The influence of maternal hens on chick behaviour

STSM report

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1. Aims and objectives of the STSM

Galliform species such as chickens are precocial and thus able to move and feed independently shortly after hatching. The ability to survive independent of their mother has predisposed domestic chickens to commercial farming, in which birds hatched for either egg or meat production are reared in large flocks without parental care. Although orphaned chicks are capable of survival within a commercial context, they often exhibit damaging behaviours such as feather pecking, which is both a welfare issue and of significant economic cost to farmers (Gilani et al. 2013) . In both domestic and wild birds, maternal care is observed for weeks after hatching (McBride et al. 1969), however it's importance in the development of appropriate behavioural development is poorly understood. It is therefore a possibility that the damaging and abnormal behaviours observed in farmed birds may result from inadequate parental care.

Arguably one of the most important roles of the mother hen in addition to her involvement in thermoregulation and predator avoidance is her guidance in feeding (Stokes 1971). In a wild context, the hen is responsible for finding high quality food and highlighting its presence to her clutch. Upon detection of food, hens peck at the ground and emit a characteristic feeding-associated vocalisation which attracts the chicks to the food source and instigates feeding (Stokes 1971). This combination of auditory and visual stimuli is modulated by a number of factors such as the distance of the chicks from the hen (Wauters & Richard-Yris 2003), the hunger of the hen herself (Wauters et al. 1999) as well as the quality and amount of food (Wauters et al. 1999, Wauters & Richard-Yris 2003). The hen therefore facilitates social learning and the development of appropriate feeding behaviours and preferences in chicks, which may not develop in her absence (Suboski & Bartashunas 1984). Indeed, unbrooded chicks peck indiscriminately at both food and non-food items when they are young (Nicol 2004). Further quantification of the development of feeding behaviour in relation to maternal care is, however, needed.

In the absence of maternal cues, commercial birds are provided with an abundance of clearly visible chick crumb to try and minimise indiscriminate pecking. Although chicks are able to learn from each other in this context, copying conspecifics is unlikely to provide the same quality of behavioural guidance as an experienced mother. Pecking preferences may therefore be redirected towards non-feed objects such as the feathers of other chicks (Blokhuis & Arkes 1984). Here, I quantify the behaviour of brooded and unbrooded chicks in order to determine the influence of maternal care on the development of behaviour in layer chicks. In particular, I determine differences in feeding behaviour to assess their role in the development of damaging behaviours such as feather pecking in the absence of parental guidance. I test the hypothesis that the presence of a mother hen alters the development of feeding behaviours in chicks.

Aims and objectives

The overall aims of the STSM were:

1) To determine the influence of maternal care on chick behaviour. In particular, to determine if feeding-related behaviours differ between brooded and non-brooded chicks.
2) To gain proficiency in behavioural analysis of video data.
3) To build a collaborative relationship with Dr Edgar at the University of Bristol.

In addition, the scientific objectives of aim 1 were:

1) To quantify the behaviour of layer chicks reared with or without mother hens.
2) To determine if the behavioural influence of the hen changes with the age of developing chicks.

2. Description of work undertaken

Methods

i) Animals

Primiparous broody hens (mixed breeds) aged 50–100 weeks, were obtained from a breeder and housed individually in a floor pen (1.5 × 1 m). The pen was bedded with wood shavings (5 cm) and contained a feeder with layers mash, a drinker and a cardboard nestbox. The hens were allowed to sit on 12 infertile eggs within the nestbox for 24 h before the eggs were swapped with 12 fertile eggs. The hens were then allowed to incubate these until hatching. Throughout this period, once per day, hens were gently lifted and moved out of the nestbox, to encourage them to feed and drink. The fertile eggs contained Lohmann classic chicks, meaning that the hens and chicks were unrelated. Non-brooded chicks were incubated and hatched in an incubator (Brinsea OvaEasy 100 Advance) and on their day of hatching moved to a pen (matched with the pens above but with the addition of a heat lamp positioned overhead). For all treatments, only female chicks were kept, with a resulting 5 female chicks per pen. All groups were fed a commercial chick crumb. The temperature in the room was 23 °C and the lighting schedule was 12:12 h light:dark. Pens were recorded using a swann cctv system.

