

Prelying behaviour of laying hens (*Gallus gallus domesticus*) in different free range settings

Das Legeverhalten von Legehennen (*Gallus gallus domesticus*) unter verschiedenen Freilandbedingungen

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Introduction

In Switzerland, housing systems and equipment for farm animals sold commercially must be approved by the Swiss Federal Veterinary Office in respect to animal welfare (ANON., 1981; ANON., 1978). The present study emerged from the development of a testing procedure to assess whether nest boxes meet the needs of laying hens. To develop such a procedure, it was necessary to have accurate knowledge of the hens' natural nest-oriented behaviour.

Surprisingly only short and incomplete descriptions, and no quantitative data of the prelying behaviour (the behaviour expressed in the hours before oviposition) in a natural or semi-natural habitat were found in the literature. Some observations have been made on a population of domestic fowl established on an uninhabited island off the coast of Scotland by DUNCAN et al., (1978). Even though no continuous data of prelying behaviour was recorded, it was observed that many elements of behaviour such as locomotion or the gake call, were similar to that of domestic hens kept in pens, but at a reduced frequency or intensity. MELISSER and HUGHES, (1989) observed the prelying behaviour of hens in alternative systems where the proportion of time spent in the nest progressively increased in the last hour before oviposition while the other observed behaviour occurred mostly at the beginning of this period. High levels of exploratory behaviour (including pacing) in the prelying period and a high incidence of the gake call may be indicators of frustration (WOOD-GUSH, 1972; ZIMMERMAN and KOENE, 1998; OLSSON and KEELING, 2000; COOPER and ALBENTOSA, 2003; ZIMMERMAN et al., 2000).

Selected nest sites of hens in their natural habitat ranged from well-concealed holes to more open sites (DUNCAN et al., 1978). COLLIAS and COLLIAS, (1967) found nest sites mostly in or near patches of tall bunchgrass when observing a red jungle fowl population in north-central India.

The aim of the present study was to give a qualitative and quantitative description of the prelying behaviour of domestic laying hens in two different free range settings. These semi-natural habitats enable us to record the behavioural elements, and their frequencies, that are performed by modern hybrids when not influenced by restrictive housing systems. We observed the behaviour of hens from daybreak until oviposition in 2 experiments with different conditions.

Materials and Methods

Animals and pre-experimental housing

The study was conducted with brown "Lohmann Traditional" laying hens in 2 experiments (Experiment A and B), each with 2 successive replicates (Replicate 1 and 2). For each replicate, the animals were purchased at 18 weeks of age from a commercial breeder. In Experiment A, 16 birds were used in Replicate 1 and 12 birds in Replicate 2. In experiment B 16 hens were used in each replicate. All hens were commercially reared in a littered shed with access to a wintergarden. During rearing the animals had no access to nest boxes.

For the first two weeks, the hens were kept in a pen (4.3 x 2.6 m, height 1.9 m) with a littered floor (wood-shavings) and perches (10.7 m in length at a height of 0.9 m). Ad libitum access to layers' mash in round food troughs (diameter 0.30 m) and water via nipple drinkers was provided. Hens were fed with commercial layers mash (ME 11.5 MJ/kg; CP 160.0 g/kg; Met 3.3 g/kg; Ca 40.0 g/kg; P 5.3 g/kg).

The pen was illuminated with fluorescent lamps and the animals were kept on a 13 h light/11 h dark schedule, with lights on from 9:00 a.m. and a 15 minute twilight phase at the beginning and end of the day. No nest boxes were provided in the pen in order to avoid influencing a hens' "idea" of a suitable nest site, which could have biased the behaviour shown during the experiment.

The experiment began in week 21 of hen age, as all the hens had by then started to lay. During the day, the hens stayed in one of two adjoining pastures (each 14 x 14 m) surrounded by a wire-mesh fence. The lower part of the 2 m high fence between both pastures was covered with a 1 m high roofing cardboard to prohibit visual contact. Trees, bushes and patches of high grass provided potential nest sites. Feed in a round food trough (diameter 0.3 m) and water via a fountain were available ad libitum under a tree in the middle of each pasture.

Experiments

At the start of the experiments in week 21, hens were randomly assigned to groups of 4 hens each and was marked individually with leg bands.

