again onto the floor. The activities recorded are presented in Table 1.

2.3. Data recording and analysis

The hens were observed directly, using a handheld computer (Psion Workabout, Psion PLC) and the software package THE OBSERVER (Noldus Information Technology). Observations were performed as continuous observations of focal animals, alternating between the three hens in each group every second minute, so that each hen was

Table 1
Activities recorded during observations in the experimental pens

States	Instantaneous behaviours
Standing	Steps on the floor
Sitting	Shuffles on the perch (steps or turning around)
Moving between perches	Pushes to other hens on the perch
Walking	Chases
Preening	Threats
Foraging	Pecks on own breast feathers
Feeding	Aggressive pecks to other hens
Drinking	Non-aggressive pecks to other hens[a]
Other	Pecks on the perch/ plexiglass cover
	Intention movements to fly[b]
	Flying attempts[c]

[a] Soft pecks, not directed towards head/neck region.
[b] When the hen made the first movements for flying but without taking off.
[c] When the hen flew towards an object on which it could not land and therefore fell back on the floor.

observed one third of the total observation time. Behaviours recorded as states were expressed as the percentage of time observed for each hen and instantaneous behaviours as frequency per 15 min observed. For statistical analysis, the mean of the data from the three hens in each pen was used. Data from the observation before the lights went off were analysed separately from the data from the observation after lights-off. The 60-min observation period in the dark was further divided into four sub-periods of 15 min each, for which durations and frequencies of behaviours were calculated separately. Comparisons between treatments were made on an average of the four sub-periods. Comparisons within treatments were made between the first and the last of the four sub-periods.

Walking and feed-related behaviour could by definition be performed only on the floor, and were therefore expressed as percentage of the time observed on the floor, to allow comparisons between treatments with and without perches. In a similar manner, moving between perches could only be performed when on the perch, and was therefore expressed as percentage of the time observed on the perch. For the statistical analysis, feeding, foraging and drinking were grouped together into a new category called ''consummatory behaviour'' and aggressive pecks, threats and chases were grouped into the category ''agonistic behaviour.'' Intention movements and attempts to fly were grouped into ''attempts to take off.''

The Base treatment was classed as habituation, so for comparisons the Post treatments served as the control. The following comparisons were made: PCov vs Post, PRem vs Post and PCov vs PRem. Statistical analysis was carried out using the statistical software MINITAB (Minitab). All data were analysed in pairwise comparisons using Wilcoxon Matched Pairs Signed Rank Test with Bonferroni corrections for multiple comparisons. Data analysis was based on means of three individuals, and therefore results are presented as mean $\pm$ standard deviation.

3. Results

3.1. Experiment 1 — roosting in groups of hens

When observed under normal circumstances in their home pens, less than five hens in each group were seen on the perch just before lights-off, but as soon as the lights went off, birds started to go up onto the perch. After 10 min, more than 90% of the hens were on the perch (Fig. 1).

Hens got onto the lowest perch and then jumped further up from perch to perch. The birds perched close together and hens that got an end position were frequently seen trying to move to the center, pushing other hens out of place. Hens did this by moving down to a lower perch and then trying to push themselves between two others on the upper perch. While changing positions, the hens used all perch levels and even occasionally went down onto the floor. This shuffling lasted for about 10 min before all birds were settled tightly together on the top perch. Hens did not make use of all the space available at the top level but left about one-fourth empty. Lower perches were

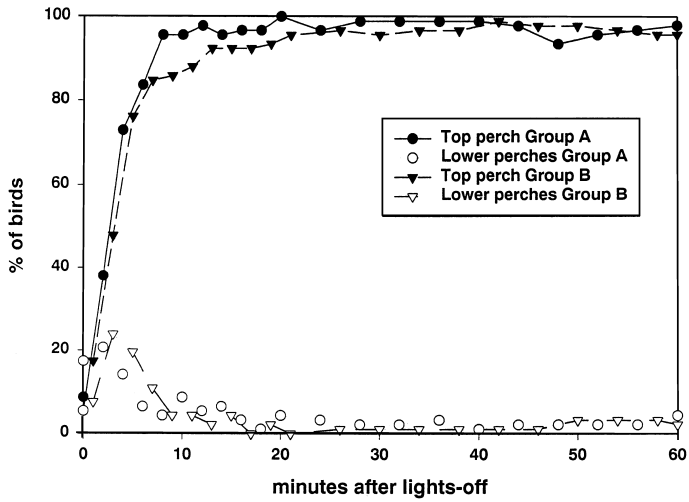

Fig. 1. Percentage of birds on the different perch levels when observed in the home pens during 60 min after lights-off. Top perch: 63 cm. Lower perches: 43 and 23 cm.

never used for roosting and observations of birds on lower perches were always in connection with movements on the perch. No bird roosted on the floor or in any other location in the pen.