ii) Video analyses

a) Tray proximity tests

In order to determine the magnitude of feeding behaviour, video stills were taken every 15 minutes from 08:00-19:00 for a total of 5 brooded and 5 unbrooded groups (21 days of age, each consisting of 5 chicks with or without a hen, respectively). The number of individuals present on the food tray was noted at each time point. For brooded groups, the presence or absence of the hen was also noted.

b) Behavioural scan sampling

A more detailed scan sampling of brooded and unbrooded chicks was also performed, in which observations were made in 10 minute intervals from 07:00-19:00. All chick and hen behaviours were recorded at 2, 21 and 42 days post hatch for 14 brooded and 6 unbrooded groups, each consisting of 5 chicks with or without a hen, respectively. A behavioural score of 0 indicated that 0 chicks were performing the behaviour at the given time and a score of 5 indicated that all 5 chicks were performing the given behaviour. Values were then summed for the day, giving a proxy for the amount of time spent by the group performing each behaviour. The occurrences in which all chicks were within one chick length of each other was also noted in order to illustrate the cohesiveness of the groups.

c) Behavioural focal sampling

In order to obtain a more detailed snapshot of the chicks' behaviour, focal sampling was performed for 10 minutes at 11 am in 21 day brooded and unbrooded chicks using BORIS event-logging software (ref). The percentage of time spent in each of the coded behaviours (foraging, drinking, tray eating, walking, running, preening, sitting, standing and out of sight) was calculated for each chick and hen for a total of 2 treatment groups.

iii) Statistics

Data (with the exception of body mass data) showed non-normal distribution and therefore non-parametric analyses were used throughout. For tray proximity tests, behavioural scan sampling and behavioural focal sampling, Wilcoxon rank sum tests were used to test for differences between brooded and unbrooded chicks. All statistics were performed in r studio Version 1.1.383.

3. Results

i) Growth

Growth was significantly different between brooded and unbrooded hens at day 1, 3, 7, 21, 35, 49 and 63. At all time points, unbrooded chicks were heavier than brooded chicks. Unbrooded chicks were 6% heavier at day 1 ($p<0.05$), 26% heavier at day 21($p<0.001$) and 9 % heavier at day 63 ($p<0.01$).

