Effect of manipulating feathers of laying hens on the incidence of feather pecking and cannibalism

T.M. McAdie*, L.J. Keeling

Department of Animal Environment and Health, Swedish University of Agricultural Sciences, P.O. Box 234, 532 23 Skara, Sweden

Accepted 24 January 2000

Abstract

Feather pecking is a problem in commercial laying hens, particularly in loose-housing systems, where many hens can be affected by only a few feather peckers. In addition, feather pecking can become an even larger problem if it spreads throughout the flock. There are several possible ways that feather pecking may spread. The simplest way is that one hen may damage the feathers of a hen, and another hen may find the damaged feathers an attractive pecking target. The aim of this experiment was to determine if damaged feathers were feather-pecked more than undamaged feathers on the same body area, and to determine whether some types of feather-body area manipulations were preferred over others as pecking stimuli. Manipulations involved damaging the feathers on the rump, tail or belly of different hens, with two or three levels of severity of manipulation at each body area. Sixteen groups of 11 Lohmann Brown hens between 26 and 28 weeks were observed with the recipient, the feather pecker and the body area that was pecked all being recorded. The feather pecks were classified separately as either gentle or severe. Damaged feathers received significantly more severe feather pecks than undamaged feathers. There were also more gentle feather pecks to damaged feathers, although this did not reach statistical significance. The feather-body area manipulations that received the greatest number of severe feather pecks were the tail feathers when they were cut very short, the rump feathers when they were trimmed, and the rump when feathers were removed. These results support the suggestion that feather pecking does indeed spread through flocks by damaged feathers becoming an attractive target for feather-pecking behaviour. An unexpected result of performing the feather manipulations was an outbreak of cannibalism in half of the experimental groups. Even though
there was no visible damage to the skin of the hens after having the feathers manipulated, 13 of
the 16 attacked hens were wounded on the part of the body where the feathers had been damaged
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Keywords: Feather pecking; Aggression; Cannibalism; Chickens

1. Introduction

There can be problems in any animal husbandry system. In commercial poultry
housing systems, for example, birds often show misdirected or inappropriate pecking
behaviour. In cage systems, where there are few hens per standard cage, if there is a
problem with one individual hen pecking the other hens, then this affects only her
cagemates. However, in loose-housing systems, where thousands of hens can be housed
together, misdirected pecking can be potentially more of a problem as many hens can be
affected by one hen’s behaviour (Keeling, 1995). With the phasing out of cage systems
for laying hens in Sweden and elsewhere, it becomes increasingly important to solve
problems, such as feather pecking and cannibalism. In a recent study of loose-housing
systems, the extent of the feather-pecking problem was found to be considerable, with
up to 99% of hens victims of feather pecking and up to 12.6% of hens victims of cloacal
cannibalism (Gunnarsson et al., 1999).

Feather pecking is when one hen pulls out or pecks at the feathers of another hen, and
can be classified in several different ways (Savory, 1995). In short, though, they can be
divided into two broad categories. Gentle feather pecks are ones where the feathers are
nibbled but not pulled out and the recipient does not usually react. It has been argued
that this type of feather pecking is likely to be normal exploratory pecking behaviour
(Hansen and Braastad, 1994). Severe feather pecks or feather pulls, however, usually
involve the feather-pecking hen either vigorously pulling at the feathers or removing one
or several feathers from the recipient bird. The recipient hen often reacts with a
vocalisation, or moves away, or retaliates against the feather-pecking hen. Hens can
become almost completely denuded as a result of this type of feather pecking. It is not
known why feather-pecking hens perform this behaviour, but it is generally accepted
that severe feather pecking or pulling is an abnormal behaviour.

Feather pecking is a problem on both economic and welfare grounds. It is an
economic problem as the denuded bird loses heat and energy and, therefore, needs to
consume more food to maintain its body temperature (Leeson and Morrison, 1978). This
results in more expensive production of eggs for the farmer. It is a welfare problem as it
has been suggested that having feathers pulled out is painful for the recipient hen
(Gentle and Hunter, 1990).

