AN ETHOLOGICAL INVESTIGATION OF FEATHER PECKING

By

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DECLARATION

I declare that this thesis has been composed by me and that the work described here is my own.

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ABSTRACT

In this thesis feather pecking in the domestic fowl was studied from an ethological viewpoint. Observations on the development of feather pecking and associated behaviour were carried out mainly on small groups of young birds.

In the first Chapter the feather pecking syndrome was described and the literature reviewed. This previous work tended to fall into three broad categories; consideration of managerial, nutritional and behavioural factors. There was no consistent evidence that any of these were of overriding importance. The aims of this thesis were then outlined and in Chapter 2 the materials and methods used were described.

There follow seven chapters describing investigations into various influences on feather pecking behaviour. It was found that many factors had some effect on this behaviour but the most important was the disposition of individual birds; some being inclined to feather peck and others to be pecked. It was shown that these two types could be consistently identified and separated and that their behaviour differed in a number of ways.

Hormonal and hereditary factors were both found to have a role in influencing the behaviour of individuals. Other factors implicated to various degrees were the stimulus properties of the objects being pecked (visual properties alone were not found to be adequate to elicit sustained pecking behaviour), and the environment. As this was made more complex an increase in pecking behaviour was found. No relationship was found between measures reflecting aggressive behaviour and feather pecking.

It was concluded that many of the factors previously thought to influence feather pecking outbreaks were of secondary importance and their effects would only become evident if some fundamental variable, such as a specific genetic component, was present.

CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

INTRODUCTION

Feather pecking and the often associated behaviour, cannibalism, are conditions that have persisted in the poultry industry since intensive methods of farming became common practice. The results are serious, both for the poultry farmer who can lose large numbers of birds, and to the hen itself which must be presumed to suffer considerable pain and discomfort.

Definition of feather pecking and cannibalism.

Feather pecking is one bird pecking at and removing feathers from the body of another. In its least damaging form this simply involves pecking at the feathers and in time removing the barbs from the feather shafts but not the whole feather from its follicle. A more severe form is found when whole feathers are removed thus exposing large areas of bare skin, and finally, at its most damaging the pecking is aimed at the flesh as well as the feathers and this results in tissue damage, blood loss and often the death of the victim. When pecking reaches this third stage it is often referred to as cannibalism though the evidence of any real distinction, except one of degree, between this and feather pecking is not conclusive since both feathers and tissue are eaten at all stages of the condition. In many instances an outbreak of feather pecking also includes some cannibalism and vice versa. There is little convention in the use of these terms in the literature, both appear to be used quite loosely to cover the whole syndrome. In this thesis the term "feather pecking" will be used to

Feather Pecking and Cannibalism in 3 week old chicks

Figure 1.1. Feather and tissue damage at the base of the tail.

Figure 1.2. Similar damage as in Figure 1.1. accompanied by feather pecking of the back.

Feather Pecking and Cannibalism in 3 week old chicks

Figure 1. 3. Feather pecking affecting back, wing and neck.

Figure 1. 4. Feather pecking and cannibalism affecting the back and wings.

Feather Pecking and Cannibalism in 3 week old chicks.

Figure 1. 5. Considerable tissue damage and areas denuded by feather pecking.

Figure 1.6. Bird with barb pecked tail and wing feathers.

Figure 1. 7. Similar but slightly more severe feather damage. This bird was housed in the same cage as the two birds in Figure 1. 8.

Figure 1.8. Two birds from the same cage showing extreme effects of feather pecking.

Cannibalism in Adult Birds

Figure 1. 9 The only damage to the bird was a severe wound on the head.

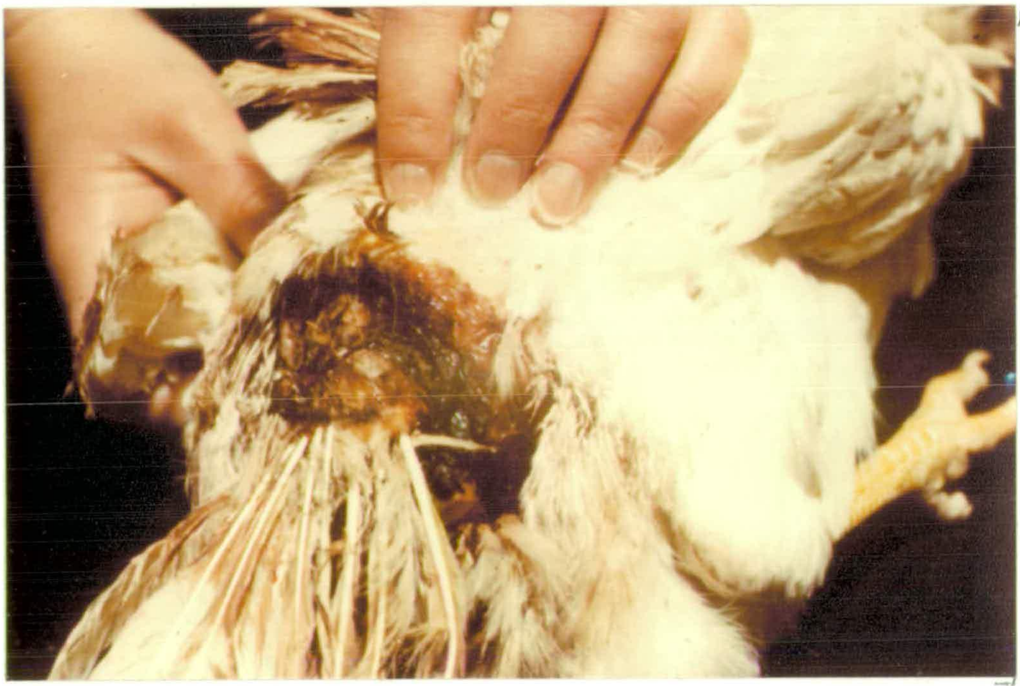


Figure 1. 10. Damage was again restricted to one region, the base of the tail.

describe all forms of feather removal and also superficial tissue damage. "Cannibalism" will only be used to describe the more serious forms of tissue damage.

Feather pecking and cannibalism do not appear to be restricted to any particular period in a birds lift although it is more likely to occur at sometimes rather than others. Figure 1.1 - 1.5 show chicks 3 weeks old which have been damaged by cagemates of the same age but as Figures 1.6 - 1.8 and 1.9 - 1.10 show this type of damage can happen equally well to mature birds. These figures show both the age range and damage range involved in this behaviour.

Suggested causes and methods of investigation.

Investigations into the problems of feather pecking have been many and have resulted in almost as many suspected causes and contributory factors. In 1937 Miller and Bearse wrote, "Many preventitive measures have been recommended involving management practices such as increasing the floor space per bird, more eating and drinking space, elimination of idleness, less confinement, coder and better ventilated brooder houses, elimination of floor layers, use of more and better nests and removal of injured and pecked individuals ..... use of ruby red lights, trimming beaks and application of distastful substances to the birds body and use of vent protectors, beak guards and blinders." Other investigators have blamed nutritional, hormonal and genetic causes. However, 40 years later it is impossible to say that there is any more agreement as to the causes of or the cure for feather pecking and cannibalism. Most of the suggestions and explanations concerning feather pecking and cannibalism are based on large scale husbandry investigations and thus the remedies tend to involve, and be related to, management procedures.

Basis of experimental approach in this thesis.

It was thought necessary to look at the problem under more controlled conditions than had previously been used; both by using very young birds or birds whose history was known and by using different experimental methods. Thus the emphasis in this study has been on the behaviour of small groups; and in a majority of experiments intensive observations were made for the first few weeks of life with a long term follow up until at least 25 weeks.

It was hoped that by observing birds, usually in small numbers, during the development of pecking behaviour it would be possible to discover its causes by manipulating both the internal and the external environment of the animals. Some work of this nature has been done on the pheasant, (Hoffmeyer, 1969) but the domestic fowl has not been studied in this way.

REVIEW OF THE LITERATURE

Although many causes have been suggested for feather pecking and cannibalism most studies have concentrated on single aspects of the problem. The literature, therefore, falls conveniently into several separate sections and will be reviewed as such. The main body of work is concerned with management problems such as lighting, food form, population size, density and nutrition, these will be considered first and then the importance of behavioural factors, genetic influences, hormonal control and evidence from other species will be reviewed.

Management Factors

Work on the causes of feather pecking and cannibalism began in 1920 and 1930 as the use of intensive rearing methods became more widespread. Since there is little evidence that feather pecking and cannibalism occured on any scale before these methods were introduced the not unnatural assumption was made that there was a failure in the management of flocks where outbreaks occured. Siren (1963) quotes Oettel (1873) as being the first to write a complete description of the behaviour concluding that it was due to lack of green food and that it was not observed in birds that were allowed to roam freely.

Importance of lighting.

Carver (1931) suggested that the close confinement of birds during feather growth was a major factor since at this time the feather shafts are full of blood and this encourages the removal of feathers and the continuing of pecking once it has started. He proposed that the remedy was to make the blood invisible to the birds so that if any damage did occur attention was not drawn to it by the colour of the blood. He found that ruby coloured lights in the hen house reduced feather pecking and possibly prevented it from starting. Similar results were obtained by Schaumaier (1968) who reared chicks from hatching to 20 weeks under red, white or green light and found that the incidence of feather pecking was 0%, 30% and 41% respectively. It is not clear why the pecking should be greater under green rather that white light since the colour contrast would be greater in the latter case, however, the difference between the incidence of pecking in these two groups was not very great.

Van Manen (1934) found that by replacing the clear glass in the poultry house windows with red glass feather pecking and cannibalism could be controlled. He attributed feather pecking to two main causes, firstly over heating, leading to a "nervous reaction" resulting in either toe or feather pecking and secondly to the presence of blood on another bird due to accidental injury. By making the blood in this type of injury invisible van Manen suggests the red glass is effective in preventing an outbreak of feather pecking from becoming established. The pattern of pecking observed in brown and white feathered birds often appears to differ, perhaps this is also associated with the visibility of the damaged areas. In brown birds there seem to be large patches of superficial damage, whereas white birds often have small but very deep wounds.

Physical characteristics of the food.

Under intensive conditions food is very easily available either in hoppers spread around the house as in many deep litter systems or in food troughs outside the battery cage. In either case very little effort has to be made by the bird for it to obtain its full quota of food. This is especially true if pellets are fed. Jensen, Merrill, Reddy and McGinnis (1962) found that the amount of time spent feeding by birds fed on mash or pellets varied considerably in a 12 hour day. Turkey poults spent 136 minutes per day eating 62g mash but only 16 minutes eating 57g of pelleted food, similarly, New Hampshire chicks spent 103 minutes eating 38g of mash and only 34 minutes eating 37g of pelleted food. Thus it has been suggested that the birds might have "time on their hands" and occupy it by pecking at other individuals in the group. Davidson, Schaible, Brant and Card (1941) in very extensive studies found that when birds were fed entirely on mash an average of 6% of the deaths were due to cannibalism, whereas in groups fed on a mixture of mash and grain together an average of 36% of deaths were due to feather pecking and cannibalism. They do not conclude anything definite from these findings but suggests that food particle size is an important variable in a very complex problem. Unfortunately they do not appear to have controlled the nutritional value of the two forms of feeding so that absolute comparisons are difficult.