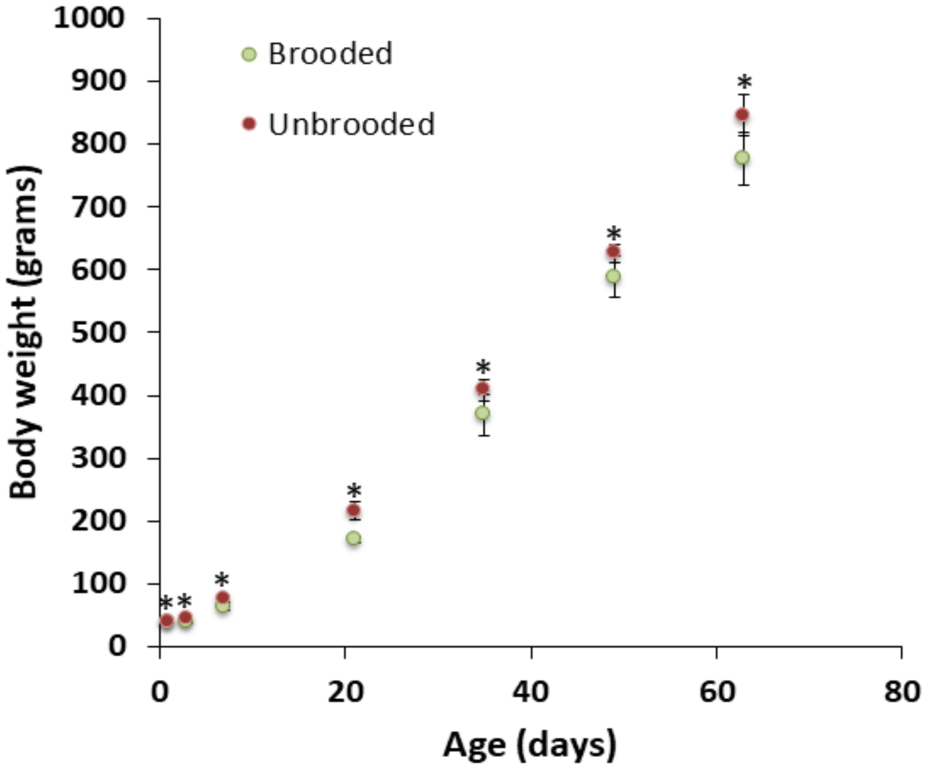

Figure 1: Growth curves for brooded (green) and unbrooded (red) clutches. Stars indicate significant differences at given time points ($p<0.05$). Error bars indicate standard deviations.

ii) Tray proximity tests

Brooded and unbrooded chicks appeared to spend more time not feeding than feeding at the food tray, however both groups spent a similar percentage of time at the tray (36% and 41%, respectively) and away from the tray (64% and 59%, respectively) (Figure 2). This lack of difference in tray feeding between groups was also seen in the average number of chicks at the tray at a given time (Figure 3A, $p>0.05$). In brooded chicks, the number of individuals at the food tray was higher when the hen was present compared to when absent (Figure 3B, $p<0.01$).

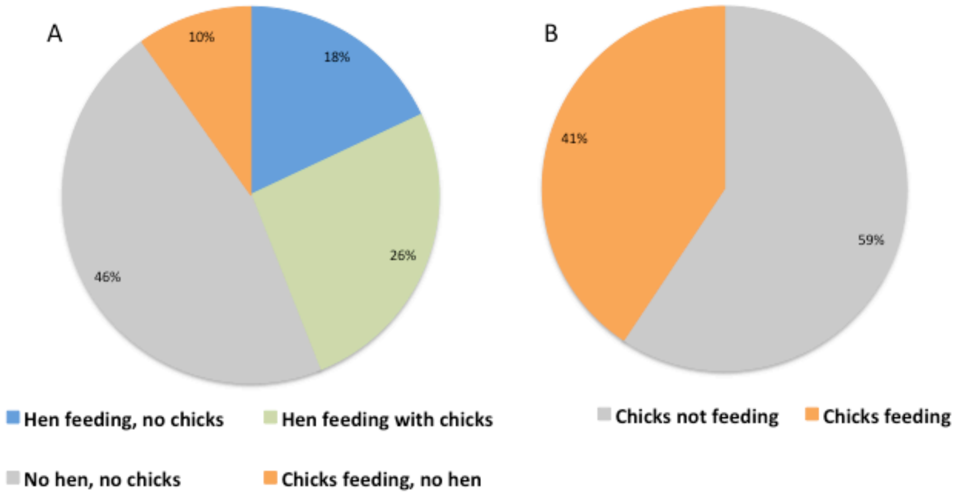

Figure 2: Chick and hen presence at the feeding tray in brooded (A) and unbrooded (B) clutches at 21 days post hatch.