Another reason why feather pecking is considered to be a welfare problem is that it
has been suggested that it can lead to cannibalism (Allen and Perry, 1975). Cannibalism
has been defined in many ways, the most objective describing it as the “pecking and
tearing of the skin and underlying tissues of another bird” (Keeling, 1994). Cannibalism
is a painful and often fatal process for the victim (Yngvesson, 1997). The removal of
feathers by feather pecking can result in bleeding from the skin or follicles (especially
with not fully grown feathers), which may stimulate cannibalism. It is also possible that
hens which have been denuded by feather pecking, and are therefore lacking the
protection of feather cover, are more likely to be victims of cannibalism as their bare
skin may be more easily damaged by scratches, pecks and knocks. The blood resulting
from these injuries may also elicit cannibalistic attacks.

Attempts have been made to stop the occurrence or spread of feather pecking and
cannibalism, with the most common (and effective) of these being beak trimming.
However, beak trimming is illegal in some countries, and has been shown to cause
long-term pain in hens (Gentle et al., 1991). If the causes of feather pecking and
cannibalism were established, then such invasive methods of stopping them occurring
may no longer be required. Two major theories are currently being used to explain why
feather-pecking behaviour occurs. It has been argued that feather pecking is related to
redirected ground or food pecking (Hughes and Duncan, 1972; Blokhuis, 1986, 1989),
or is related to dust-bathing behaviour (Vestergaard and Lisborg, 1993). In either case, it
has been argued that the rearing of the hens is crucial in the development of feather
pecking, and that a suitable substrate must be provided to young chicks in order to
prevent misdirected pecking to conspecifics.

However, rearing is not the only factor that seems to have an effect on the
development of feather pecking. There is also a genetic component to feather pecking. It
has been repeatedly documented that feather pecking differs between strains of hens
(e.g., Craig and Muir, 1993, 1996). It has also been demonstrated that feather-pecking
traits can be selected for or against (Keeling and Wilhelmson, 1997).

If only certain individuals in a group have a genetic trait that predisposes them to
feather pecking, then the problem could be solved by simply removing those individuals
from the flock. Unfortunately, identifying individual feather peckers in a large flock
would be time-consuming and impractical. Even if genetic selection and rearing were
used to reduce the number of feather-pecking individuals in a flock, it is possible that
feather pecking could spread from the few initial feather peckers to other hens. This
could occur in three ways. Firstly, if the flock is disrupted in some way by the presence
of the ‘original’ feather peckers, then this disturbance may trigger an outbreak of
abnormal behaviour, such as feather pecking that disrupts the flock even more, and so
this cycle becomes self perpetuating. Secondly, one hen may observe the feather-peck-
ing behaviour of another individual and copy this behaviour. If the behaviour is found to
be of value to that individual, then she will continue to feather peck and, in turn, could
provide a model for feather-pecking behaviour for other individuals. It has already been
shown that individuals learn through observation of conspecifics’ behaviour (e.g., Nicol,
1995). The third and most simple way that feather pecking could spread throughout a
flock is by an initial feather pecker damaging the feathers of another hen by its
feather-pecking behaviour, and then another hen being attracted to peck at the newly
damaged feathers. It has already been found by Hughes (1985) and Preston (1987) that
feathers damaged by contact with walls of cages are an attractive target for feather
pecking; therefore, this third option seems to be a likely method whereby feather
pecking may spread.

It is not only the condition of the feathers which seem to contribute to the occurrence
of feather pecking. It has also been suggested that there are specific areas of the body
which seem to be attractive targets for feather-pecking hens (Allen and Perry, 1975; Bilcik and Keeling, 1999). Therefore, the aim of this experiment was to determine if damaged feathers on the belly, tail, or rump elicit feather pecking and, if so, whether particular types of feather damage to these areas of the body are attractive as a feather-pecking stimulus.