Experiment A. During the night, each group was housed in a separate pen (0.9 x 2.6 m, height 1.9 m) that contained litter, a perch, a feeder and 2 cup drinkers. The hens were carried out into the pastures every morning at 8:45 a.m. before turning on lights in the pen. In the evening between 5 and 6 p.m. the hens were lured back into the pen.

Each replicate of the experiment consisted of an adaptation phase and an observation phase. During the 8 day adaptation phase, 2 groups were kept together in one pasture for 2 successive days, then they exchanged pastures with the other 2 groups for the next 2 days and so on. For the 12 day observation phase, one group was observed in a pasture for 3 consecutive days whereas the other groups stayed in the other pasture. This continued until each group had been observed alone in one of the pastures. With this system we balanced the number of days each group had been in both pastures, and made sure that every group had spent the 3 days preceding observation in the same pasture where they were observed.

Experiment B. A chicken coop (1.9 x 1.3 m, with 1.5 m height) was placed into each pasture which was accessible all day and where the hens stayed during night to avoid the changing between the stable and the pastures. A glass window (0.7 x 0.4 m) in the wall of the coops allowed observation of the inside. The coops were furnished with 1.9 m long perches (height 1.2 m), a feeder and a chicken fount. Layers' mash and water were available ad libitum and the ground was littered with wood-shavings. An automatic door (0.2 x 0.3 m) opened at the break of dawn and closed at dusk.

The adaptation and the observation phases were the same as in Experiment A, with 2 additional adaptation days immediately preceding observation so that the observed group stayed in one pasture alone, whereas the other 3 groups stayed in the second pasture. This allowed stabilization of the social relationships between the hens in the group, thus minimizing social stress during the days of observation. Due to the additional adaptation time only 3 instead of the 4 groups were observed in Replicate 1.

Behavioural observations

The observer sat on a chair outside the pasture, with an overview of the whole pasture. Hens were individually marked with coloured hair spray on the tail feathers and part of the back. Observation started when hens were moved from indoors (Experiment A) or when the automatic doors opened with break of dawn (Experiment B) respectively and stopped either after the fourth hen had laid her egg or the latest after 5 hours. Scan sampling was used to record the behaviour of the hens every 15 seconds. The following behaviours were noted: (i) *Resting*: 'Standing' or 'sitting' outside the nest. (ii) *Nest-related behaviour*: 'Standing' or 'sitting' in the nest, 'rotating' (moving in one direction for a greater angle than 90 degree while sitting in the nest) and 'egg-laying position' (the penguin-position, defined by FÖLSCH and VESTERGAARD, 1981). (iii) *Exploratory behaviour*: 'Locomotion with raised head'. (iv) *Foraging*: 'Head down' or 'ingestion'. In addition, 'calling' was recorded once per sequence when the gavel call was heard between 2 scans (the gavel call is an indicator of expectation and frustration, and decreases when a need has been fulfilled, SCHENK et al., 1983). The nest site was defined as either the place where the hen laid her egg or the place where the hen showed the typical body movement with which she enters a nest (while walking, the legs are bent up to the abdomen with every step and the head is ducked down). In addition, the number of nest entries, the total time spent on the nest, and the duration of the final nest stay relative to oviposition were recorded.

The location and number of eggs inside the shed and outside in the pastures were registered. The location outside was classified into 'trees and bushes' or 'open area' in Experiment A and into 'in the coop', 'on the roof' or 'in the pastures' in Experiment B.

Statistical analysis

When a hen laid the egg between 1 and 5 hours after day-break, her data was included in the statistical analysis. Therefore, in Experiment A observations from 10 hens in Replicate 1 and 8 hens in Replicate 2 were analysed. In experiment B observations from 11 hens in Replicate 1 and from only 4 hens in Replicate 2 were used. Most of the hens in Replicate 2 were laying in the late afternoon. As no significant differences were found in each experiment regarding the recorded data between the two replicates, the data sets were analysed together (Mann-Whitney U-test).