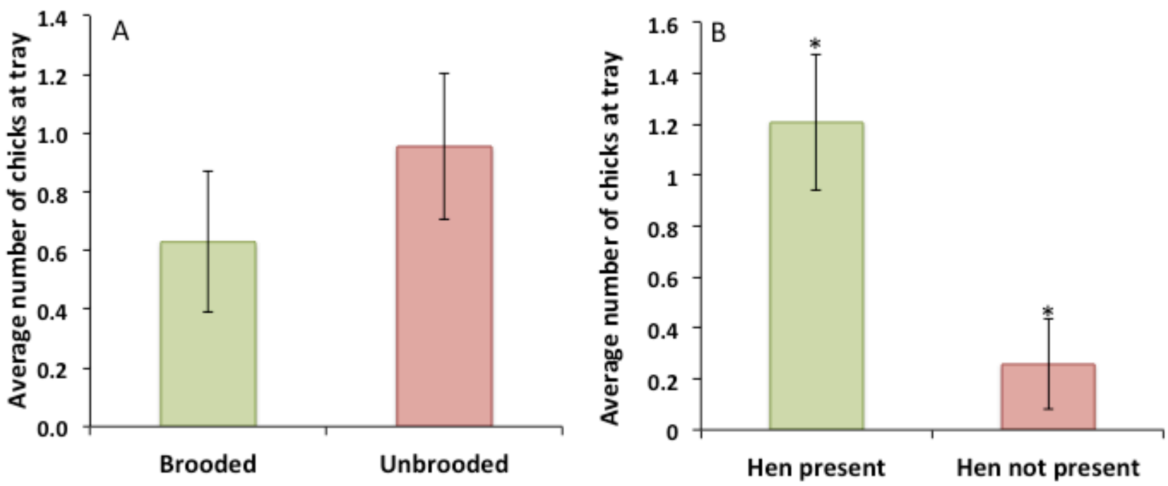

Figure 3: Food tray presence (as indicated by the average number of chicks at the feed tray) for 21 day old brooded (green) and unbrooded (red) clutches (A) and brooded clutches with (green) and without (red) the presence of the hen. Stars indicate significant differences ($p<0.05$). Error bars indicate standard deviations.

iii) Behavioural scan sampling: effects of brooding and age

At 2 days of age, chicks differed in time spent in 4 of the 11 behavioural measures, as determined by the sum of the counts for each behaviour for an entire day (Figure 4A). Brooded chicks spent less time sitting ($p<0.001$), more time feeding at the tray ($p<0.05$) and foraging away from the tray, represented by scratching behaviour ($p<0.01$). Unbrooded chicks also spent more time out of sight, however this was the result of the heat lamp obscuring the camera view. At 21 days (Figure 4B), The lower sitting activity and higher foraging/scratching activities were still seen in unbrooded birds. Feeding at the tray no longer differed ($p=0.13$), however brooded chicks spent longer preening than unbrooded birds ($p<0.05$). By day 42, brooded and unbrooded birds spent similar times in all behaviours except for foraging ($p<0.05$), which was higher in brooded birds (Figure 4 C).