2. Materials and methods

2.1. Animals and housing

Non beak-trimmed Lohmann Brown hens were reared in large groups in traditional litter floor pens and were bought at point of lay and placed in 16 experimental pens. The birds were kept at 16 hens/pen for 6 weeks and then the number was reduced to 11 hens/pen. The stocking density during the experiment was, therefore, 3.7 birds/m². All hens had ad lib access to food and water. At the start of the experiment, the hens were 25 weeks old.

The experimental floor pens were 2 × 1.5 m in size, with a litter floor of wood shavings. The walls of the pens were 1 m high, with wire netting going from the top of the solid walls to the ceiling. In each pen, there was a colony nest (23 × 28 × 84 cm) with an astroturf mat on its floor. There were also two perches, 95 and 75 cm above the floor. These perches extended across the width of the pen. The light intensity across pens ranged between 17 and 22 lx at hen head-height level.

In each pen, every bird, but one, was individually marked with a large numbered wing tag on each wing which observers could easily read. The remaining hen was not wing-tagged.

After an outbreak of cannibalism, hay was added to each pen and vitamin B was added to the water. In addition, whole oats were scattered on the floor of each pen every day thereafter.

2.2. Feather manipulations

Within each pen, 8 of the 11 hens had their feathers experimentally manipulated. Each of the experimental hens had only one type of feather damage on only one area of their body, and the damage systematically varied from minor to more major manipulations. There were three control hens in each group, two with wing tags and one without, in case the attachment of the wing tags damaged feathers and so encouraged feather pecking to the wings of these birds.

Every hen had remarkably good feather condition, which would have been scored as perfect feather condition using the Tauson et al. (1984) method. The only feather damage found before the manipulations were carried out was an occasional slightly scruffy looking tail feather.

The feathers on three areas of the body were manipulated: The rump (the area extending approximately 10 cm in the direction of the head up the back of the hen from the uropygial gland), the tail, and the belly (the area extending approximately 10 cm
downwards from the cloaca. These body areas had three distinctly different types of feathers on them. The rump feathers were approximately 4–5 cm in length and overlapped each other. The tail feathers were long (approximately 20 cm in length and 3 cm in width) with a thick shaft. The belly feathers were short (approximately 2 cm in length), soft and fluffy, and had lighter colouring towards the base of the feathers.

Control birds received a sham manipulation. They were removed from the pen at the same time as the experimental hens and were handled and restrained for a period equivalent to the time required to perform the feather manipulations. Three different manipulations were carried out to the rump and the tail feathers. Two different manipulations were carried out to the feathers on the belly.

2.2.1. Manipulations

2.2.1.1. Rump.

(a) Trimmed: This involved cutting very small amounts off the ends of some of the rump feathers so that the lighter coloured base of some of the feathers showed through, thus giving an untidy appearance.
(b) Removed: Feathers were pulled out, leaving a bare area of approximately 3 cm in diameter, although undamaged feathers around the area often obscured some of the bare patch. There were no visible injuries to the skin after this was completed.
(c) Removed and cut: Feathers were pulled out, leaving a 3 cm patch of bare skin, as for the manipulation above. But, in addition, some of the surrounding feathers were cut, making the bald patch much more visible.

2.2.1.2. Tail.

(a) Ruffled: This involved the experimenter holding the top of the tail feathers (one at a time) in one hand and then running the fingernails of the thumb and forefinger of the other hand forcefully down the feather, thus breaking the small barbs, and giving the tail feathers a scruffy appearance.
(b) Trimmed: 1 cm was cut off the end of the tail feathers.
(c) Cut short: Only 1 cm of the tail was left remaining, after most of the feathers had been cut off the end of the tail.

2.2.1.3. Belly.

(a) Trimmed: A very small amount was cut off the ends of belly feathers (< 1 cm) until the lighter coloured base of the feathers were visible.
(b) Cut short: The belly feathers were cut very short, exposing a bare patch of skin, approximately 3 cm in diameter.