The last 60 minutes before oviposition were divided into intervals of 5 minutes. The mean frequency of the behaviour of all hens was calculated per interval. To determine how behaviour changed over the last 60 minutes before oviposition we used the Wilcoxon-test for paired samples (two tailed, $\alpha = 0.05$) by comparing the first and the last interval.

For the comparison between the experiments the statistical unit was the group of four hens (sample size for Experiment A is 7, for Experiment B it is 6). The mean of all hens in a group over the whole observation time was calculated for the recorded behaviour and for the number of nest entries, the total time spent on the nest, and the duration of the final nest stay relative to oviposition. We used the Mann-Whitney-U-test for two independent samples (two-tailed, $\alpha = 0.05$) to compare the recorded parameters between the two experiments.

Results

Experiment A

59% of the eggs were laid in the pastures (154 of 259 eggs). The remaining 41% (105 of 259 eggs) were laid in the pens inside the stable either in the morning before the hens were carried outside or in the evening after the hens were brought back into their pens. Eighteen hens (of 28) laid their eggs in the pastures. During observation, two thirds (12) of these hens consistently laid their eggs under trees and bushes. The other 6 hens laid in unsheltered areas.

The frequency of all behaviour changed significantly during the 60 minutes before oviposition (Figure 1). The frequencies of resting and foraging declined significantly from 60% to 16% and from 27% to 12% respectively (resting: $T = 0$, $N = 17$, $p < 0.01$; foraging: $T = 6$, $N = 18$, $p < 0.01$). Simultaneously, nest-related behaviour increased significantly towards the time of oviposition from 8% to 68% ($T = 0$, $N = 18$, $p < 0.01$). Exploratory behaviour varied between 23% and 31% in the first 40 minutes and significantly declined to 14% in the last 5 minutes ($T = 6$, $N = 17$, $p < 0.01$). Calling varied between 9% and 15%, but significantly declined to 3% in the last 5 minutes ($T = 3$, $N = 15$, $p < 0.01$).

The number of nest entries in the hour before oviposition was 6 (± 3). Hens spent on average 18 min (± 14 min) in the nest and the final nest entry lasted for 12 minutes (± 12 min).

Experiment B

Eighty-nine percent of the eggs (408 of 457) were found in the wood-shavings of the chicken coops. Thirty-six eggs (8%) were found on the roof of the coops, and 13 eggs (3%) were found in the pastures. All hens showed a consistent nest site choice over all days observed.

The frequency of all recorded behaviour changed significantly over the last 60 minutes preceding oviposition

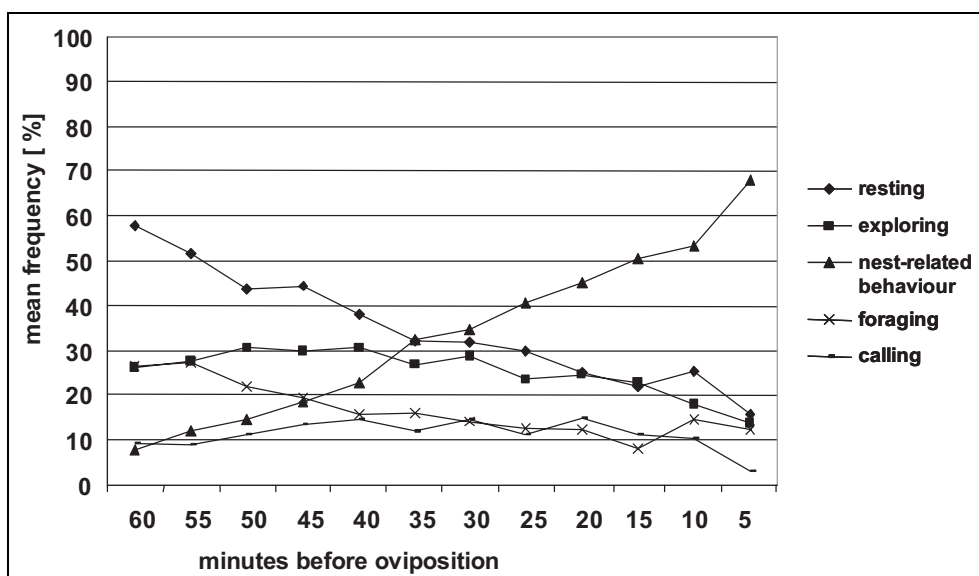


Figure 1. Changes in frequencies of different behaviour over the 60 minutes preceding oviposition in experiment A
Frequenzänderungen der verschiedenen Verhaltensweisen in den letzten 60 Minuten vor der Eiablage in Experiment A