Heywang and Morgan found little effect of different forms of food on the amount of feather pecking in early experiments (1940) but when these were repeated (1944) and included stocking density as an additional variable then they found that pellet fed groups indulged in more feather pecking but only when housed at a high density. When the area per bird was increased feather pecking disappeared irrespective of the feed.

Ziegenhagen, Corman and Hayward (1947) showed that turkey poults were affected by feed particle size in the same way, those being fed on mash doing much less pecking than those fed on pellets or granules. In 1949 Bearse, Berg, McClary and Miller, made a further pellet versus mash comparison but they also varied the fibre contents of their diets. Their findings were similar to those of other workers; the pellet fed birds pecking earlier and more severely than mash fed ones. But the effect of an increase in fibre content was different for the two forms of food, having no effect in a pelleted diet but reducing pecking in the mash fed groups. Thus the evidence suggests that the size of the particle does have some influence on the incidence of feather pecking but that it is not the sole factor and possibly not even a major one. Calet (1965) suggested that the form of the diet was a contributory factor in the incidence of feather pecking but that there were many other causes ranging from "faulty rearing, bad ventilation, too high density, and nutrient deficiency". He suggested that the feeding of pellets may make the birds more nervous and that this in turn may cause feather pecking to break out especially if there are other predisposing conditions. This explanation of feather pecking in terms of "nervousness" is very unsatisfactory. Calet cites evidence which shows that pellets result in more feather pecking but there is none to relate it to "nervousness". He assumes that birds involved in feather pecking are nervous, thus "whilst flocks of chicks may be perfectly calm when they are fed on a mash diet, there is a tendency towards cannibalism among the birds fed on pellets and particularly on crumbs". He continues by saying that pellets are not the primary cause of nervous excitement and cites studies to show that feather pecking ceases once birds are returned to correct rearing conditions. This conclusion that nervousness, whatever that might be - and there is no attempt to define it - is a cause of feather pecking seems to be without substance, the two terms being confused and without independent existance. Thus a nervous bird appears by definition to be one that indulges in feather pecking, and when it loses its nervousness it is because it returns to a nonfeather pecking state!

Nutrition and feather pecking.

In addition to the physical form of the feed a considerable amount of attention has been focused on the effects of nutrient levels on the incidence of feather pecking; feather pecking generally being associated with an imbalance or lack of some particular nutrient in the diet. The two main groups of substances involved are amino acids and various forms of cellulose. In 1937 and 1938 Miller and Bearse conducted two experiments which showed that feather pecking was considerably less in groups of birds fed with oats in some form, even just the hulls, than in groups receiving other cereals. They concluded that oats had a preventative property not shared by the other cereals and also showed that this property was destroyed by heating i. e. feeding oat hull ash was not effective in preventing feather pecking. Spruce saw-dust was included in some diets and although this was found to reduce feather pecking it was not as effective as the oat supplement, leading the authors to suggest that the result is not explained solely by the increase of the fibre content but that oats contain some factor which is altered or destroyed by ashing. In an attempt to discover this prevent-ative property they tested manganese sulphate. Only a very slight reduction in the amount of feather pecking was observed, so they concluded that this was not the agent responsible for the beneficial effect of oats. Pullianen (1965) repeated the experiments with pheasants and found that the birds fed oats did not develop feather pecking until the oats were removed, pecking could then be stopped again by replacement of the oat supplement. He found that the effect was very rapid, within 48 hours of the alteration of the diet, and suggested that the amino acid arginine might be responsible.

More support for the role of arginine in the controlling of feather pecking was found by Siren (1963), working with pheasants and cockerels he found that a supplement of arginine reduced feather pecking within 48 hours and like Neal (1956) he supposed that feather pecking birds are simply searching for a source of the relevant amino acid. Siren also tried to increase feather pecking by altering environmental conditions such as light and temperature and by staining some birds' feathers with blood, but all of these were ineffective whereas a reduction in the amount of arginine produced an outbreak immediately. However, when Madsen (1966) tried to repeat these findings using pheasant and partridge chicks he found arginine completely ineffective in reducing or preventing feather pecking and in some cases he found that birds given this amino acid actually showed more pecking behaviour than those without it.

Kull (1948) favoured manganese sulphate as a major feather pecking preventative and suggested that with supplements of this and of horn meal almost all outbreaks could be controlled although he also allowed that bad management in the form of poor sanitation, presence of injured, diseased and parasitized birds and high temperature could act as releasers as could the temperament of the bird. Like so many investigators he did not appear to have much faith in his findings and so needed to evoke other factors to explain unexpected outbreaks.

Another amino acid sometimes found to reduce feather pecking is methionine. Neal (1956) found that this result could be observed as soon as the methionine had time to reach the blood stream, and that pecking only returned when the methionine in the blood dropped below a certain level. He also suggested that birds showed a specific appetite for methionine and that when they pecked each other they were looking for a source of the amino acid. He noticed that some birds were "peckers" and others "peckees" and that the latter did not peck each other if penned together. He assumed that the "peckers" were deficient in methionine whereas the "peckees" were not. Wolter, Thion and Baratou (1971) carried out feeding trials using pheasants and found that supplements of lysin and methionine were beneficial in reducing feather pecking but that arginine was not. They concluded that dietary factors are of secondary importance in causing and controlling feather pecking. Sherwood (1958) found no effect of feeding added methionine, and niacin and similarly Creek and Dendy (1957) found that additional methionine did not reduce or prevent cannibalism. Willimon and Morgan (1953) tried several supplements but found no differential effects. The work reviewed here leads to no general conclusions about the role of dietary factors in controlling feather pecking nor which substances have an effect on this behaviour or why. Schaible, Davidson and Bandemer (1947) suggested that malnutrition in general could result in feather pecking and that many deficiencies seemed to be effective in producing an outbreak.

Stocking density.

One of the most obvious differences between free range and intensively housed birds is the amount of space available to them; thus the effect of density on the incidence of feather pecking has been questioned. Van Manen (1934) said that feather pecking occurred in overcrowded conditions because of over heating which in turn led to an increase in the nervousness of the birds which resulted in both toe and feather pecking. This argument, like that of Calet (1965) seems to rely more on intuitive thought than on empirical evidence and in any case the simple assertion that birds feather peck because of increased nervousness takes us no further in understanding the real causes underlying the behaviour. However, he also suggested that crowding at the food hoppers due to lack of space resulted in birds pecking at each other in an attempt to reach the food and once one bird had become damaged it was difficult to prevent a full outbreak.

Other workers have not seen overcrowding as the sole cause of feather pecking but rather a triggering factor along with many aspects of environmental stress. Wells (1974) found that as both density and population size increased so did feather pecking and cannibalism, suggesting that both density and the number of birds caged together are important. Hughes and Duncan (1972) found no effect of stocking density although population size did appear to be important; groups of four showing less pecking than groups of eight. In this experiment vent pecking rather than feather pecking might have been involved since the difference between the groups showed itself most clearly around point of lay. Allen and Perry (1965) also found population size to be a more important factor than population density. Hill and Binns (1973) describe feather pecking as a reproductive disorder and they found different effects of density depending on the age of the birds. In the first year of life they found population size was an important factor whereas in the second year stocking density had more effect on the amount of feather pecking. Mather and Gleaves (1970) also found that the effect of density was dependent on the age of the birds, but in quite the opposite direction. Young birds showed an increase in feather pecking with an increase in density but older birds did not. Brantas (1974) on the other hand found no direct relationship between density and the incidence of feather pecking.

Here again the conflicting results make it impossible to decide whether density and population size are fundamentally important variables in feather pecking or whether they are simply contributory factors. The latter seems the more probable.

Conclusions on the importance of management factors.

The work reviewed so far does not suggest that any single management factor is primarily responsible for outbreaks of feather pecking and cannibalism. Not only is there lack of agreement between the results of the different studies but the methods and designs used in many of the experiments also vary greatly. Since much of the work has been done from an agricultural point of view many experiments have been run on commercial flocks or at least under commercial conditions. This means that whilst observations on trends within and between flocks have been recorded the behaviour of individuals has largely gone unnoticed and as Neal (1956) pointed out, it is quite possible that not all birds within one flock behave in exactly the same way with regard to feather pecking and cannibalism. Added to this, birds of different ages, strains and sexes have been used in the various experiments so that direct comparisons from one study to the next are not always valid or useful. Similarly many different environmental factors both specified and unspecified vary in these experiments so that no attempt can be made to estimate all the influences involved.

An added complication is that there is no uniform method of evaluating the incidence or amount of feather pecking and cannibalism observed. For example Siren (1963) Madsen (1966) Duncan and Hughes (1972) and Miller and Bearse (1938) all use a system of scoring the damage suffered by each bird whereas Wells (1973) Miller and Bearse (1938) and Neal (1956) give the number or percentage of deaths due to feather pecking and cannibalism and Wolter, Thion and Baratou (1971) and Ziegenhagen (1946) simply state that a given number of birds were affected without giving details of the extent of the damage. Less complete still are the accounts which give no numerical information but simply a statement of whether the behaviour was observed or not, for example, Voss (1933) Kull (1948) Carver (1931) and Heywang and Morgan (1944). Similarly, the terms used to describe the behaviour involved do not follow any particular convention. For example, is the "pica" referred to by Wolter et al (1971) the same as Neal's (1956) "pick outs" or Miller and Bearse's (1938) "cannibalism". At least where scores have been alloted for the damage suffered by each individual bird it is more possible to compare the results, but even here the systems used are very different, both in the areas they include and the details they describe, Hughes (1973) Pulliainen (1965). These differences may be due in part to the fact that birds of different strains may show different patterns of feather pecking but this only adds to the confusion. Thus it is difficult to know whether authors are even discussing the same syndrome or whether some are refering to much more specific behaviour patterns and the resulting damage than others.

If none of the management factors are solely responsible for outbreaks of feather pecking, then other possible variables must be considered, such as whether feather pecking is a form of aggression or is related to the hormonal balance of the birds or influenced by genetics.