We were intending to remove the belly feathers to make it similar to the rump manipulation of Removed feathers, but found in some pilot tests, that pulling feathers
out caused damage to the skin of the belly. Therefore, we cut the feathers as short as possible to the skin to have a manipulation similar to the Removed rump feather manipulation. In addition, as the belly feathers were so soft, they could not be ruffled in the same way as the tail feathers. We chose, therefore, to have only two belly manipulations in the actual experiment.

At the completion of the feather manipulations, the hens were returned to their home pens.

2.2.2. Outbreak of cannibalism

Soon after the manipulations had been completed, there was an outbreak of cannibalism in 8 of the 16 pens. In all cases, the injured hen was removed immediately from the pen and put into an individual cage to recover. The body area injured in each cannibalistic attack, and the dates when they occurred, were recorded. In every case, initially, the hens were wounded on the rump where the feathers had been removed, or feathers removed and cut. To prevent any possible further cases of cannibalism, all hens with feathers removed from the rump (two manipulations/pen) were removed from their home pens and put into cages. The hens that were removed (but not wounded) were returned to their home pens the day the first observations were carried out (4 days after they had been removed). There was little, if any, aggressive behaviour associated with the return of these hens to their home pens. Wounded birds were not returned to their pens until the end of the experiment, when they were completely healed.

2.3. Observations

Observations were made on weekdays over a 2-week period, between 0900 and 1800 h when the birds were between 26 and 28 weeks of age. There were 8 observation days where the behaviour of the hens in each pen was recorded. Each observation day was divided into four observation periods — two in the morning, and two in the afternoon. Each observation period was approximately 1 h in duration, during which time four pens were observed. In the next hour, four different pens were observed, and so on, resulting in all 16 pens being observed in an observation day. The time period in which the pens were observed was balanced, so that each pen was observed twice at each of the observation periods.

The observer sat in the aisle outside the pen and allowed 2 min for the hens to become accustomed to her presence.

During each 15 min observation of each pen, the experimenter recorded all gentle and severe feather pecks. The body was divided into 11 sections (Bilcik and Keeling, 1999) and all pecks to each body area were recorded. There were few pecks delivered to the body areas other than the rump, tail or belly, and so pecks to these body areas were not included in any analyses. The identity of the recipient and the pecker was also recorded.

All data were recorded in a computer spreadsheet on a laptop computer during the observations.

2.4. Analyses

Analyses were carried out on the feather-body area manipulation data from the 8 pens where cannibalism had not occurred.
To establish whether more feather pecks were delivered to the three body areas with damaged feathers than to the same body areas without feather damage, the data were analysed (separately for severe and gentle feather pecks) in the following ways.

For each pen, the total number of pecks given to the damaged feathers on the rump, tail and belly was divided by the total number of manipulated body areas (three hens with damaged rump feathers, three hens with damaged tail feathers, and two hens with damaged belly feathers = eight manipulated body areas). This gave the mean number of pecks per feather-body area manipulation. In a similar way, the total number of pecks that were given to undamaged feathers on the rump, tail and belly was divided by the number of areas of undamaged feathers (eight hens without damaged rump feathers, eight hens without damaged tail feathers, and nine hens without damaged belly feathers = 25 nonmanipulated body areas). This gave the mean number of pecks per nonmanipulated body area.

The mean number of pecks for each feather-body area manipulation was then summed across pens to give a total number of pecks per manipulated area in the experiment. The average number of pecks per nonmanipulated area was also summed across pens. These data were nonnormally distributed and, therefore, were analysed using the Mann–Whitney U-test to determine if there were any significant differences between the number of severe or gentle pecks made to the damaged feathers and the number of pecks made to the undamaged feathers on the same body areas.

The data were further analysed to determine what was the most preferred feather-body area manipulation as targets of feather pecking. This analysis was also performed separately for gentle and severe feather pecks.