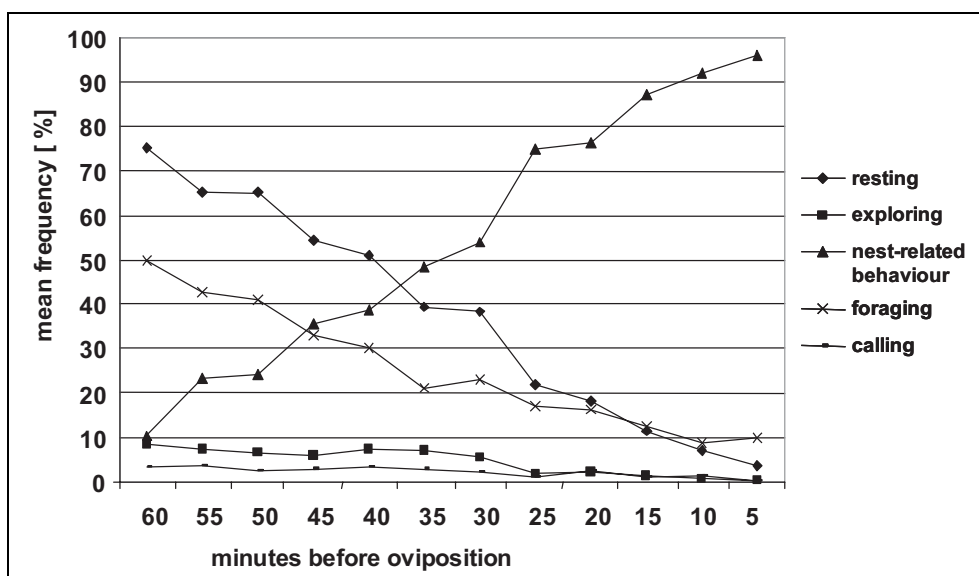


Figure 2. Changes in frequencies of different behaviour over the 60 minutes preceding oviposition in experiment B
Frequenzänderungen der verschiedenen Verhaltensweisen in den letzten 60 Minuten vor der Eiablage in Experiment B

(Figure 2). The frequencies of resting, exploratory and foraging behaviour outside the nest declined from 75% to 4%, from 9% to 1% and from 50% to 10% respectively (resting: $T = 0$, $N = 15$, $p < 0.01$; exploratory behaviour: $T = 0$, $N = 13$, $p < 0.01$; foraging: $T = 1$, $N = 14$, $p < 0.01$). The frequency of calling declined from 4% to 1% ($T = 1$, $N = 7$, $p < 0.05$). However, nest-related behaviour increased from 10% to 96% ($T = 0$, $N = 15$, $p < 0.01$).

The average number of nest entries in the hour before oviposition was 6 (± 3). Hens spent on average 32 min (± 9 min) in the nest and the final nest entry lasted for 16 minutes (± 8 min).

Comparison of Experiment A and B

The frequency of exploratory behaviour was significantly lower in Experiment B (25% versus 4%; $U_1 = 4$, $U_2 = 38$, $p < 0.01$; Figure 3) as was the frequency of calling (11% versus 2%; $U_1 = 5$, $U_2 = 37$, $p < 0.03$). The frequency of nest-related behaviour was significantly higher in Experiment B (33% versus 56%; $U_1 = 37$, $U_2 = 5$, $p < 0.05$). Foraging and resting behaviour were not significantly different in the two experiments (foraging 18% versus 24%, $U_1 = 32$,

$U_2 = 10$, $p > 0.05$; resting 34% versus 38%, $U_1 = 21$, $U_2 = 11$, $p > 0.05$).

Hens in Experiment B spent significantly more time in the nest during the 60 min before oviposition (32 min versus 18 min, $U_1 = 38$, $U_2 = 4$, $p < 0.02$). No significant differences were found in the mean number of nest entries (6 in both experiments) and in the duration of the final nest stay (12 min and 16 min). A hens' individual choice of a nest site did not alter during the three days of observation.