3.2. Experiment 2 — roosting in normal and frustrated situations

3.2.1. Before lights-off

3.2.1.1. Locations. No birds were seen in the nest before darkness in any of the treatments. Since there was no perch available in the PCov and PRem treatments birds spent 100% of the time on the floor. In the Base treatment, birds spent $18.5 \pm 16.4\%$ of the time on the perch, whereas in the Post treatment, $52.8 \pm 29.8\%$ of the time was spent on the perch. In both treatments, the rest of the time was spent on the floor.

3.2.1.2. Activities. Before the light was switched off, hens showed mainly consummatory behaviour (foraging and feeding) or were standing (Fig. 2a and b). There were no significant differences between treatments in how the hens distributed their time on different activities.

3.2.2. After lights-off

3.2.2.1. Locations. In the Base and Post treatments where perching was possible, the hens started to go up onto the perch almost immediately after the light was switched off,

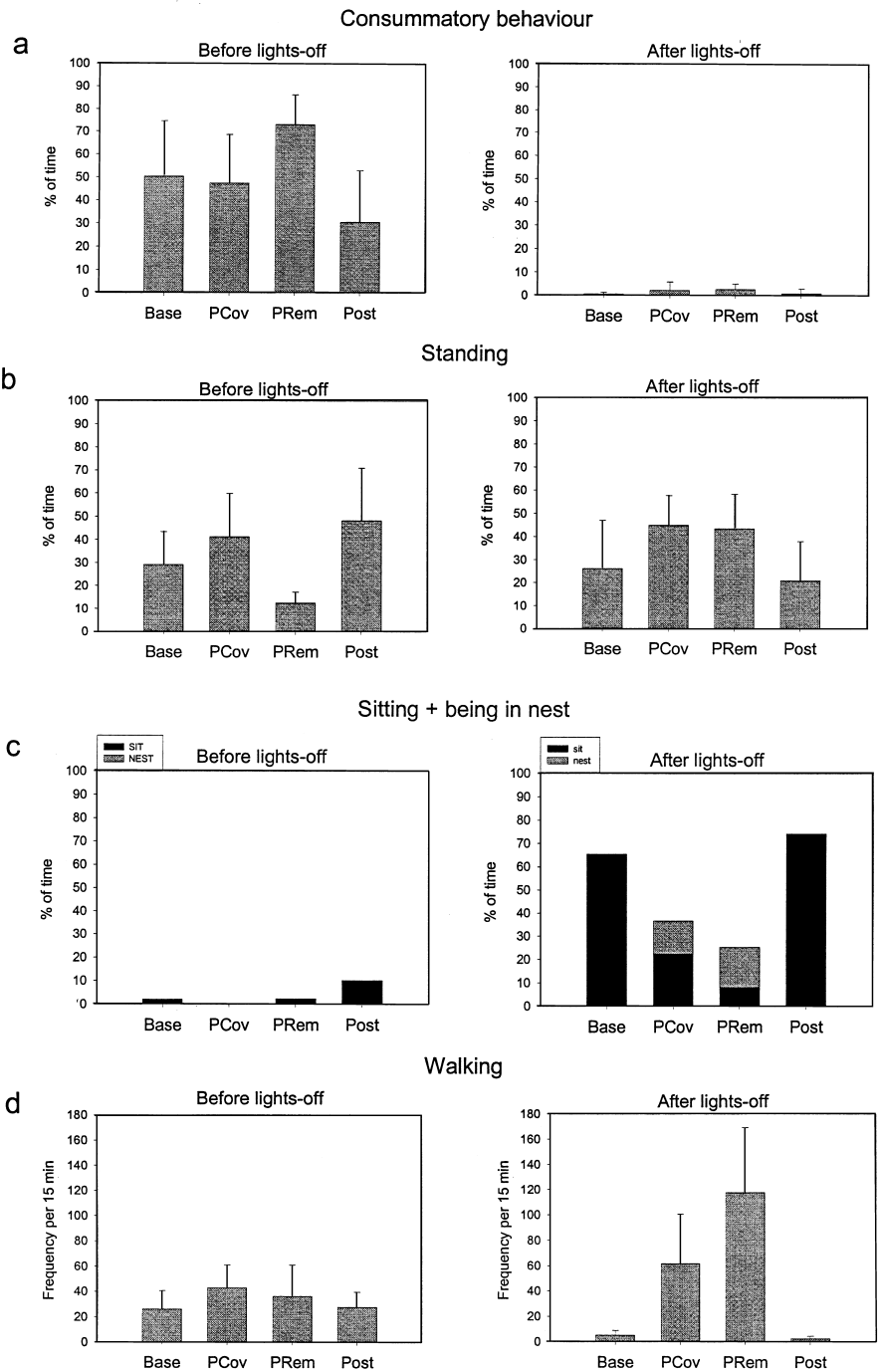
Consummatory behaviour
a
Before lights-off
After lights-off
% of time
Base
PCov
PRem
Post
Standing
b
Sitting + being in nest
c
SIT
NEST
sit
nest
Walking
d
Frequency per 15 min