Behavioural Factors

Aggression

From all superficial appearances feather pecking would seem to be a form of agression using the word in the general sense as defined by Hinde (1970). "Aggression is not easy to define precisely but refers to behaviour directed towards another individual which could lead to physical injury to the latter, and often results in settling status, precedence, or access to some object or space between the two". During feather pecking encounters one bird pecks another, removes feathers and sometimes damages skin and draws blood. The peck order of the fowl is a well known aspect of behaviour and it seems obvious that feather pecking is the result of the birds maintaining this rank order in a rather confined space where the subordinate birds are unable to escape from any of the pecks aimed at them. Whittle (1957) suggests that the position in the hierarchy is an important factor in determining the amount of pecking damage a bird receives and Pulliainen (1965) claims to have found a direct relationship between position in the peck order and the amount of damage sustained. Pulliainen's results are a little suspect since to obtain his measure of dominance he appeared to count all pecks directed by one bird at another so that a bird doing large amounts of feather pecking would have a very high score on the dominance scale and thus a positive relationship between feather pecking and dominance would be inevitable. Hughes and Duncan (1972) used a competitive feeding situation in which to measure the position in the hierarchy and then related this to the amount of feather pecking damage suffered by each bird. Within groups of four birds they found that birds at the top of the hierarchy tended to be the least pecked but that there was certainly no exact relationship. They concluded that, "This association between tendency to feather peck and social dominance is not an absolute one".

Hoffmeyer (1969) working with pheasants claimed that there is, "No primary correlation between the two phenomena". She found that birds low in the hierarchy would peck those higher up, female would peck male, young would peck old, in fact all the combinations that would be least expected in an aggressive situation. Hoffmeyer also found that the postures adopted before a peck were very different in the two cases as were the responses of the two birds involved after the incident had taken place.

Wennrich (1974) used similar methods to look at aggression and feather pecking in the domestic fowl and he came to similar conclusions. Feather pecking and aggressive pecking appeared to be very dissimilar. Postures adopted during, before and after the pecking act were all very different in the two contexts. Characteristically aggressive behaviour was accompanied by orientation by the aggressor towards the head of the opponent followed by a frontal attack at the head and neck area. This attack could also involve the ruffling of the aggressor's neck feathers, flapping of its wings and jumping at the opponent and this behaviour might continue after the peck had been delivered. The feather pecking bird on the other hand was much more relaxed in its posture, pecked at almost any area of its cagemates, approached mainly from behind and followed the feather pecking by any one of a large range of behaviours including pecking at another bird, the same bird or the ground. The feather pecked bird showed little or no response to being pecked. Wennrich suggests from his observations that both feather pecking and cannibalism are food pecking directed towards companions and that neither are related to aggressive pecking; these are exactly the conclusions reached by Hoffmeyer with her work on pheasants.

Thus the evidence is contradictory, measures using hierarchy suggest that there is some relationship between feather pecking and aggression even if it is not a straightforward one whereas observations on the behaviour patterns associated with the two forms of pecking suggest no relationship at all, but rather a connection between feather pecking and feeding. Studies involving the correlation of position in the hierarchy and the amount of feather damage suffered are possibly looking at the problem at too late a stage. Such studies can give no answer to the question of whether birds are at the bottom of the hierarchy and so are badly feather pecked or whether they are in that position because they are badly pecked. Similarly for those at the top of the hierarchy, is it because they are not damaged and so need not fear situations that might result in an attack by another bird. A final piece of evidence against the aggression hypothesis is found in an experiment by Hughes (1973) who administered testosterone to pullets and then scored the amount of feather pecking damage suffered by treated and nontreated birds. Although it was not measured in this particular study it might be expected that the level of overt aggression would increase due to this treatment, as found by Guhl (1961) whereas no increase was found in the incidence of feather pecking among birds who had been treated with testosterone, in fact quite the reverse occurred.

Since no measures were made of the effect of the testosterone on aggressive behaviour, however, it is perhaps unjustifiable to dissociate aggression and feather pecking completely until firmer evidence is available.

Weaver and Bird (1934) suggested that outbreaks of feather pecking might be due to a decline in "health and natural aggression" of the victims who thus became easy prey for flock mates. As evidence for this view he cites the finding that the egg production of birds killed by feather pecking and cannibalism was considerably lower for several months before their deaths than the production of non-affected birds. It could equally be argued that feather pecking undermined the health of the affected birds, resulting initially in a drop in egg production and finally ending in death.

Boredom and the pecking drive.

A further behavioural explanation for the sudden increase in feather pecking with the development of intensive systems of farming is that the birds have a "pecking need" or requirement which is not fulfilled under these conditions, or that the birds are "bored" or frustrated by the lack of variety in their environment. Levy (1938) raised birds both on wire and on free range and found that by five weeks every bird raised on wire floors had signs of feather pecking and was much more restless than those reared on range. When some birds were moved from wire to the range, pecking gradually declined until at eighteen weeks there was no sign of feather pecking at all and all pecks were directed at objects in the environment. Thus Levy suggested that the hens had a pecking requirement that was not being fulfilled on the wire floors, but that this requirement was higher in young birds than in older ones since by thirty weeks all birds in both conditions were fully feathered. When all the birds were moved out to free range feather pecking appeared again, Levy explains this by saying that when under stress, being in new surroundings, the hens regressed to infantile behaviour and so began to feather peck again. Unfortunately no further work has been done to substantiate these claims and no objective definition of fowl infantile behaviour seems to exist. Despite the use of Freudian concepts Levy is no nearer understanding what caused feather packing in his groups of birds at various ages. He only makes his explanations more complex but no more meaningful by adding extra, undefined variables such as "infantile" behaviour.

Both Duncan and Hughes (1973) and Bareham (1976) suggest that although feather pecking may be multifactorial, "the effect of these factors is to increase the fowl's general tendency to peck, and that the objects to which the pecking is directed is governed by the nature of the environment". Although these authors are not involving non-specific influences such as "instinct" or "pecking drive" they are suggesting that the environment is at fault by not meeting the needs of birds in an acceptable way. This is in essence what Hoffmeyer (1969) says when she suggests that in industrial rearing conditions the environment is too uniform for the pecking drive to find expression.

No distinction has been made between the suggestion that there is a pecking drive and that the hens are bored, although the latter is often given as a cause of feather pecking and cannibalism, Sanctuary (1934) Miller and Bearse (1937) Hungerford (1962) Richter (1954) Whittle (1957). There does not even seem to have been any attempt to test this widely used explanation of boredom perhaps because it is so intuitively obvious that it is not worth examining.

An attempt to reduce boredom by sedation was made by Marsboon and Sierens (1962). They administered a neuroleptic drug via the food and water supplies and found that in many cases feather pecking reduced although this reduction did not necessarily last beyond the time that the drug was active. Although the authors compared the performance of experimental birds with control groups throughout the experiment the measures they were using referred to growth, food intake and food conversion. No attempt seems to have been made to measure activity or to compare the groups with reference to their behaviour. It is stated that none of the experimental groups showed over-tranquillisation but it does not appear that any tests were made to support this claim. In fact one experimental group showed greater weight gain and food conversion than the controls suggesting perhaps that these birds had been generally less active than their non-drugged counterparts.

Habit is another blanket term that is often used to describe feather pecking and cannibalism. Carpenter (1940) suggested that an unusual form of cannibalism, pecking at the lower eye lid, was due to the development of a habit. It would certainly seem from casual observation that once an area is found to be rewarding to peck at on one bird the behaviour is generalized to the same area on other birds in the group. However, as with much theory concerning feather pecking and cannibalism no detailed studies appear to have been made which would prove or disprove this hypothesis.

Genetic Factors.

As early as 1934 Sanctuary suggested that feather pecking and cannibalistic behaviour might contain a genetic element. He found that the victims of vent pecking occurred in families and that the elimination of these families resulted in the disappearance of cannibalism. Richter (1954) also proposed a genetic cause for feather pecking but he suggested that the influence was on the birds doing the pecking rather than on those that were pecked since he found that only one or two birds in each pen were responsible for the feather damage. Richter claimed that feather pecking was more prevalent in some strains than in others and that when he crossed a strain known to do a lot of feather pecking with one known to do very little pecking he found intermediate behaviour as would be expected from a hybrid. He also found that housing birds from non-pecking strains with those from pecking strains did not result in the former developing the behaviour.

Other workers have also reported that some strains of hens did more feather pecking than others. Voss (1933) found that a strain of brown Italian hens was very prone to feather pecking. Kull (1951) found White Leghorns worse than heavier breeds as did Hughes and Duncan (1972). Richter made the point that feather pecking often seems to affect the popular breeds so it may be that breeders have been inadvertantly selecting for it.

Whittle (1957) also points to breed differences but he suggests that the relevant factor is speed of feathering, fast feathering strains being less affected. In this he agrees with Sanctuary by saying that it is the stimulus that is affected by a hereditary factor not the act or inclination of pecking.

The only author to state categorically that feather pecking is not affected by breeding is Dickerson (1961). He claims that only aggressive pecking is affected by hereditary factors and lists as causes of feather pecking accelerating sexual maturity, feeding crumbs instead of mash and failing to debeak. This surely is a preposterous suggestion - just because hens have beaks it does not mean that they have to use them to peck at cagemates. Similarly the suggestion that feeding crumbs causes feather pecking seems highly unlikely. It is presumably the extra unoccupied time that Dickerson is referring to and not the effect of the crumbs themselves.

Thus the arguments concerning a genetic cause of feather pecking are really based on very slight and unsubstantiated observations and illogical thought. It would seem highly likely in fact that feather pecking may in part be influenced by genetics, since there are considerable strain and breed differences in susceptibility to the condition. However, none of the work done so far is adequate to allow any positive conclusions to be drawn.

It may also be that any genetic effects do not show themselves directly as a simple propensity to feather peck or not but rather they may result in some extra nutritional requirement which in turn might increase the general pecking activity of the birds as they search for the required nutrients. Hutt (1961, 1966) showed that it was possible to breed birds with different requirements for arginine, riboflavin, thiamine etcetera.

Hormonal Influence

To complete the list of suggested causes of feather pecking the effects of hormones must be mentioned. Ritchter (1954) and Siren (1963) suggest that hormones may play a part in the causation of feather pecking but they give no evidence to support their conclusion. The assumption may be that because a rise in vent pecking is often apparent at point of lay then hormones are very likely to be involved. Working on this theory Hughes (1973) implanted pellets of oestradiol, testosterone, progesterone and progesterone and oestradiol combined into twelve week old pulets. His results showed that progesterone and oestradiol/progesterone increased the incidence of pecking whereas testosterone decreased the amount of pecking shown. He suggested that the treatments are effective in increasing feather pecking because they reproduce the internal environment as it is at point of lay and the associated pecking behaviour follows. Testosterone, which reduced feather pecking, also delayed the onset of lay. Hughes concluded that gonadal hormones play an important part in initiating the damaging forms of pecking which occur during and shortly after onset of laying.

No mention was made of the condition of the birds before they were feather pecked. It is quite likely that at point of lay most birds would have an enlarged vent which would offer an extra stimulus and encourage pecking that otherwise might not have occurred. In Hughes' experiment all the birds within a group were similarly treated and so it was not possible to make a distinction between treated and untreated birds in the same group. If this had been possible it might have been very informative.