Discussion

Nest sites of hens in the wild range from hollows, partly containing feathers or leaves (COLLIAS and COLLIAS, 1967; DUNCAN et al., 1978), to patches of high grass or ledges (DUNCAN et al., 1978). All observed nest sites in the wild were hidden and protected. Also under commercial conditions hens prefer nests with a certain degree of seclusion (APPLEBY and SMITH, 1991; COOPER and APPLEBY, 1996b; DUNCAN et al., 1978; WEEKS and NICOL, 2006). Nests are already inspected by the hens before the onset of lay (RIETVELD-PIEPERS et al., 1985), therefore it is recommend-

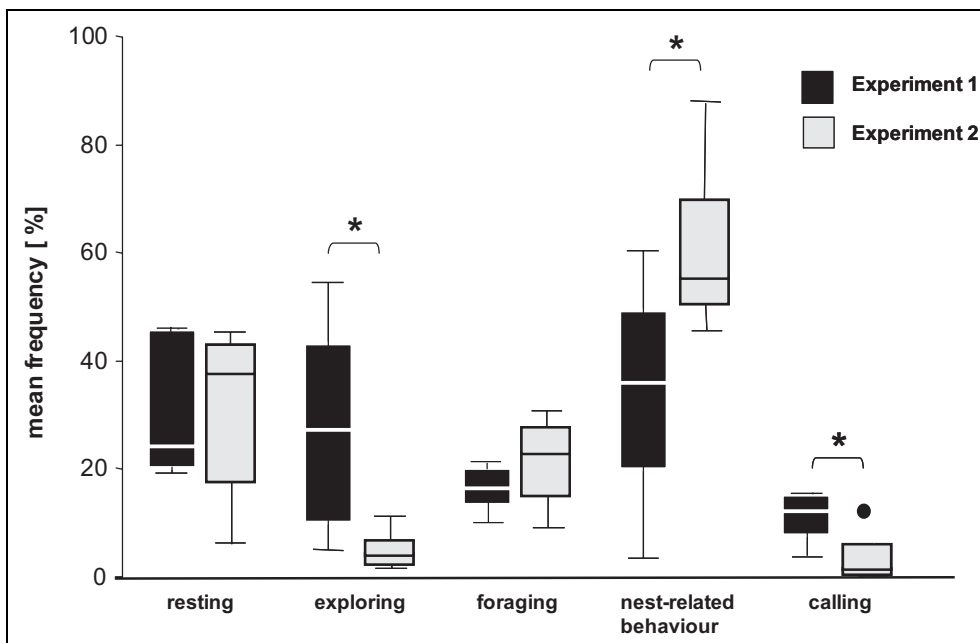


Figure 3. Mean frequencies of resting, exploratory behaviour, foraging, nest-related behaviour and calling in the 60 minutes preceding oviposition in experiment A and B (* $p < 0.05$)
 Durchschnittliche Frequenzen des Ruhe-, Erkundungs-, Futtersuch- und nestbezogenen Verhaltens und des Gakelrufs in den 60 Minuten vor der Eiablage in Experiment A und B (* $p < 0.05$)

ed to offer nest sites before egg-laying starts. Nest choice depends also on a hens experience during rearing and in the weeks before the onset of lay (APPLEBY and MCRAE, 1986).

The large proportion of eggs laid inside the stable in Experiment A suggests that not all hens were able to adapt to the environmental changes from indoor in the rearing period to outdoor in the experimental period. As hens are very constant in their nest choice (COOPER and APPLEBY, 1996; own observations) some of our test hens continued to lay indoors in the litter where they had laid their first eggs. We suppose that the hens were so attached to the pen and its substrate that they retained the egg during the day and laid in the pen at the end of the day or during the night, both very unusual laying times. Another explanation for the unusual prelying behaviour of the hens could be a distraction of the animals because of the specific handling of the birds, i.e. catching them in the pen and carrying them out into the pasture every morning and bringing them back every evening. In Experiment B where the hens spent the night outside in the coops and where they had the choice to lay into the litter in the coops, most of them preferred this place for laying.