Table 2
Time spent at different locations during observations in the experimental pens during the 60-min period after lights-off. Durations are expressed as percentage of total time observed and are given as mean ± standard deviation

Location	Treatment			
	Base	PCov	PRem	Post
Floor	2.20 ± 2.06	85.7 ± 12.7	82.6 ± 20.6	1.10 ± 2.06
Nest	0.00 ± 0.00	14.2 ± 12.8	17.4 ± 20.6	0.00 ± 0.00
Perch	97.8 ± 2.06	–	–	98.9 ± 2.06

and all birds were roosting within 6 min. In all observations, except one (where towards the end of the observation period all birds went down to the feeder for some minutes and then returned to the perch), birds remained perching. In the PCov and PRem conditions where birds did not have access to the perch, they spent most of the time on the floor (excluding the nest), but they also spent some time in the nest. No significant difference was found between PCov and PRem treatments in how time was distributed between the floor and the nest. Means and standard deviations are presented in Table 2.

3.2.2.2. Activities. After lights-off, birds spent less time sitting ($W = 36$; $p = 0.042$) and also tended to spend more time standing ($W = 1$; $p = 0.06$) in the treatments without a perch (Fig. 2b, right, and c, right). When the hens were in the nest, their activity could not be observed, and if it is assumed that most of that time was spent sitting, the above is an underestimate of the total time spent sitting. However, if the variable 'being in the nest' is added to 'sitting,' there is still a tendency for birds to sit less when they do not have access to the perch ($W = 1$; $p = 0.06$).

Walking was measured as number of steps. This was higher in the treatments without perch ($W = 36$; $p = 0.042$) than in the control treatment, and tended to be higher in PRem than in PCov ($W = 2$; $p = 0.09$) (Fig. 2d). Birds were thus moving more in the treatments without a perch than when they had access to a perch. However, a comparison between the first 15 and the last 15 min of the observation period shows that birds moved less later in the observation also in the PCov and PRem treatments. In both treatments they spent more time sitting (PCov: $W = 0$, $p = 0.022$; PRem: $W = 0.0$, $p = 0.022$) and less time walking (PCov: $W = 36.0$, $p = 0.014$; PRem: $W = 36.0$, $p = 0.014$) during minutes 45–60 than during minutes 1–15 (Fig. 3a).

Attempts to take off were seen more often in the PRem treatment than in the control treatment ($W = 0$; $p = 0.042$) (Fig. 4). Attempts to fly were seen only in treatments without perch (PCov and PRem). In the treatments without perch, the frequency of attempts to take off were significantly lower during the last 15 min than during the first

Fig. 2. Behaviours observed in the experimental pens during the 15-min period before lights-off (left column of graphs) and during the 60-min period after lights-off (right column). Results are presented as mean ± standard deviation. (a) consummatory behaviour, (b) standing, (c) sitting + being in the nest, and (d) walking.