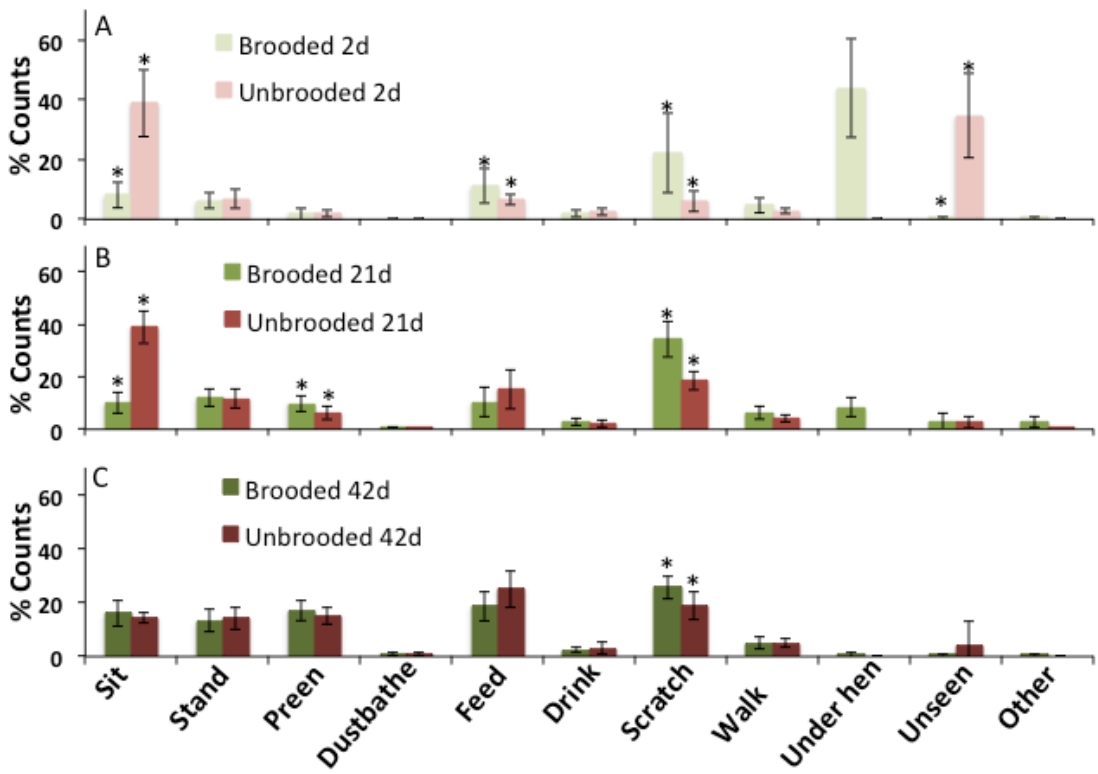

Figure 4: Summed counts for 11 behavioural categories as a percentage of total counts for brooded (green) and unbrooded (red) clutches at 2, 21 and 42 days post hatch (A,B and C, respectively). Stars indicate significant differences ($p<0.05$). Error bars indicate standard deviations.

iv) Chick proximity with brooding and age

At 2 days old, brooded chicks spent a larger proportion of time in close proximity to each other than unbrooded chicks (p<0.01, Figure 5). This difference was, however reversed at 21 (p<0.01) and 42 (p<0.01) days at which time brooded chicks were less commonly in close proximity to each other in comparison to unbrooded individuals.

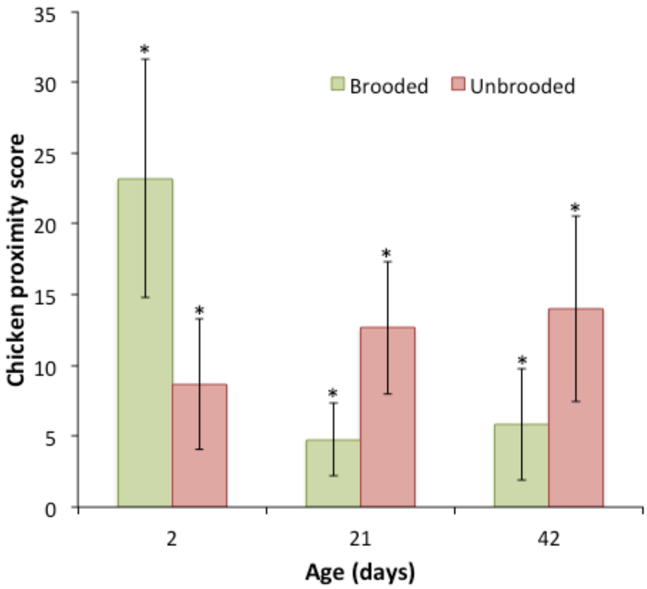

Figure 5: Proximity scores for brooded (green) and unbrooded (red) clutches at 2, 21 and 42 days post hatch. Stars indicate significant differences (p<0.05). Error bars indicate standard deviations.

v) Behavioural focal sampling: effects of brooding

Brooded and unbrooded individuals at 21 days of age were not different in the % time spent performing any of the behaviours measured (Figure 6).