The number of pecks given to each type of feather damage for each of the target body areas (rump, tail and belly) was ranked for each pen. The feather-body area manipulation that received the most pecks was ranked as 1, the second ranked 2, and so on, until the feather-body area that received the fewest pecks was ranked as 8. Tied ranks were given the mean rank, so that if an equal number of pecks were given to the third and fourth ranked feather-body area manipulations, they both received the rank of 3.5. To obtain an average measure of the preferred feather-body area manipulation across all the pens, the ranks from all of the 8 pens were averaged.

The data were nonnormally distributed and, therefore, a Kruskal–Wallis analysis of the mean ranks across the pens was used to determine if there was an overall difference between the ranks. A Mann–Whitney U-test was used to identify significant differences between the ranks of the eight feather-body area manipulations. As our hypothesis was that there would be more pecks directed to the manipulated areas than to the nonmanipulated areas, our tests were one-tailed.

3. Results

The mean number of severe feather pecks received by control hens was compared with the mean number of severe feather pecks received by the hens with experimentally manipulated feathers. There were almost three times as many severe feather pecks
delivered to each manipulated hen (1.75) than to each control hen (0.71). This difference was significant ($W = 48, \ p = 0.02$).

The mean number of gentle feather pecks received by control hens was compared with the mean number of gentle feather pecks received by the hens with experimentally manipulated feathers. It was found that there was a tendency ($W = 53, \ p = 0.06$) for more gentle feather pecks to be delivered to the manipulated birds (12.6 per hen) than to the control birds (6.9 per hen).

3.1. Pecks made to manipulated body areas

3.1.1. Severe feather pecks

It was found that a median of 0.69 severe feather pecks per feather-body area manipulation were received when the body areas had damaged feathers, and a median of 0.06 severe feather pecks were received to the same body areas without any feather damage. This difference was significant ($W = 89.5, \ p = 0.01$).

3.1.2. Gentle feather pecks

It was found that a median of 3.0 gentle feather pecks per feather-body area manipulation were received when the body areas had damaged feathers, and a median of 0.70 gentle feather pecks were received to the same body areas without any feather damage. This difference was not significant ($W = 83, \ p = 0.06$).

3.2. Preferred type of feather damage and body area

3.2.1. Severe feather pecks

The Kruskal–Wallis analysis of the mean ranks across the pens showed an overall significant difference between the feather-body area manipulations ($H = 12.55, \ p = 0.04$). The subsequent Mann–Whitney $U$-test showed that three feather-body part manipulations (the very short tail feathers, the rump with feathers removed, and the trimmed rump feathers) were all ranked significantly higher than the ruffled tail feathers, and both manipulations of the belly feathers ($W = 50.5, \ p = 0.02$ for each of these manipulations).

Fig. 1 shows the average ranks of the number of severe feather pecks made to each of the feather-body area manipulations. There appears to be an orderly relationship between the severity of the manipulation to the tail and the ranking of preferred areas with the most severe manipulation being preferred. This was not the case for the manipulations to the rump and to the belly.

3.2.2. Gentle feather pecks

A Kruskal–Wallis analysis of the mean ranks across the pens found that there was no significant difference between the preferred types of damaged feathers on the manipulated areas ($H = 4.44, \ p = 0.36$). A Mann–Whitney $U$-test showed that the rank of the number of gentle feather pecks made to the rump when the feathers were removed was
significantly greater than the rank of the number of pecks made to the ruffled tail feathers ($W = 49.0, p = 0.02$). No other ranks were significantly different from each other.

3.2.3. Cannibalistic attacks

An immediate result of the manipulation of the hens' feathers was an outbreak of cannibalism in 8 of the 16 pens. Twelve hens were cannibalised (none fatally) in the first week following the feather manipulations, with at most two victims from each pen. Of the 12 victims, all but one (i.e., 92%) were wounded on the area where the feathers had been damaged by the experimenters. The remaining hen was toe-pecked. During the rest of the experiment, there were four more incidences of cannibalistic pecking — two more to manipulated areas, and two attacks to nonmanipulated areas. Thus, throughout the experiment, 13 out of 16 hens were cannibalistically pecked on the area of the body where the feathers had been damaged. The wounds that occurred during this time were generally small although there was one fatality due to cannibalism during this period. This one death from 176 hens made a mortality rate of 0.6%.