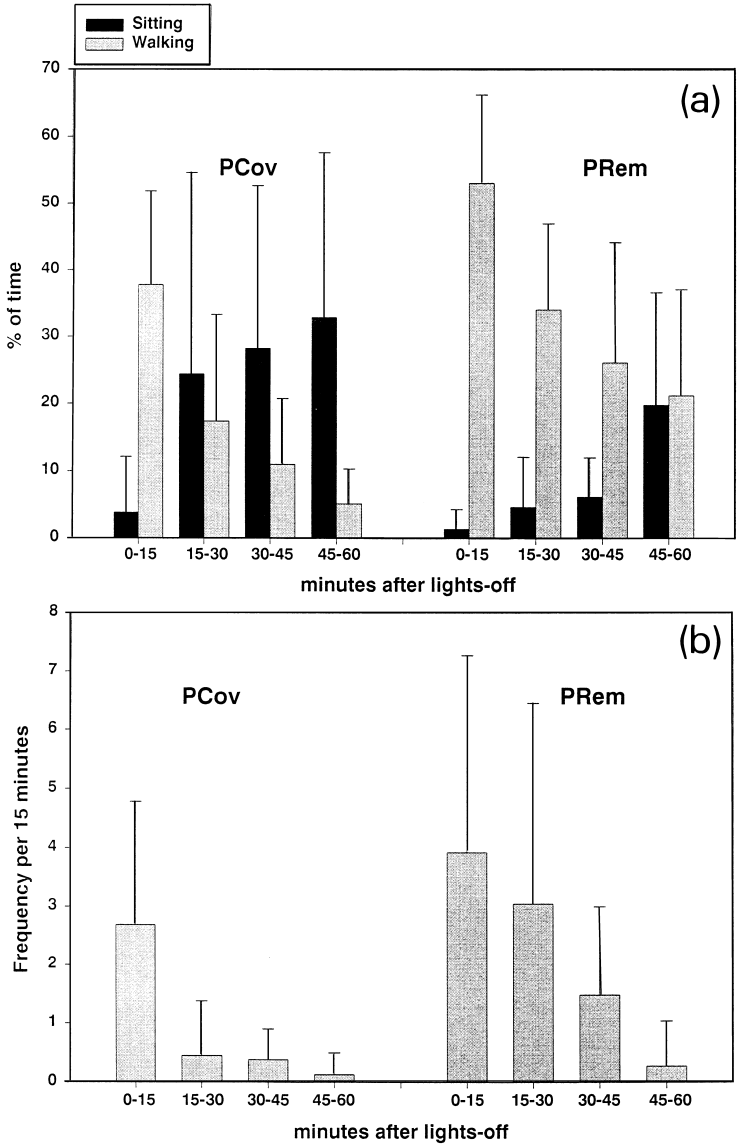

Fig. 3. Behaviours observed per 15-min interval in experimental treatments PCov and PRem during 60-min observation after lights-off. Results presented as mean ± standard deviation. (a) sitting and walking, (b) attempts to take off.

15 min of the observation period (PCov: $W = 21.0$, $p = 0.036$; PRem: $W = 26.0$, $p = 0.05$), as can be seen in Fig. 3b.

Pecks on the birds' own breast feathers were seen only in the PCov (freq 0.154 ± 0.082 per 15 min observed) and the PRem (0.20 ± 0.086 per 15 min observed) treatments.

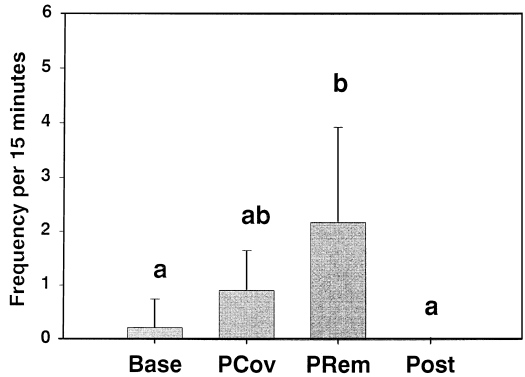

Fig. 4. Frequency of attempts to take off during 60-min observation after lights-off in the experimental pens. Results presented as mean ± standard deviation. Different letters indicate differences significant at $p = 0.05$.

Agonistic behaviour and non-aggressive pecks were seen in all treatments but at very low levels (frequencies less than 0.6 and 0.2 per 15 min observed) and with no significant difference between treatments.

4. Discussion

Earlier experiments have shown that domestic hens given access to a perch will use it for night-time roosting (Wood-Gush et al., 1978; Duncan et al., 1992; Lambe and Scott, 1998), but those studies did not address the question of the hens' motivation for roosting. Our experiment suggests that laying hens are motivated to roost on perches. We found that all hens used perches for roosting at night when allowed, and when roosting behaviour was thwarted (by removing the perch or making it inaccessible) birds moved more, showed attempts to perch at other sites and took a longer time before they settled. These behaviours can be interpreted as frustration or as increased exploration behaviour and are indicators of motivation to get access to the resource (Duncan, 1970; Nicol and Guilford, 1991).

In the first part of the experiment, roosting behaviour was studied in the birds' home pens. Under these conditions, the hens started to go up onto the perch as soon as the lights went off. Although much moving and shuffling occurred before the birds had occupied their final roosting positions, no birds left the perch to roost in another location and all birds chose their final roosting position on the top perch. These results are consistent with Blokhuis (1984), who found that almost all birds rested on the top perch and observed competition for places before hens came to rest.