Typical prelying behaviour in the wild as far as it had been described, starts in the morning when a hen leaves the group for nest search (DUNCAN et al., 1978). At this stage of prelying behaviour the gakel call is heard and when it increases, the cock leads the hen to a nest (FÖLSCH and VESTERGAARD, 1981; MCBRIDE et al., 1969). In experiments with domesticated laying hens the gakel call was often heard when the performance of a behaviour was prevented (SCHENK et al., 1983; MELJSSER and HUGHES, 1989; ZIMMERMAN and KOENE, 1998). In contrast to the wild, the frequency of the gakel call remained high in cages without nests (SCHENK et al., 1983). This may be interpreted as a sign of frustration caused by the lack of a nest site (KITE, 1985).

As expected, in both experiments the frequency of resting and foraging declined towards the time of oviposition while nest-related behaviour increased. These findings are in accordance with the results of MELJSSER and HUGHES, (1989), who compared the behaviour of hens in battery cages and in 3 alternative systems. They found that in alternative systems, feeding, stepping and standing occurred

most often at the beginning of the last hour before oviposition whereas the proportion of time spent in the nest progressively increased over this time. We expected exploratory behaviour to increase towards oviposition, as the hens should become more agitated and interested in potential nest sites with approaching oviposition (APPLEBY, 1990). In contrast, exploratory behaviour in Experiment A occurred at high frequencies but did not have an increasing tendency towards oviposition. The gakel call was often heard during the observations. Although the changes in the frequencies of the observed behaviour over the 60 minutes preceding oviposition were qualitatively the same in both experiments, there were significant quantitative differences: In Experiment A resting, foraging, and nest-related behaviour were observed on a lower level than in Experiment B, while exploratory behaviour and the frequency of the gakel call were on a higher level.

The remarkably high level of exploratory behaviour (including pacing) in Experiment A and the high incidence of the gakel call in the hour before oviposition in combination with the high percentages of eggs laid in the pens in the evening or during the night may be interpreted as an indication of frustration (WOOD-GUSH, 1972; ZIMMERMAN and KOENE, 1998; OLSSON and KEELING, 2000; COOPER and ALBENTOSA, 2003; ZIMMERMAN et al., 2000).

We conclude that Experiment A did not offer optimal conditions for all of the hens. We assume that mainly the lack of litter (the substrate in which the first egg was laid) and the change of potential nest sites (from indoor to outdoor) and possibly also the stress associated with handling and with changes in group composition could be the reasons for this unusual prelying behaviour.

The reduced frequencies of exploratory behaviour and of the gakel call in Experiment B in comparison to Experiment A confirm that the changes to the experimental design were successful in reducing frustration in the prelying phase, although we can not distinguish these effects in detail. In addition, when a free choice between the litter in the coops and the pastures was presented, virtually all hens chose to lay in the coops. This demonstrates how attractive the coops were as a nest site.

We conclude that the quality and the level of the observed behaviour in Experiment B are closer to the hens

natural behaviour than the observed behaviour in Experiment A. Possible explanations are: a perceived higher security in the coop, the effect of a positive experience with, and an attachment to the site and substrate where the first egg was laid, or possibly a preference for wood-shavings as nesting material compared to the possibilities offered in the pastures.

Conclusions

This study reports a qualitative and quantitative description of prelying behaviour and influencing effects on it in two different free range settings. Important parameters were exploratory behaviour, the gakel call and the change of frequency of these parameters during the 60 minutes preceding oviposition. The hens with access to potential nest sites, similar to the nest sites (litter) they had used before the experiment started, showed less signs of frustration compared to the hens having solely access to natural nest sites in the pastures. The behavioural indicators may serve as a basis for comparing and assessing commercial laying nests in respect to their suitability for hens.

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Summary

The aim of this study was to achieve a better knowledge of prelying behaviour of laying hens in semi-natural environments. Two experiments (Experiment A and B) with 2 replicates (Replicate 1 and 2) each were conducted. In Experiment A 28 laying hens were kept in a pen without nest access until week 21. From then on they were carried out into a pasture during the day where their prelying behaviour and their chosen nest sites were observed. In Experiment B from week 21 on the hens additionally had access to chicken coops in the pastures in which they also spent the night.