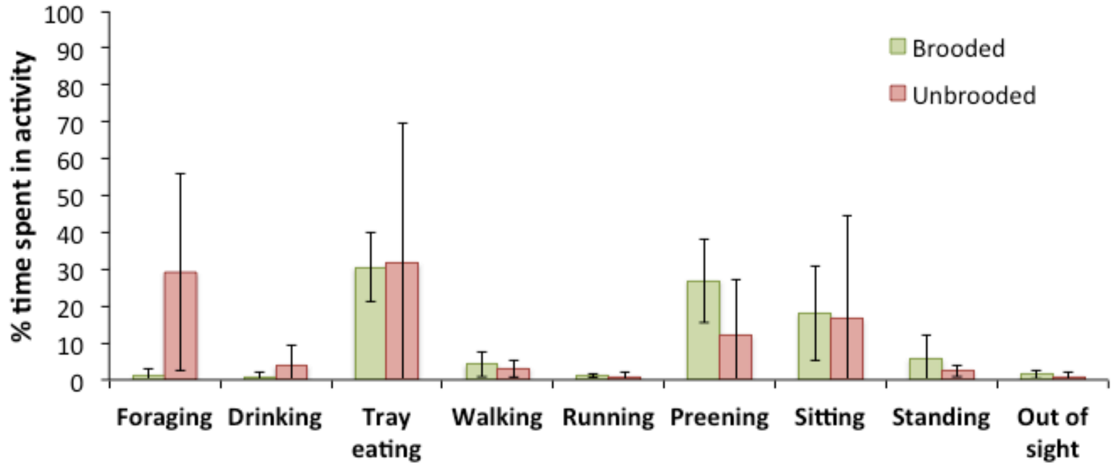

Figure 6: Percentage of time spent performing 9 behaviours for brooded (green) and unbrooded (red) clutches at 11 am, 21 days post hatch. Error bars indicate standard deviations.

4. Discussion

The data presented demonstrate an influence of maternal care upon chick behaviour. In keeping with our original hypothesis, some of the behvioural differences between brooded and unbrooded chicks related to feeding and are retained until at least 42 days of age. For example, two days after hatching, unbrooded chicks spent a larger proportion of their time sitting and less time feeding and foraging. By 21 days of age, brooded birds still foraged more in their pens and spent an increased time preening, although this higher self-maintenance was not seen in 42day old birds. Although focal sampling did not highlight any differences in behaviour, noise in the data was very high and the sample size was too low to draw any conclusions from. Our finding that brooded birds spend more time foraging is in keeping with previous studies that have also shown a higher level of ground pecking in brooded chicks (Blokhuis & Arkes 1984, Riber et al. 2007). Increased floor pecking is associated with a reduction in feather pecking (Blokhuis & Arkes 1984) and appropriate foraging behaviour is thought to be one of the major factors in reducing feather pecking (Gilani et al. 2013). Brooding therefore appears to facilitate the development of appropriate oral and directed pecking behaviours and would be expected to reduce feather pecking. It is currently unknown, however, to what extent pecking behaviours were present in the current study. Previous studies using small numbers of chicks have not found differences in feather pecking between brooded and unbrooded chicks (Riber et al. 2007), however larger experimental groups may be needed to generate the conditions required for misdirected pecking.

The mechanisms by which the hen drives the observed differences in behaviour is unclear. Unbrooded chicks are capable of foraging by ground scratching and pecking, indicating that the behaviour itself is not taught. Instead, increased foraging in brooded birds may be the result of the maternal hen instructing chicks when to forage, driving ultradian rhythms (Lumineau et al. 2000). Indeed, maternal feeding displays consist of high-pitched vocalisations and pecking towards food items in order to elicit feeding (Edgar et al. 2016). Here, the maternal hen appeared to initiate tray feeding in chicks, which were rarely seen at the feeding tray when the mother was absent. Further investigation into the hen's feeding and vocalisation behaviours in the presence or absence of chicks is needed to determine to what extent the hen drives feeding or is passive in following chicks. In the latter case, the increased foraging of brooded chicks may simply result from a sense of increased security resulting from the guarding presence of the parent.

Despite spending less time foraging, unbrooded chicks grew more than brooded individuals, in keeping with other studies (de Margerie et al. 2013). Here, unbrooded chicks were higher in mass at day 1, indicating that the incubation by the hens may have resulted in submaximal hatching weights. Upon hatching, all chicks were then fed *ad libitum*, giving them the opportunity to catch up in terms of growth. Other feeding-related factors may therefore have contributed to the observed weight differences between groups throughout rearing. Although the differences were non-significant, unbrooded birds spent a higher proportion of the time feeding at the food tray. Given that the feed tray contained a large volume of feed, the proportion of time spent at the feed tray is not necessarily indicative of food intake and even small increases in feed tray presence could be associated with large differences in food intake and growth. It is possible that unbrooded birds were binge eating, consuming more food whilst at the feeding tray as opposed to during the more natural foraging behaviour seen in brooded chicks. An additional explanation for the lower mass of brooded chicks is that, in the absence of a stationary heat source, they have a more unpredictable thermoregulatory environment (de Margerie et al. 2013). Unbrooded chicks are therefore at an advantage in terms of being able to devote more time to feeding and less energy to thermoregulating. Therefore, a mobile mother may be beneficial in driving exploratory behaviour, albeit at the expense of body growth. Mimicking aspects of brooding could be beneficial in rearing schemes requiring slow growth, such as the broiler breeder industry.