In the second part of the experiment, the hens were exposed to situations where perching behaviour was thwarted. This resulted in more locomotion and a longer time before the hens came to rest. In a situation of high internal motivation for a certain behaviour and in the absence of appropriate external stimuli, animals may show an increase in general exploratory activity. Under natural conditions, this response would

increase the probability of finding the relevant external stimuli for the behaviour (Nicol and Guilford, 1991). In our experiment, we saw that when the hens were walking along the walls of the pen, they were looking up at the walls and also occasionally made attempts to fly. We suggest that the hens were not only generally exploring, but also specifically searching for an alternative place for roosting when the normal perch was not available.

Increased aggression, displacement preening and escape attempts/stereotyped pacing have been reported as responses to frustration (Duncan, 1970; Duncan and Wood-Gush, 1971, 1972). The escape behaviour reported by Duncan and Wood-Gush (1972) as an initial response to frustration was very similar to what was observed in our experiment: quick walks along the walls of the pens and circular movements with the head, as if trying to escape. In our experiment, pecks at the birds' own breast feathers (possible displacement preening) occurred only in treatments without a perch, but the levels were so low that statistical analysis revealed no difference between these and treatments with perch. No difference in aggressive behaviour was seen. All together, these findings indicate that birds may have experienced some frustration, although not to the extent reported in the feed-thwarting experiments of Duncan and Wood-Gush (1971, 1972).

In the PCov treatment, the perch was covered with plexiglass, so that it was visible but not accessible, i.e., the stimulus was present but the consummatory behaviour could not be performed. In PRem, the perch was completely removed, and thus possibly the external stimulus was removed. This set-up was chosen to test the idea of 'out of sight — out of mind,' i.e., that hens in the absence of external stimuli are not motivated because they are not able to form a mental representation of performing the behaviour (Petherick et al., 1990). Contrary to this we found that in the absence of the external stimuli, the hens tended to walk even more than when the external stimuli were present but inaccessible. Although this could indicate that birds are even more motivated to perch in the absence of the perch, a more likely explanation is that moving about on the floor was made easier when the perch was removed (although available floor space was not changed since birds could walk under the perches). Furthermore, one cannot exclude that hens perceived other things as appropriate stimuli for perching. The walls of the pens consisted of an upper part made of netting and a lower wooden part, and the line between the two parts may in the dim light have been perceived as a possible perch. Birds were indeed seen to fly towards the wall and to try to hold themselves onto the netting, although they always fell back down again. In any case, our results do not support the idea that hens would be less frustrated when the perch is absent. Duncan (1970) reported a similar lack of difference between treatments with and without external stimuli present in an experiment investigating nesting motivation.

When the hens had no access to perches, it took them took longer to roost than when the perches were available. Hens finally settled sitting either on the floor (often in a corner) or in the nest. Our impression was that in the absence of a usable perch, the hens looked for some other type of protection for their roosting site. Such protection could be found under the plexiglass-covered perch or in the gap between the perch and the wall, but was more difficult to find in the pen where the perch had been completely removed. Hens will brood their chicks in protected locations on the ground until the chicks are old enough to manage to perch on low branches (McBride et al., 1969; Wood-Gush et al.,

1978; Kent et al., 1997), so although ground roosting has not been reported for adult fowl without chicks, it occurs in the natural behavioural repertoire of the hen.

At the time when the perch was re-introduced in the pen, after 1 h of darkness, hens had already settled down for the night on the floor. Nevertheless, they would always get up and within 15 min be roosting on the perch, which further supports the suggestion that they preferred the perch as a roosting site. Our subjective impression was that hens roosting were quieter and less disturbed when on the perch, and it has also been shown that birds on a raised perch are less fearful (Keeling, 1997). When birds were roosting on the floor or in the nest, there were many disturbances as a result of interactions between birds followed by changes in behaviour. This was particularly so in the nest, where if one hen was in the nest and another one entered, the interaction always ended with one of them coming out from the nest again. We conclude that although hens will settle on the floor, under such conditions resting will be more disturbed than when on a perch.

5. Conclusion

When hens had access to perches, they always used them as the location for night-time roosting and were never seen to roost at other sites. When perches were not accessible, the hens showed signs of frustration and/or increased exploration. These signs tended to be more frequent when the external stimulus of the perch was absent than when the perch could be seen. In conclusion, these results indicate that laying hens are motivated to use a perch for night-time roosting and that this motivation remains in the absence of the external stimulus of the perch. However, the effect of earlier experience remains to be studied. For the assessment of welfare, it would be valuable to extend the study of perching motivation with an experiment, which includes quantification of motivation in different situations, including hens with no previous experience of perching.

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