Oetell (1873) reports that females indulge in more pecking than males and Richter (1954) also found that females exclusively were involved in feather pecking. These findings suggest that gonadal hormones might be involved. Madsen (1966) on the other hand found that female pheasants were less prone to pecking, at least on the back and wings, than were males. It is quite possible that the varying results obtained by different authors are due to the fact that they may be looking at different facets of the problem. Vent pecking by twenty week old birds may be quite unrelated to the straight forward feather pecking observed in young chicks.

Even though these results are conflicting and contradictory there is clearly some evidence to support the theory that gonadal hormones are a factor affecting feather pecking and cannibalism even if the precise mechanisms involved are not yet understood. However, there is no evidence to suggest that hormones are any more important than any of the other variables already mentioned since in every single case there is some supporting information as well as cries of dissention.

Similar Behaviour in Other Species

Evidence of other animals being intensively housed and showing similar aberrant behaviour comes from pigs, which indulge in tail biting, and from laboratory mice, which whisker trim. Whisker trimming has been claimed to be both an expression of dominance, Long (1972) and of genetic factors, Hauschka (1952). More fully documented is tail biting in pigs. This often begins by slight nibbling of the tail of one pig in a group and may end not only with the removal of the tail but also large parts of the hind quarters and abdomen as well. Thus, as with feather pecking, what begins in a very minor way may develop into harmful cannibalism. The causes of tail biting that have been suggested are numerous, diet, ventilation, habit and boredom, (Gadd, 1967; Van Putten, 1967; Ewbank, 1969; Hafez, 1969). Penny et al. (1972) found that carcasses going through a slaughter house showed twice as many males as females with their tails removed. Gadd (1967) also blamed endocrine changes.

Jerico and Church (1972) attempted to induce outbreaks of cannibalism in pigs and then make accurate studies of the behaviour involved. They found that the behaviour appeared quite suddenly at about six weeks of age in several differently housed groups of pigs and declined almost as suddenly about six weeks later. It was thought that cannibalism had many contributary causes including high population density, a relatively low protien diet, a short period of feed availability, a high ambient temperature and boredom. The authors also suggest that social stress caused by high stocking density etcetera. led to increased corticosteroid levels and that this might have influenced the behaviour of the pigs resulting in increased cannibalism.

Von Faber (1964) claimed that muscovy ducks in feather pecking groups also showed an increase in corticosteroid release but he suggests that this was because of the feather pecking and not, as suggested by Jericho and Church, the cause of feather pecking. His arguement in favour of feather pecking preceeding a rise in corticosteroid release was that groups of birds that had been debeaked and thus could not feather peck did not show the same symptoms of stress, i.e. a check in growth, adrenal hypertrophy and bursa atrophy. It is unfortunate that his numbers were so small since 13 debeaked and 17 intact birds is not a very large sample. However, this is one of the few studies that has connected physical symptoms of stress with the feather pecking syndrom and thus is very important from the humanitarian aspect of the problem. It has been claimed by members of the farming and advisory professions that feather pecking (as opposed to cannibalism) does not harm the birds involved, it would seem that here there is evidence in direct conflict with this view. It is particularly interesting that even groups of birds that were only slightly feather pecked still showed these symptoms of stress.

The most frequent explanation for tail biting however, is that pigs are burrowing animals and so unless they are provided with material in which to burrow and chew then the behaviour is directed to other aspects of the environment. This is similar to the arguement that hens are pecking animals and an environment that does not provide enough peckable material results in an outbreak of feather pecking. Piggeries that provided straw for their animals showed a much smaller incidence of tail biting than those that did not provide straw. Whether this was due simply to the chewable properties of the straw or whether the increase in fibre in the diet gained in this way is a relevant factor has not been distinguished (Ewbank, 1973). As with feather pecking there is not enough evidence to support any one explanation and indeed there may not be a single cause in either case.

Conclusion

A considerable number of studies have been carried out on various aspects of feather pecking and cannibalism but it is impossible to say that we are much nearer to understanding the casual factors involved. Previous studies have shown that many things may be implicated when a bird begins to peck or be pecked and no single cause has been isolated. It would seem therefore that either there are many direct causes of feather pecking or that conditions can act as triggers as long as a certain other single condition is also present.

The latter suggestion would explain why repeatability not only between workers but also within the work of a single individual is often so difficult to obtain. For example, Schaible et al. (1947) Willimon and Morgan (1953), Hill and Binns (1973) and Hughes (1973) all obtained conflicting results. The pattern described by Richter (1954) is still very prevalent, "It happens from time to time that feather eating throughout the whole flock suddenly diminishes and even ceases altogether ... it begins again, generally with equal suddenness, and to a greater or lesser extent." So far however the literature is unable to explain these sudden changes except in the vaguest of terms.

One of the main reasons why work on feather pecking has been so unsuccessful is because the majority of workers have been interested in feather pecking only from a secondary point of view. No one has concentrated on the question of why feather pecking occurs but only whether it is affected by certain specific variables. There are of course exceptions to this, Hoffmeyer (1969), but for too long there has been an ad hoc approach to the problem which has resulted in the continuation of ill-founded beliefs about the causes of feather pecking and the lack of any co-ordinated research. Under these circumstances it is not surprising that as yet no clear understanding of the problem has been reached.

Summary of the aims of this study

Since nothing seems absolute in the world of feather pecking it was thought necessary to begin this study by discovering under what conditions feather pecking occurred, at what age it appeared and if the white light hybrid used at the Poultry Research Centre for a number of behavioural experiments was a bird prone to this behaviour.

Having established these basic facts there were a number of important variables to consider. Firstly, do all birds feather peck to an equal extent. If not is there any variation in their other behaviour that would suggest such a difference. Is feather pecking primarily in response to specific external stimuli such as the shape or the colour of a bird or part of a bird. Do birds respond differently to being pecked thus providing different types of stimuli, either encouraging or discouraging to feather peckers.

Once these questions have been discussed the importance of some of the variables already mentioned in the review of the literature will be investigated. The relevance of the external environment, genetic factors, hormonal influences and the role of aggression all seem to be worth investigation. In relation to some of these variables the influence of learning and of boredom will be discussed.

CHAPTER 2

MATERIALS AND METHODS

In this chapter the methods and proceedures that were used in several experiments are described and discussed. Details that are specific to only one or two experiments will be described in the relevant place but the general information regarding the birds used, the methods of rearing and observing behaviour, and the rationale behind the collecting and analysis of the data will be given here.

Subjects

It was decided that only by obtaining chicks at day old could an accurate picture of the development of feather pecking be gained. In this way the background and early experience of all the birds could be controlled and no alterations in living conditions, from litter to cage for example, could occur without the experimenter's knowledge.

The chicks obtained from the Poultry Research Centre stock farm were mostly white light hybrids derived from the commercially bred Shaver 288, which was also bought in from an outside hatchery for some experiments. The majority of work was conducted on this type of bird since it proved to be a frequent feather pecker and also because it is widely used in the poultry industry.

Rearing Methods

Housing

Without exception the chicks were reared in wire cages. Initially these were adapted battery cages but later in the study purpose built ones were used. Both types of cage were similar in construction, see Figure 2.1.

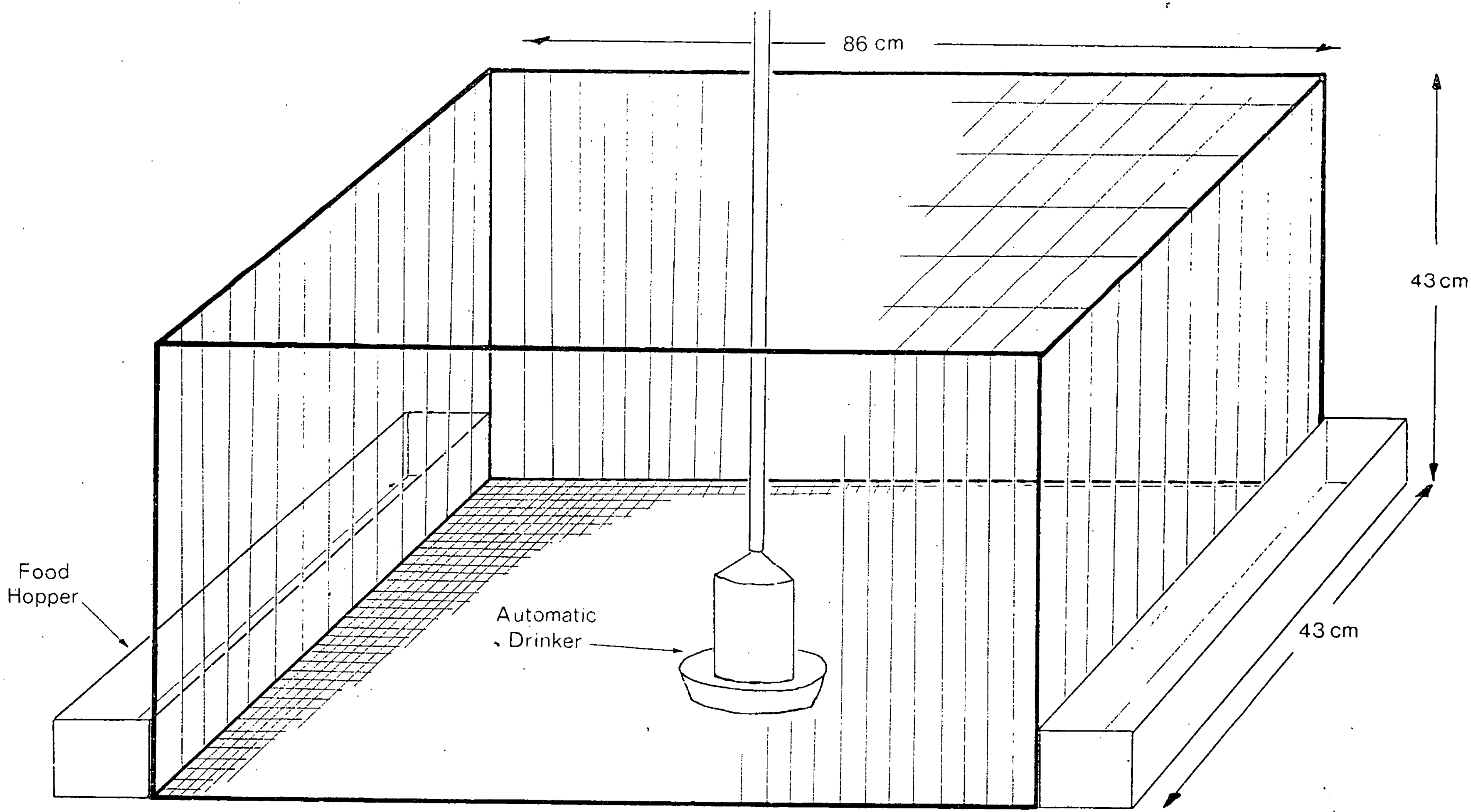


Figure 2.1 Rearing Cage

The wire floors were covered with plastic matting for the first four weeks of life to prevent damage to the chicks feet and to make walking easier than on the wide wiremesh.