In Experiment A several hens regularly laid in the pen in the evening or during the night whereas in Experiment B most hens used the chicken coop as their nest site. In both experiments the frequencies of resting, exploratory behaviour and foraging in the hour before oviposition declined significantly while the frequency of nest-related behaviour significantly increased. Occurrence of the gakel call declined significantly in the last 5 minutes in Experiment A. Even though the changes in frequencies of the behavioural activities were qualitatively the same in both experiments, exploratory behaviour and the gakel call were at a lower level in Experiment B which might indicate less frustration.

Hens in experiment B which had access to litter at any time (the substrate in which they had laid before the experiment started) showed less frustration compared to the hens in experiment A which had access only to natural nest sites in the pastures and which were carried out every morning. This indicates that the nest site and/or the substrate in which the first eggs were laid and/or the handling procedure are of great importance for nest choice and prelying behaviour.

This study reports a qualitative and quantitative description of prelying behaviour and effects influencing it in different free range settings. The results about the observed behaviour may serve as a basis for comparing and assessing commercial laying nests in respect to their suitability for hens.

Key words

Laying hens, prelying behaviour, nest sites, free range

Zusammenfassung

Das Legeverhalten von Legehennen (*Gallus gallus domesticus*) unter verschiedenen Freilandbedingungen

Das Ziel dieser Studie war es, ein besseres Verständnis des Legeverhaltens von Legehennen unter naturnahen Bedingungen zu erhalten. Es wurden 2 Experimente (Experiment A und B) mit jeweils 2 Durchgängen (Durchgang 1 und 2) durchgeführt. In Experiment A wurden 28 Legehennen bis zur 21. Lebenswoche in einem Stall ohne Zugang zu Nestern gehalten, danach tagsüber in einem Auslauf, in dem ihr Legeverhalten und ihre gewählten Nestplätze aufgenommen wurden. In Experiment B hatten die Hennen zusätzlich ab der 21. Lebenswoche in den Ausläufen Zugang zu Hühnerhäuschen, in denen sie auch die Nacht verbrachten.

In Experiment A legten mehrere Hennen regelmäßig am Abend oder in der Nacht im Stall, die meisten Hennen in Experiment B dagegen nutzten die Hühnerhäuschen als ihren Nestplatz. In beiden Experimenten sank die Frequenz des Ruhe-, Erkundungs- und Futtersuchverhaltens signifikant in der Stunde vor der Eiablage ab, während die Frequenz des nestbezogenen Verhaltens signifikant anstieg. Das Auftreten des Gakelrufes sank signifikant in den letzten 5 Minuten ab. Obwohl die Frequenzänderungen der Verhaltensweisen in Experiment B qualitativ denen in Experiment A entsprachen, fanden sich in Experiment B die Frequenz des Erkundungsverhaltens und des Gakelrufes auf einem niedrigeren Niveau, was auf eine geringere Frustration hindeutet. In Experiment B hatten die Hennen Zugang zu Einstreumaterial, dem Substrat, in dem sie vor Beginn des Experiments legten, und sie zeigten weniger Frustration im Vergleich zu den Hennen in Experiment A, denen nur natürliche Nestplätze in den Ausläufen zur Verfügung standen und die jeden Morgen in die Ausläufe gebracht wurden. Dies weist darauf hin, dass der Nestplatz und/oder das Substrat, in dem die ersten Eier gelegt werden und/oder das morgendliche Heraustragen, von großer Bedeutung für die Nestwahl und das Legeverhalten sind oder auf eine eventuelle Überlegenheit des Einstreumaterials als Nestmaterial gegenüber den Möglichkeiten zur Eiablage in den Ausläufen.

Diese Studie liefert eine qualitative und quantitative Beschreibung des Legeverhaltens unter verschiedenen Freilandbedingungen, und Faktoren, die dieses beeinflussen. Die Resultate des beobachteten Verhaltens können als Vergleichsgrundlage dienen, um kommerzielle Legenester und das Legeverhalten von Hennen bezüglich der Tiergerechtigkeit zu beurteilen.

Stichworte

Legehennen, Legeverhalten, Nestplätze, Freiland

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