The most attractive feather-body area manipulation for cannibalistic pecks was identified by recording the order in which hens were attacked in each of the pens. For example, if a hen was injured on the trimmed rump, and it was the first time that cannibalism had occurred in that pen, this feather-body area manipulation was ranked as 1. The subsequent (if any) injuries in that pen were then ranked as 2 (Fig. 2).
Fig. 2. Mean rank for each of the feather-body area manipulations subjected to cannibalism. Note that the y-axis values are reversed so that the most preferred feather-body manipulation is at the top of the figure, and the least preferred is at the bottom of the figure. The p-values for the rump with feathers removed and cut against each of the other feather-body area manipulations are as follows: trimmed rump: $W = 49.0, p = 0.02$; rump with feathers removed: $W = 56.0, p = 0.10$; ruffled tail: $W = 42.5, p = 0.00$; trimmed tail: $W = 41.5, p = 0.00$; very short tail: $W = 45.0, p = 0.02$; trimmed belly: $W = 41.0, p = 0.00$; very short belly feathers: $W = 43.5, p = 0.01$.

The Kruskal–Wallis analysis of the mean ranks of the order in which body areas were attacked showed that there was an overall significant difference between the feather-body area manipulations ($H = 18.08, p = 0.01$). A subsequent Mann–Whitney U-test showed that the rump, when feathers were removed and cut, although not significantly different to the rump with feathers removed, was the target of cannibalism significantly more often than the other feather-body area manipulations.

The area with removed rump feathers was attacked significantly more than ruffled tail feathers ($W = 50.0, p = 0.02$), trimmed tail feathers ($W = 50.0, p = 0.02$), and trimmed belly feathers ($W = 50.0, p = 0.02$).

Very short tail feathers were cannibalistically pecked significantly more than the ruffled tail feathers ($W = 84.5, p = 0.04$), trimmed tail ($W = 84.5, p = 0.04$), and the trimmed belly feathers ($W = 51.5, p = 0.04$).

When we attempted to return two apparently completely healed hens to their home pen at the conclusion of the experiment (several weeks later), they were immediately (within 30 s) cannibalistically attacked and injured. They were again removed and were placed back into the individual cages. Therefore, we were unable to return the remainder of the previously wounded hens to their home pens. When different healed victims of
cannibalistic attacks were placed into a pen that was not their own home pen there were no cannibalistic attacks on them for the entire 30 min observation period. At the end of the observation period these hens were again put back into individual cages.

4. Discussion

The results from this experiment suggest that hens with damaged feathers received more feather pecks than hens with undamaged feathers. In addition, damaged feathers do encourage more feather pecking than undamaged feathers on the same body areas. Clear preferences were demonstrated for particular types of feather-body area manipulations, with the most preferred target for severe feather pecks being the tail when the feathers were cut very short, followed equally by the rump, which had feathers trimmed or feathers removed. The most preferred area for gentle feather pecks was the rump, which had feathers removed. In addition to the feather-pecking results, it was found that cannibalistic attacks seemed also to occur to body areas where the feathers had been damaged, in particular to the rump when feathers were removed and cut, and when the rump feathers were only removed.