The cages were arranged in two tiers around the walls of the experimental rooms and observations could be made on any one cage without disturbing the birds in any of the others. Food and water containers were placed inside the cages for the first three days of life but after that they were attached to the outside of the cage and the chicks fed and drank through the bars. This allowed the full floor space for the use of the chicks. In later experiments water was provided inside the cage from small automatic drinkers as shown in the diagram, (Figure 2.1.).

Light and temperature

The brooding temperature of 33°C was maintained by infra-red lamps suspended above each cage. The temperature was gradually reduced as the chicks got older.

The room lights were on for fourteen hours each day for the majority of the experiments, the birds being placed on this regime from day one. The light intensity used was quite bright, about 350 lux, in comparison with average commercial rearing conditions and in some instances of severe feather pecking the intensity of lighting was reduced.

Feeding

Food and water were available ad libitum. Commercially formulated chick crumbs were fed from 0-6 weeks, followed by rearer from 6-12 weeks and pullet developer from 12 weeks until point of lay. All these diets were in the form of crumbs. Birds kept beyond point of lay were fed a layers mash.

Stocking

The birds were placed in the conditions just described on day one, i.e. at day old. They were wingbanded on arrival and individually marked with leg rings on days two and three.

Group sizes varied slightly in different experiments but the usual number of chicks within each cage was fifteen, this gave a floor area of 192.5 cm^2 per chick. Depending on the design of the experiment it was rare for fifteen birds to remain in each cage for more than three weeks, but even when the birds did stay in their original groups until six weeks they were not unduly crowded in comparison with commercial birds reared in cages.

Treatment of older birds

In some experiments the birds were moved at six to seven weeks to conventional battery accommodation. The details of these cages and of group sizes are given for the relevant experiments but in general the conditions were much the same as in the cages described here. Food and water were available ad libitum, a 14 hour day was maintained and group members were normally the same as in the smaller cages, however, the intensity of lighting was slightly lower than in the experimental room. By the time the birds were moved to these surroundings behavioural observations had usually ceased and so were not affected by the change in the environment.

Behavioural Measures

Observations

All observations were conducted with the experimenter sitting in the centre of the experimental room about one metre from the cage being observed. Comparisons were made of recordings made with and without a hide and as no difference in behaviour was found all observations were carried out without the use of a hide.

It was found that the bouts of activity of young chicks lasted for approximately ten minutes and so the majority of the observations lasted for this length of time although in some of the earlier experiments a fifteen minute period was used.

Observations made to identify birds involved in feather pecking incidents began as soon as signs of this behaviour appeared. General observations and stimulus observations, however, were usually begun at fourteen days of age since the chicks did not show sustained bouts of activity until this time.

General Observations

Observations made on the pecking behaviour of the chicks without short-term alterations of the environment were called "general observations". These were conducted on many of the birds in an effort to see whether or not the objects at which birds pecked differed, either between individuals under the same treatment or between groups under differing treatments.

During the observation period the pecking behaviour of the birds was recorded on a time sampling basis once every thirty seconds; the pecking behaviour of each bird in the group being noted. The objects that the birds pecked at tended to fall into four categories; (1) pecks directed at the birds own body, feet, down, etcetera, this was referred to as "self pecking". (2) Pecks directed at other birds in the group; the plumage or eyes for example; and called allopecking. (3) Pecks directed at the environment, including the floor and food and water containers; environment pecking. (4) Pecks directed at food, whether in the hopper or on the cage floor, this was simply called food pecking. No distinction was made between food ingested and food simply picked up and dropped again.

These four classifications were maintained throughout the study with only occasional modifications. The most noteable of these modifications was the division of allopecking into barb pecking and feather pecking. "Feather pecking" was defined as a peck made by one bird towards the feathers of a cagemate with enough force to substantially damage or remove the feather. This type of pecking resembled pecks directed towards food in that it was quite forceful, however except when a bout of feather pecking was in progress the frequency of the pecks was a lot slower than in food pecking. "Barb pecking" on the other hand occurred with much greater rapidity than feather pecking but appeared to be a much more gentle peck and aimed at the tips of the feather barbs Spearman (1974) rather than the whole feather. Several birds were often seen standing in a group barb pecking each other; this rarely, if ever, happened with feather pecking.

A separate category for aggressive pecking was unnecessary since this type of encounter was observed so rarely that their inclusion in the records was not important. Had the birds been older this would not have been the case but up to the age of six weeks almost no aggressive pecks were observed.

The pecking score

The results obtained by the time sampling method were expressed as a pecking score. This referred to the number of chicks involved in a particular type of pecking behaviour on each sampling occasion over the whole observation period. Thus the score for "total" or any other category of pecking is only an estimate of the behaviour that occurred. Since the number of observations made on each group was large it was thought that this type of estimate would be accurate.

Stimulus Observations

In several experiments novel objects were presented to the chicks and their reaction in terms of the amount of pecking directed towards the object recorded. If it was relevant to know the effect of the stimulus object on other types of pecking behaviour as well a time sampling method as described for the general observations was used, the stimulus object being a fifth category at which the chicks could peck. If the only relevant information was how many pecks the stimulus object received then a continuous record was made of this number and of the identity of the chicks doing the pecking.

Presentation of the stimuli

Initially chicks were removed from the home cage and placed individually in a test cage, allowed time to acclimatize to the new situation and then tested with the stimulus object. However, it soon became apparent that the chicks were so disturbed by the move to the test cage that very little response was obtained from them. The later

Figure 2.2. Some of the stimuli used in this study.

Key

1. Wooden block.
2. Feathered block.
3. Spotted block.
4. Model bird.

tests were conducted on the group as a whole. The object to be tested was simply placed in the centre of the home cage and the number or amount of pecking it received recorded.

It was appreciated that this method might introduce a bias in that some groups might include very active individuals and also in the group situation there would be the opportunity for social facilitation of stimulus pecking. It was thought that the first problem could be overcome by recording the identity of the individuals which did the pecking and it would then be clear how the general the response was within each group. The fact that social facilitation could occur in the test situation was not regarded as a great problem since conditions that allow feather pecking must also allow social facilitation of pecking. Thus observing responses of groups of marked individuals was felt to give a realistic picture of the way pecks were made at stimuli, whether they be feathers or bits of wood.

In general the stimuli were presented for five minutes at a time. Trials were conducted which showed that if a stimulus was going to be approached this normally happened within the first three minutes and in the majority of cases responses to the stimuli did not continue much after the seventh minute. In no instance during the trials were there more responses to the stimulus in the second five minutes than in the first.

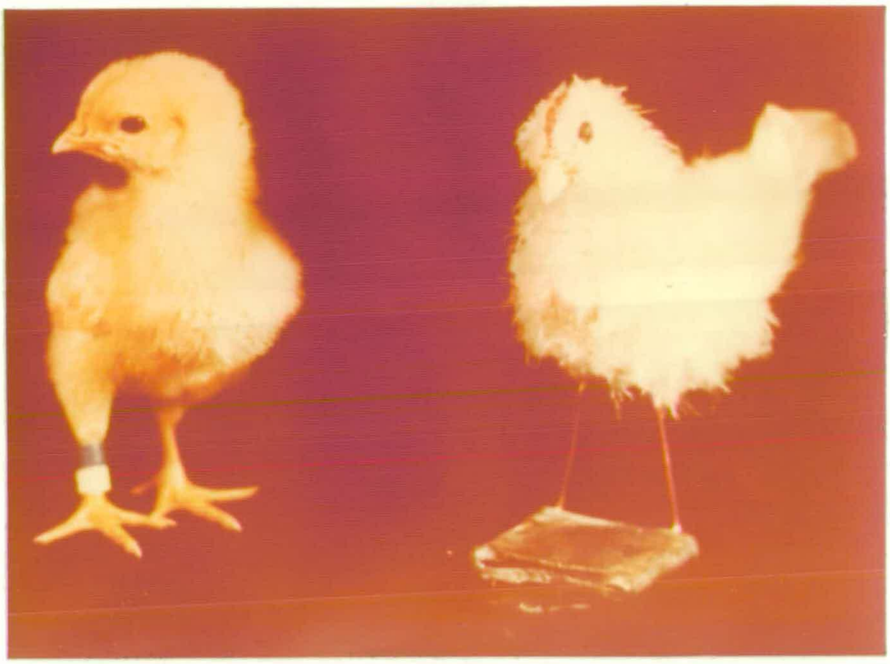
Stimuli

A number of different stimuli were used in the experiments. Those most frequently tested are described below, the remainer will be described in the relevant chapter.

1. Wooden block; this was a wooden block 9 x 5 x 1cm. painted green and studded with metal drawing pins. See Figure 2.2. Variations of this stimulus were used in experiments described in Chapter 4.

2. Feathered block; this was a wooden block 5 x 5 x 5cms. with downy white feathers stuck into it, giving an overall height of 12.0cm. A lead weight was nailed to the bottom of the block to make it more stable. See Figure 2.2.

Figure 2. 3. Model bird with a four week old light hybrid chick.



3. Spotted block; this was made in the shape of the base of a cone in white plaster measuring 7cm. diameter at the base, 5.5 cm. diameter at the top and 4.5cm. high. Small holes were made in the plaster and painted in three different colours, red, green and yellow. See Figure 2.2.

4. Model birds. These were basically chick-like outlines made of material, stuffed and then covered with feathers from an adult white light hybrid. The model had a balsa wood beak painted yellow, black painted eyes and a red comb painted onto the head. The legs were made of wire and fastened to a single lead 'foot'. The models were about the size of a 3-4 week old chick, 14.0 cms. long and approximately 13.0 cms. from the top of the head to the floor but the height and positioning of the model could be altered by bending its legs. A number of variations of the model bird were used including ones with differently coloured feathers, with different degrees of downy-ness, without feathers at all and also made entirely of various types of wood. See Figures 2.2. and 2.3.

5. Modified birds. These were chicks of the same age and strain as the birds being tested but each was 'different' in some way. The least treated was a normally feathered chick that was unknown to the group under test. This differed simply by being a stranger. Others were altered by the removal of the feathers from a small area at the base of the tail, the bare bird; by having the feathers in a similar area marked with red dye, the dyed bird; by having a similar patch but marked with blood, the bloodied bird, and finally by having a small denuded and scabby area at the base of the tail, the scabby bird.

All the stimuli were presented in a similar way by being placed in the centre of the home cage. The arrangement of presentation and the age at testing varied slightly between experiments but care was always taken to see that no group was tested on successive occasions with the same stimulus or with more than two stimuli on any one day. If more than one stimulus was presented in one day at least one hour between presentations was allowed.

Measure of feather damage.

A scoring system was devised so that the amount of damage through feather pecking could be calculated. The amount of damage and its appropriate score are shown in Table 2.1. In addition to these scores an extra score of one was given if there were signs of tissue damage.

Scoring was always carried out by two observers. Both independently scored the birds in question and if there was not complete agreement, which was unusual, then the average of the two suggested scores was used. It was hoped to keep the scoring as objective as possible by this system.