In addition to differences in feeding behaviours, the cohesiveness (i.e. the proximity of chicks to each other) of brooded and unbrooded chicks differed. Here, brooded chicks were more homogenous at day 2 as much of their behaviour was conducted in proximity to their mother and therefore to each other. In the absence of parental guidance, unbrooded chicks were less cohesive, exploring the environment in a less directed way. However, brooded chicks became more independent by 21 days old in comparison to unbrooded chicks, which remained as homogeneous as they were at 2 days. Thus, brooding appears to foster the development of independence, possibly indicating functional maturity in behaviours. The finding that brooded chicks are more dispersive is in keeping with previous data for Japanese quail, which are more exploratory when placed in new environments when reared with a mother (de Margerie et al. 2013). Conversely, unbrooded chicks, in the absence of parental tuition may rely on conspecifics to learn behaviours and lack spatial skills so stay in close contact through behavioural maturation (de Margerie et al. 2013). Such close proximity between individuals could be conducive to the development of damaging behaviours which may be exacerbated in the absence of appropriately developed feeding behaviours.

In conclusion, the behavioural development of feeding differs between brooded and unbrooded chicks. Brooded chicks spend their early days feeding and foraging with the mother hen, leading to independent foraging within the first few weeks of life. The absence of a mother hen appears to preclude this behavioural development but leads to higher feeding, chick proximity and increased growth. The magnitude of damaging behaviours seen in an industrial setting may therefore result, in part, from immature foraging behaviours coupled with close-packed flocks caused by both high stocking densities and the lack of behavioural independence. Future work should focus on establishing the causative and mechanistic links between parental feeding displays and the development of chick feeding behaviours. By identifying the mechanisms by which hens facilitate behavioural development, researchers may be able to develop artificial methods which are implementable in industry and which reduce the development of damaging behaviours.

5. Future collaboration possibilities with the host institution

The STSM has opened up many new possible avenues for collaboration between Linköping University and the University of Bristol. I hope to continue my connection with Dr. Edgar, taking advantage of her behavioural expertise, thermal imaging capabilities and the new chicken experimental facility at the University of Bristol. In turn, I hope to apply my physiological and molecular techniques to the welfare questions being asked within the research group at Bristol. This integration of behavioural, physiological and molecular data is necessary in order to fully evaluate the welfare of captive species. In addition, I hope to collaborate with Dr. Edgar within Sweden, looking into the effects of domestication on maternal care and feeding. I also hope to integrate her expertise in body temperature measurements into the physiological work that we perform in Linköping regarding the physiological basis of hunger.

6. Future plans including future publications

Dr. Edgar and I plan to submit a grant to the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (FORMAS). The project will focus on the effects of domestication upon maternal care with both an evolutionary and applied emphasis. By performing experiments similar those presented here, we will aim to determine the nature and individual variation in maternal care in the red junglefowl (the ancestral bird to domestic chickens). In addition, we will then quantify the physiological consequences of brooding for chicks and, finally, determine how maternal care has changed through artificial selection using cross-fostering experiments.

7. Outputs produced (paper, dataset, funding application)

The STSM has resulted in a new dataset from previously unprocessed data which have yielded new insights into the influence of maternal care on the development of feeding behaviour in chicks and the development of damaging behaviours. This data will eventually form part of a broader publication from Dr Edgar's group. The insights and discussion that have arisen from the STSM will contribute to future collaboration and will form the basis of a grant application which, if successful, will result in numerous outputs regarding animal behaviour, physiology and welfare.

8. References

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