There are three likely reasons for the manipulated areas to have become targets for feather pecking. Each of these may stand on their own, or there could be some interaction between them, which might have caused the feather pecking to take place. The first reason is that the newly manipulated area presents something novel and, therefore, something new to be explored. Ruffled tail feathers were barely pecked at during this experiment. Before the manipulations were carried out in the present experiment, some tail feathers were slightly scruffy, possibly due to abrasion from rubbing against other birds or the walls of the pens. The manipulation of ruffled tail feathers looked similar to these scruffy tail feathers. It could be the case that because scruffy tail feathers were not a novel stimulus, they did not attract much severe or gentle feather pecking. Tail feathers that were cut short however, were a completely novel stimulus. It is possible that this is why they may have attracted severe feather pecking. The trimmed rump feathers also received severe feather pecks. It is unusual for rump feathers to become scruffy as they do not commonly come into contact with the walls or equipment in the pens, so it could again be the case that the novelty of trimmed rump feathers could have encouraged pecking to this area.

The second reason for the results could be that the feather manipulation may have made some parts of the manipulated feathers more easily visible and so encouraging exploratory pecking. When the outer brown feathers of the hens were trimmed to give an untidy appearance, the lighter coloured lower areas of feathers became exposed or, in the case of the feathers being removed, a bare patch of skin was exposed. In both of these cases, there was a difference in colour between the outer feathers and the inner area. It is possible that such a contrast in colour between the outer brown feathers and the white downy base of the feathers or the bare skin contributed to making these areas attractive to hens. Contrast between the sharp edges of the tail feathers where the shaft of the feather was cut and the usual appearance of these feathers may have also been an attractive visual stimulus, with the flat edges of the feathers looking markedly different from the normal gradually angled ends of tail feathers.
The third reason that the feather-body area manipulations may have been attractive to feather-pecking hens is that light colours (such as the downy base of the feathers) may be preferred by hens as pecking stimuli. Jones and Carmichael (1998) found that hens preferred to peck at white and yellow bunches of string over orange and blue bunches of string. However, it is not clear whether exploratory pecking at bunches of string is the same behaviour as feather pecking. In addition, if birds preferred to peck at light coloured feathers, then feather damage would be expected to be worse in flocks of white strains of birds and this is not always the case (Abrahamsson et al., 1996).

It was intended here to attempt to create different levels of attractiveness of feather damage by having different levels of severity of feather manipulation for each body area. At least for the manipulations to the tail, it seems that this attempt to make the feather manipulations increasingly attractive was successful. For the tail, for both severe and gentle feather pecks, the most preferred manipulation was the most drastic i.e., the very short tail feathers, followed by the tail with only 1 cm removed, followed by the tail with ruffled feathers. This would seem to suggest that the greater the damage done to the feathers, the greater the attractiveness of those feathers to feather peckers. It is possible therefore, that once feather pecking occurs in a flock, it becomes a cumulatively serious problem, with the more damaged feathers causing even more hens to feather peck. This is particularly problematic if the damage attracts the interest of hens that had not previously shown feather-pecking behaviour.

In summary, we have demonstrated that feather damage does encourage feather pecking, and that at least one likely mechanism for the spread of feather pecking within a flock is the attractiveness of damaged feathers. Presumably, feathers can be damaged initially by a feather-pecking bird, but damage may also occur by abrasion against other birds at high densities or against equipment in the system or the side of cages. It may even be the case that some individuals are predisposed to peck at their flock mates irrespective of the target birds’ plumage and so initiate feather damage whereas other individuals may peck only at damaged feathers.

One surprising effect of the damage or removal of feathers were outbreaks of cannibalism in half of the pens. It has long been argued (Siren, 1963) that cannibalistic birds were deficient in nutrients or some other necessary dietary requirement. Even very recently, the effects of diet on health, mortality and plumage condition have been investigated (Wahlström et al., 1998). It has also been suggested that victim birds were in some way different in their behaviour, or personality, to the other hens (Neal, 1956). Cannibalistic attacks in nature have been reported to occur when there has been some sort of asymmetry between the cannibal and the victim, such as size or strength (Yngvesson and Keeling, 1999). It is possible that by changing the hen’s feathers in our experiment we have recreated the situation where one hen looks different. This possibility is especially borne out by the fact that most victims were attacked on the area of the body where the feathers had been manipulated.