Table 2.1. Scoring of Feather Damage.

0	Plumage in perfect condition.
1	Feathers damaged but not removed.
2	One small denuded area up to 5 cm^2.
3	Two small or one large area (7.5 cm^2) denuded.
4	Extensive denuding.
5	Three areas remaining feathered.
6	Two areas remaining feathered.
7	No complete areas of feathering left.
8	Death due to feather pecking and cannibalism.

Analysis of Results.

Both parametric and non-parametric statistical methods were used in analysing the data, depending on which seemed most appropriate.

In general non-parametric methods were used to compare individual bird behaviour both between and within groups, particularly if the numbers of subjects involved were small. Parametric methods (Analysis of Varaice and 't' tests) were used for comparing group means. generally when the effect of externally applied treatments, such as the administration of hormones and the alteration of the environment. were being tested.

CHAPTER 3

DO ALL BIRDS FEATHER PECK?

A PILOT STUDY OF THE PHENOMENOM

It was decided to run a pilot experiment to find what form feather pecking took under the conditions and with the strain of birds used at the Poultry Research Centre. This also allowed time for the development of rearing systems and methods of observing, recording and quantifying behaviour.

Method

Subjects

Twenty five day old chicks of two strains, ten light hybrids and fifteen medium hybrids were housed in separate strain groups. The birds from the Poultry Research Centres stock farm were of both sexes.

Rearing

This was as described in Chapter 2., although for these groups of five birds smaller cages, measuring 24^3cm., were used.

Observations

The first observations were very much on a "look and see" basis but gradually the system described in Chapter 2 emerged and the data were collected by the time sampling method and categorized as described.

Results

Feather Pecking

Feather pecking first appeared in one of the groups of light hybrids on day twenty one. Four of the five birds in the group were affected within two hours, the fifth bird was undamaged. Observations showed that it was the undamaged bird that was doing all the pecking, and when this bird was moved to the other group of light hybrids, where there was no sign of feather pecking, damage was observed within 3 hours of the transfer. Again all the feather pecking was being done by the same individual, although other birds in the group did join in later. In fact the bird responsible for most of the feather pecking had had a very high score for allopecking from its earliest youth. However, one of the victims in the second light hybrid group also had a very high allopecking score and yet was not involved in any feather pecking, so the relationship between damaging pecking and non-damaging pecking was apparently not crucial. For no obvious reason feather pecking stopped by day thirty three and the damaged and denuded areas of the birds affected recovered.

At no point did the medium hybrids show any feather pecking behaviour though the general observations showed that this was not because they were inactive. The two strains did in fact show similar levels of pecking activity although the medium hybrids spent a greater part of the time feeding and less time pecking at their cagemates.

Another point of interest was that in the groups in which feather pecking first occurred contained more birds with large combs, presumably males, than the other groups. The birds were not kept long enough for the sex of all the birds to be determined with absolute certainty.

Conclusions

The results of this pilot study posed a number of questions and suggested some possible lines of study. Why, for example, did some birds peck whilst others were pecked. What relationship did feather pecking have to general pecking activity and to non-damaging allopecking. What controlled the timing of the onset and disappearance of feather pecking. Why was only one strain involved, was it to do with the difference in feeding behaviour. Was comb size relevant to the amount of feather pecking shown, and if so, how.

It was decided that the most important thing to establish was whether the suggestion that not all birds peck and are pecked equally could be substantiated. If so, then an attempt could be made to find out what characterised the two classes of bird, pecker and pecked. The following experiments were conducted to see if it was possible to distinguish two such distinct types of birds.

EXPERIMENT 1.

Method

Subjects

Thirty light hybrids chicks were obtained at day old and placed in single sex groups of five, three groups (4, 5 and 6) of males and three groups of females (1, 2 and 3). Rearing conditions were as described in Chapter 2.

Observations.

General observations on the pecking behaviour of the birds began on day seven, each group being observed for 15 minutes a day on twelve occasions between the age of 7 - 24 days and on ten occasions between 25 - 59 days.

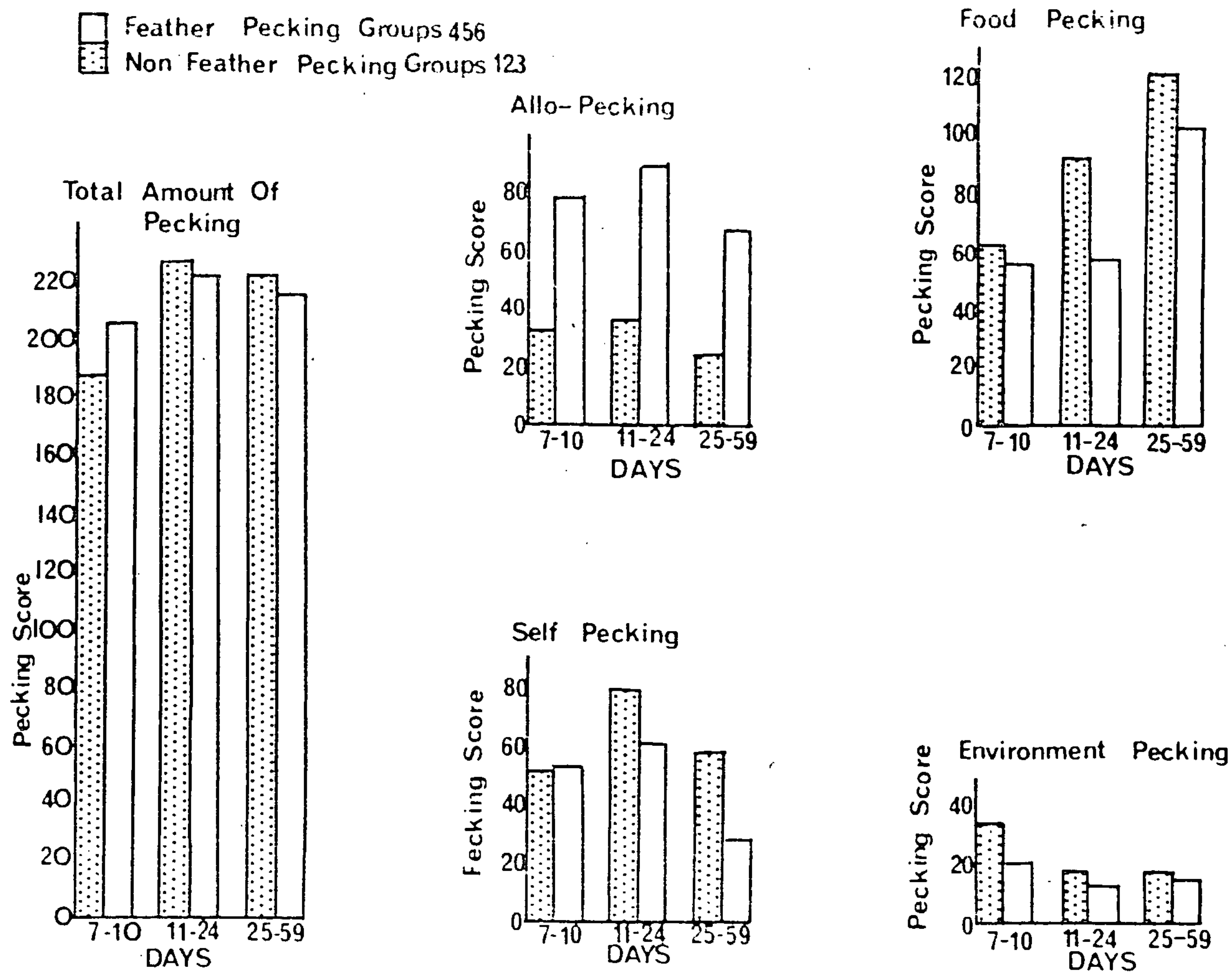
Stimulus Tests

These were given to the groups between days 14 - 50. Both novel stimuli, the green block and the feathered block, and modified birds, including the strange bird, the bare bird, the bloodied bird and the dyed bird, were presented to the groups as described in Chapter 2. Each stimulus was presented for 15 minutes on three separate occasions.

Open Field Tests

In this test the chicks were exposed individually to the open field apparatus for three minutes and the latency to move and the number of squares moved through were recorded. The open field apparatus consisted of a wooden box 92^3cm. with a wire mesh lid and a floor in natural wood divided into 36 - 15 cm. squares. The birds were given

Figure 3.1. Experiment 1. Pecking score for the two groups. Totals of mean scores for each bird.



one 3 minute familiarization period in the apparatus before they were tested.

Results

Feather Pecking

There was no sign of feather pecking in any of the groups until day eleven when it broke out in group 5, a group of males. It also developed in varying degrees of seriousness in the other male groups, 4 and 6. At one point in group 5 no bird was unpecked and several birds had large and continually bloody areas on the back and upper tail coverts, pecking was almost as serious in group 6, but in group 4 only two birds were affected. No scoring system for feather damage had been developed at this stage in the study.

General Observations

The results of the observations were computed for three time intervals, between days 7-10, before feather pecking began, between days 11-24 during which time feather pecking was at its height and between days 25-29 when pecking began to decline. The amount of pecking behaviour of all kinds was computed and a comparison made between the three groups of males that showed feather pecking and the females, which did not. A Mann-Whitney 'U' test showed that there was no significant difference in the total amount of pecking behaviour between these two groupings for any of the time intervals. See Figure 3.1.

However, a more detailed comparison showed that the amount of pecking was distributed differently between the four different classes, Figure 3.1. The non-feather pecking groups pecked more at their own bodies, this was a significant difference for days 10-24; $U = 43.5$; $p = 0.02$ and for days 25-59; $U = 25$; $p = 0.02$. These groups also pecked more at the environment, significantly so between days 7 and 10; $U = 55.5$; $p = 0.02$ and days 25-59; $U = 72$; $p = 0.1$. During the middle period the non-feather pecking groups showed greater food pecking ; $U = 39$; $p = 0.02$. Throughout the whole period the feather pecking groups showed greater amounts of allopecking than the non-feather pecking groups. Days 7 to 10; $U = 34$; $p < 0.002$; days 11-24; $U = 47.5$; $p < 0.02$ and days 25-59; $U = 45$; $p < 0.02$.

Stimulus Tests

The total number of pecks directed by the birds at the stimuli did not differ significantly except in the case of the "bloodied" bird, which was pecked significantly more by the feather pecking groups ($U = 28$; $p < 0.002$).

Table 3.1. Experiment 1. Mean number of pecks directed by the feather pecking and non-feather pecking groups at the four bird stimuli during three fifteen minute periods.

STIMULUS	NON-FEATHER PECKING	FEATHER PECKING
Strange bird	4.0	9.0
Bare bird	9.7	9.7
Bloodied bird	37.7**	74.7
Spotted bird	9.7	9.3

** Significant at the 0.01 level.

Correlations between different types of pecking behaviour.

Correlations between individual bird scores for different types of pecking were calculated using Spearman's rank correlation (r_s), for the periods 7 to 10 days and 7 to 24 days. The results showing the correlations between allopecking, environmental pecking and stimulus pecking are shown in Tables 3.2. and 3.3.

Table 3.2. Experiment 1. Correlation of allopecking and environment pecking with the response to the modified birds and the novel objects. Days 7-10.

Stimuli	FEATHER PECKING GROUPS Allo-pecking	FEATHER PECKING GROUPS Enviro. pecking	NON-FEATHER PECKING GROUPS Allo-pecking	NON-FEATHER PECKING GROUPS Enviro. pecking
Bloodied bird	+0.44*	+0.01	-0.06	-0.31
Dyed bird	-0.23	+0.49*	+0.18	-0.16
Bare bird	+0.49*	-0.17	+0.17	-0.13
Strange bird	-0.04	-0.11	+0.31	-0.05
Green block	+0.19	+0.49*	+0.51*	-0.36
Feathers	+0.47*	-0.15	-0.3	+0.02
Environment	-0.46*		+0.6**	

Table 3.3. Experiment 1. Days 7-24.

Stimuli	FEATHER PECKING GROUPS Allo-pecking	FEATHER PECKING GROUPS Enviro. pecking	NON-FEATHER PECKING GROUPS Allo-pecking	NON-FEATHER PECKING GROUPS Enviro. pecking
Bloodied bird	+0.72**	-0.09	-0.13	+0.37
Dyed bird	-0.47*	-0.08	+0.2	+0.14
Bare bird	+0.42	+0.02	-0.21	+0.07
Strange bird	+0.04	-0.03	+0.03	+0.41
Green block	+0.05	-0.3	-0.52*	+0.44*
Feathers	+0.57*	-0.03	-0.01	+0.68**
Environment	+0.28		-0.46*	

* Significant at the 0.05 level

** Significant at the 0.01 level

During the earlier period, in which no feather pecking occurred, the correlation between allopecking and environment pecking was negative in the feather pecking group and positive in the non-pecking groups. The feather pecking groups showed positive correlations between both allopecking and environment pecking and the response to the various stimuli. In the non-feather pecking groups on the other hand, the only significant correlation was between allopecking and the response to the green block.

Over the period 7-24 days, during which feather pecking developed, a rather different pattern of correlation was found (Table 3. 3.). For the feather pecking groups the association between allopecking and response to stimuli remained the same but the overall relationship between allopecking and environment pecking, which was previously negative, was now significant but positive and environment pecking was not associated with responses to any of the stimuli. In the non-feather pecking groups a negative correlation had appeared between allopecking and environment pecking, a positive correlation between environment pecking and the feather stimulus was evident and a distinction between the response of allopecking and environment pecking towards the green block stimulus had developed.

Open field test results

Similar correlations were calculated for the open field test results. Up to day ten (Table 3. 4.) they were uninformative but over the longer time period (Table 3. 5) some interesting points arise. In the feather pecking groups allopecking was positively correlated with the number of squares entered during the test period and latency to move at the beginning of the test was positively correlated with environment pecking. In the non-feather pecking groups the only significant correlation was between environment pecking and the number of squares entered, this was a negative correlation. Although the other three results from the non-feather pecking groups were not significant the correlations did show a similar pattern to those found in the feather pecking groups (Tables 3. 4 and 3. 5).

Table 3.4 Experiment 1. Number of squares entered and the latency to move in the open field situation correlated with allopecking and environment pecking. Days 7-10.

	FEATHER PECKING GROUPS		NON-FEATHER PECKING GROUPS	
	Allo-pecking	Enviro. pecking	Allo-pecking	Enviro. pecking
No. of squares entered	-0.04	+0.22	-0.19	-0.19
Latency to move	-0.01	+0.3	-0.17	-0.09

Table 3.5. Experiment 1. Days 7-24.

	Allo-pecking	Enviro. pecking	Allo-pecking	Enviro. pecking
No. of squares entered	+0.62**	-0.05	+0.25	-0.49*
Latency to move	-0.06	+0.45*	-0.37	+0.33

* Significant at the 0.05 level

** Significant at the 0.01 level.

Discussion

The main finding of this experiment was that not all birds indulge equally in feather pecking and that a pecker "type" can be distinguished on the basis of its behaviour. Observations showed that although the total amount of pecking behaviour done by all groups was similar, the objects at which the pecks were directed varied, Figure 3.1. Individuals in groups that developed feather pecking were, from a very early age, more inclined to peck at cage-mates than at the surrounding environment, and it was seen that stimuli that had blood, bare patches of skin or feathers were more pecked at by birds with a high allopecking score. Birds with a high score for pecking at the environment pecked more often at other stimuli with different characteristics;for example, dyed feathers and inanimate objects.

It is tempting at this point to consider some stimuli as more "bird-like" and thus more attractive to the allopecking individuals, as opposed to the more "environment-like" stimuli responded to by the high environment peckers. It seems, however, that experience also plays an important part in determining pecking behaviour. Before the feather pecking groups had damaged birds in their cages there was a distinct difference between birds that directed their pecks towards cagemates and those that did not, but once there were damaged birds present in the cage there was no distinction between the things that the birds pecked at (compare Tables 3. 2 and 3. 3.).

This would suggest that the stimulus of a pecked bird is a very strong one and that the birds which had not developed allopecking behaviour, perhaps when the reinforcement was less effective, learned this behaviour pattern from the actions of their cagemates and as a result of the increased stimulus of reinforcement.

It could also be argued that in time all birds would have begun to feather peck, either through imitation of cagemates or because of physical development. Perhaps a bird becomes a pecker once its beak is developed enough or used effectively enough to remove particles from the bodies of other birds thus reinforcing the pecking act. If, however, 'time' or maturation were major influences it would have been likely that at least some of the birds in the three non-feather pecking groups would have shown signs of damage. The birds in the non-feather pecking groups could also be distinguished as either allopeckers or environment peckers (negative correlation between these two activities days 7-24, Table 3. 3.) but this never resulted in damage to the birds in the groups.

Observations on these groups showed that during the first part of the experiment they did not make the same distinction between "birds" and the "environment" as did the groups in which feather pecking broke out, rather birds that were active were equally likely to peck at another bird as at the environment. Only later did a distinction between allopeckers and environment peckers begin to develop.

The results of the open field test showed that birds with high allopecking scores were more active than those with low scores. If as Gallup et al (1970) suggests fear leads to immobility in young chicks than it can be said that allopeckers are less fearful than their environmentally orientated counterparts.

There was a distinct difference in the behaviour of male and female groups. No feather pecking occurred at all in the female groups, whereas all three of the male groups showed it to a considerable degree. This would suggest that some hormonal element was involved, but the fact that males rather than females were involved is contrary to the predictions of other work. Hughes (1973) for example, found that testosterone reduced or suppressed feather pecking whereas oestrogen and progesterone increased it.

It could be claimed that feather damage was caused by aggressive pecking which would be expected to be more pronounced in males than in females, however, the first incidence of feather damage occurred at eleven days, long before aggressive behaviour had appeared in a defined way. The fact that pecking gradually declined between the fourth and eighth week is not consistent with the aggression hypothesis either since it would be expected that if any aggressive elements of behaviour had developed by this age they would still be increasing and not decreasing.

From the results of this first experiment it is possible to construct a "profile" of the typical pecker. It was a bird that indulged in large amounts of allopecking even before any damage was evident, it was active and not particularly fearful in a novel situation and it would spend only a little of its time pecking at stimuli in the environment. According to these results it would also be male.

It is obvious that the results from this experiment can only act as an indication of what may be some of the important factors in controlling feather pecking and in identifying the feather pecking birds since the numbers were very small and the effect of sex was very prominent.

However, the initial assumption that not all birds feather peck was supported and it now remains to see how reliable and important a factor this is in the feather pecking syndrome.

EXPERIMENT 2

Shortly after Experiment 1, ten birds were obtained that were thought likely to be archetypal of feather peckers and feather pecked. It was hoped that by observing them in a manner similar to Experiment 1, and presenting them with similar stimuli it would be possible to confirm or refute the earlier findings. The added advantage of the present groups was that they had specific identities before the tests and observations began rather than identities that developed during the experiment.

Method

Subjects

Four hundred light hybrid chicks were being raised for other purposes in a conventional battery brooding system, with ad libitum food and water and a 14 hour day. At eighteen days it was noticed that just a few of the cages contained birds that were damaged by feather pecking. With close observation it was possible to single out both the pecked birds and those doing the pecking. Five birds of each type were removed from the battery and placed separately in two cages as described earlier, (Chapter 2).

Observations

A 15 minute general observation was performed on the two groups each morning for five consecutive days.

Stimulus Observations

The groups were also exposed to a number of stimulus objects, see Figures 2.2. and 2.3. a) the green block, b) spotted block, c) feathered block, d) a model bird looking as similar as possible to the chicks under test, e) the scabby bird. The stimuli, excepting the scabby bird, were presented on six occasions each lasting for 15 minutes. The scabby bird was presented only five times.

Blood Test

The response of the birds to a small watch glass with a few drops of fresh hen's blood in it was also tested in a similar manner, placing the watch glass in the centre of the cage and recording the number of pecks made at it by the birds. Two trials were given, the first lasting ten minutes and the second only five minutes due to the clotting of the blood.

Feather Damage

The condition of the birds plumage was scored on an eight point scale, described in Chapter 2, as they were removed from the battery and again when they were returned at twenty nine days.

Results

General Observations

A Mann-Whitney U test was carried out on the results of the general observations and showed that the overall amount of pecking activity of the two groups did not differ significantly and neither did the amount of self and food directed pecking. Table 3. 6.

Table 3. 6. Experiment 2. Pecking behaviour recorded during general observations. Group means.

Pecking behaviour	Feather pecking group	Non-feather pecking group	'U' values	P
Self pecking	42	33	7. 5	NS
Allopecking	8	2	1. 0	**
Environment pecking	2	8	4. 5	*
Food pecking	38	35	12. 0	NS
Total	90	78	6. 0	NS

* Significant at the 0. 05 level. ** Significant at the 0. 01 level.

However, the amount of pecking directed towards the environment and other birds in the group did differ between the feather peckers and the feather pecked bird. The former pecked considerably more at other birds in the group than did the feather pecked birds, ($U = 1.0$; $p < 0.008$). The amount of environment pecking, however, was much greater in the group of feather pecked birds than in the group of peckers ($U = 4.5$; $p < 0.05$).

Stimuli.

The amount of pecking directed towards the green block, spotted block and the feathers was not very great and did not differ significantly between the groups. However, the response to the mock bird and the scabby bird was quite large and did differ between the groups. The feather peckers showed a much greater response to the scabby bird than the feather pecked, they were so active in pecking at the stimulus that the trials had to be limited to ten minutes, whereas the feather pecked birds very rarely even pecked at the strange bird, least of all at its scabby area. The feather pecked birds showed much more response to the mock bird. Table 3.7.

Table 3.7. Experiment 2. Response to the bird stimuli.