We cannot exclude the possibility that we changed the behaviour of the hens in some way by performing the manipulation to their feathers and so made them into victims of cannibalism. However, as mentioned previously, all hens in all pens were handled in the same way, with the control hens receiving sham manipulations. In addition, there was no obvious difference in preening behaviour between the experimental and control hens.
immediately following the manipulations. Therefore, it is unlikely that the victims of cannibalism somehow differed in their behaviour as a result of the change to their feathers.

It has often been claimed that there is a relationship between feather pecking and cannibalism, with the suggestion that pulling out a feather produces bleeding, and it is this that attracts cannibalistic pecking to occur (Savory, 1995). However, this relationship has not been demonstrated experimentally. The presence of a bleeding wound alone does not necessarily result in cannibalistic attacks. Even our own practical experience has shown that two injured birds can be kept together without further problems. This is in keeping with the finding that within a flock where there was both feather pecking and cloacal cannibalism, it was rare for individuals to be seen to give both types of pecks (Keeling, 1994). There may be a similar lack of relationship between cannibals and feather peckers. It appears from the present experiment that newly exposed skin is a very attractive target for cannibalistic pecks. If feather pecking is so severe as to expose the skin of the victim, then the exposed skin may elicit a cannibalistic attack from another hen. This other hen, a potential cannibal, might not have shown cannibalistic behaviour if there were no naked birds in the flock. Thus, the presence of feather peckers in a flock may indirectly lead to an outbreak of cannibalism. Of course, whether there actually is an outbreak of cannibalism will depend on whether there are potential cannibals in the flock. This probably accounts for the fact that cannibalism occurred in some pens in our experiment but not in others.

The accidental discovery that healed victims of cannibalism were immediately cannibalised on their return (often more than 4 weeks after they had been removed), and had to be again removed from their pen is supported by previous work. Similar findings have been reported previously by Cuthbertson (1978) who reported that when hens that had been toe-pecked were returned to their home pens they were also immediately toe-pecked again, even if no sign of their original injuries existed. These findings suggest that completely healed victims of cannibalism either may be changed in some way, which makes them victims again, or that the cannibals have memories of the victims and, thus, the cannibalistic behaviour once again occurs. However, it has been found that separations of 2 to 3 weeks result in hens not recognising other, previously familiar, hens (Guhl, 1962). Therefore, in this case, it is unlikely that the cannibals still had memories of their victims after months of separation. When we investigated whether healed hens that had been cannibalised in their home pens were attacked cannibalistically when placed into different pens where there had been cannibalism, it was found that apart from the usual minor agonistic interactions with the resident hens, there were no cannibalistic attacks. This, therefore, suggests that the victim’s behaviour had not changed as a result of the previous cannibalistic attack in such a way as to elicit attacks from other hens. However, it is possible that victims have better memories of location of where an attack had taken place than cannibals do for their victims. In this case, if the victim recognised that her home pen was the place where she had been attacked earlier, her behaviour might be quite different than if she was in a new pen in which she had not been attacked previously. This possibility warrants further study.

It appears that manipulating the feathers of hens has two consequences, the first of which is that feather pecking is directed towards the damaged feathers. A second
consequence of manipulating the feathers in such a way as to expose bare skin is that it seems to elicit cannibalistic attacks. The first finding is important in that it suggests that feather pecking can potentially spread through a flock if there is at least one hen in the flock that will start to damage feathers. The second finding is important as it is the first demonstration that a victim of cannibalism can become a victim merely because of a change in the quality of feather condition.

Acknowledgements

This research was funded by the European Commission and the Swedish Forestry and Farming Research Council. Thanks to Harry Blokhuis, Bryan Jones, and Mechiel Korte for their participation in the original discussions of this experiment. Thanks also to everyone who was involved with taking care of the hens, and to the staff and students at the Department of Animal Environment and Health, Section of Ethology for their comments on earlier drafts of this paper.

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