Stimulus	Feather pecking group	Non-feather pecking group	'U'values	P
Mock bird	45	58	0.5	+
Scabby bird	85	7	0.0	**

+ Significant at the 0.06 level.

** Significant at the 0.01 level.

Blood Test

The result of placing a dish of blood in the home cages of the two groups appeared to be fairly clear, see Table 3.8. The feather peckers responded at a much higher rate than the pecked on both trials, it was also noticed that a number of the pecked birds "bill wiped" after pecking at the blood and on several occasions they appeared to be quite distressed and wiped their bills with their feet as well as on the ground. The peckers on the other hand showed no such behaviour but seemed to take large "gulps" of the blood and to find the taste reinforcing.

Table 3.8. Experiment 2. Total number of pecks made at the blood stimulus by the two groups.

Trial	Feather pecking group	Non-feather pecking group	'U'values	P
1 (10 minutes)	25	13	4.5	+
2 (5 minutes)	9	0	2.5	*

+ Significant at less than 0.1 level.

* Significant at the 0.05 level.

Feather Damage.

The state of the birds' plumage when they were first removed from the battery at eighteen days showed that those observed to do a lot of pecking were not themselves damaged whereas the feather pecked birds were all, by definition, damaged to some extent. When the birds were returned to the battery at twenty nine days the peckers were still undamaged and the feather pecked birds had greatly reduced scores. Table 3.9.

Table 3.9. Experiment 2. Score of feather damage at 18 and 29 days.

Age	Feather pecking group	Non-feather pecking group	P
18 days	0	15	*
29 days	0	0	NS

* Significant at the 0.04 level.

Discussion

In Experiment 1, it was observed that those groups in which feather pecking developed were more liable to peck at their cagemates and spend less time preening, feeding and pecking at the environment during the general observations than were the groups that did not develop feather pecking. In this experiment it was found that birds removed from their original groups because they were feather peckers showed similar differences in behaviour. The feather peckers did more allopecking and less environment pecking than the feather pecked birds, but the groups were equivalent in the amount of feeding, preening and total amount of pecking shown. In fact all the findings of this experiment support the view that there are two distinct types of birds involved in feather pecking, those that inflict the damage and those that receive it,

It would seem from the general observations that the birds spend a similar amount of time pecking but the objects at which they peck vary. The feather peckers concentrating on other birds or bird-like stimuli and the pecked on the environment. The test using the blood might suggest a preference for the taste of blood on the part of the peckers, but whether this was the result of previous feather pecking experience or whether this caused the feather pecking initially cannot be determined from this experiment. It is also interesting that although the feather peckers were doing more allopecking than the feather pecked they did not inflict any feather damage on their own group during this period. This suggests that either their manner of pecking changed or that they were less liable to damage than the feather pecked birds. This would also explain why feather peckers are not also feather pecked, it is not that they do not peck at each other, but rather that they do not damage each other as they would a feather pecked type.

On the other hand in one of the male groups, in which feather pecking developed in Experiment 1, there was a time during which no bird was undamaged. It would seem therefore that it is not always the case that a pecker cannot also be pecked. Maybe in some instances birds involved in pecking behave in such a way as to reduce the likelihood of their being pecked, or perhaps are in a stage of feathering at which the removal of feathers is more difficult and so damage does not occur. However, these explanations are pure conjecture and a more detailed analysis will have to take place before a more accurate explanation can be attempted.

In this experiment all the birds were female and yet the behaviour appeared to follow a very similar pattern to that seen in the male groups in Experiment 1. Since feather pecking in the commercial situation is nearly always associated with females this result is not particularly surprising, but it does suggest that the sex difference found earlier might have been a spurious result. However, out of a batch of four hundred only ten birds were involved in feather pecking at all and only five of those were peckers, this would not appear to be a very large proportion and perhaps if the population had been male many more would have been involved in pecking.

Obviously much more work needs to be done on this aspect of the problem and once again more questions have been posed than answers provided.

EXPERIMENT 3.

If there are indeed two types of bird - peckers and pecked - then the damage sustained by birds in any one group may be the work of only a few of the members of that group. It should therefore be possible to regroup the birds in which feather pecking has developed in such a way that in some instances no further damage is done, a number of pecked birds together, in others so that it continues, both peckers and pecked together, and in yet others the damage will either be nil or considerable, a number of peckers together. The outcome of this grouping would depend on whether the peckers are themselves immune from being pecked, as suggested above.

Method

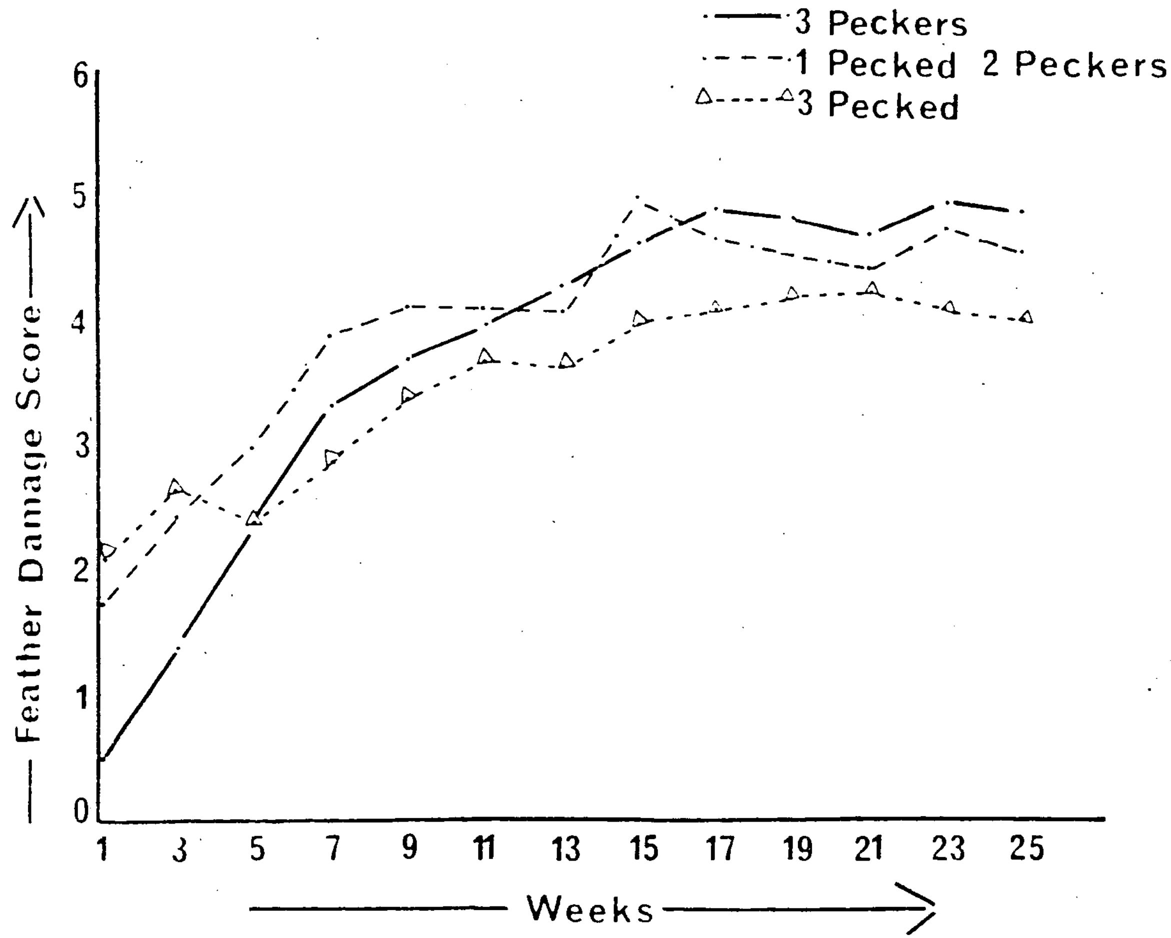
Subjects

To test the assumption that birds can be regrouped in such a way as to alter the incidence of feather pecking within the groups, 72 twenty-four week old Shaver 288 pullets that had been reared in multiple cages were used. In many of the original cages there were one or two birds whose plumage was in perfect or near perfect condition while the remainder of the birds were badly denuded, Figures 1. 7 and 1. 8. It was assumed that the birds with perfect feathering were the peckers and that all the denuded birds were victims. Using these criteria 32 peckers and 40 pecked birds were selected from groups that showed a clear distinction between damaged and undamaged birds. Eight new groups were made each containing three peckers, another eight containing three pecked and a further eight containing two pecked and one pecker, making twenty-four groups in all. The birds were not individually marked so it was not possible to follow the progress of individual birds.

Husbandry

The birds had previously been used in an experiment in which type of food, temperature, lighting and density had all been varied. For the

Figure 3.2. Experiment 3. Feather damage scores for the three groupings over a 25 week period from 24 - 49 weeks of age.



present experiment the birds were carefully selected to control for any differential effects of this earlier treatment. The groups were randomly arranged in battery accommodation and were given ad libitum food and water and kept on a 12 hour day with a light intensity of approx. 44 lux. All the cages, which measured 61cm x 46cm, were at one end of a large battery house. The arrangement of the groups was of a balanced design so that each treatment appeared equally in each of the three tiers.

Feather damage score

The birds were scored on the first day of the experiment for the amount of feather damage shown, the scoring was repeated weekly for a further twenty-four weeks until the birds were forty-nine weeks old. The scoring system was as described in Chapter 2.

Results

Feather Damage

The means of the weekly scores for each cage were combined for each of the three types of groupings, the results are shown in Figure 3.2, and Table 3.10.

During the first few weeks the scores of the three peckers groups were consistently lower than either of the other two groupings but they rose rapidly from the time that the groups were formed until the sixteenth week of the experiment when the scores began to level off. The groups containing one pecker and two pecked birds also showed a rapid rise in feather damage from the first to the fourteenth week, it then stabilised at a level just below that of the three peckers grouping. The scores of the groups of three pecked birds also rose from the first to the twentieth week, but they never reached the same level as either of the other two groupings; and the rate at which the scores increased was very much slower in this grouping than in the other two. Statistical analysis showed that the rate of the increase in the scores over the first nine weeks was significantly different; $F = 4.83$; $p < 0.05$ with the groups containing at least one pecker, increasing much more rapidly than the groups of three pecked birds.

Table 3.10. Experiment 3. Feather damage scores for the three types of group.

Group type	Mean damage scores Weeks 0-9	Weeks 15-25	Increase in score/week (weeks 1-9) *
A 3 peckers	2.43	4.73	0.41
B 2 peckers, 1 pecked	3.15	4.48	0.30
C 3 pecked	2.71	4.04	0.14
F value	1.38	1.76	4.83
p	NS	NS	0.05

* Calculated as a rolling average.

Discussion

These results confirm the supposition that the composition of a group of caged birds is important if pecking is to be reduced, and that categorising a bird as a pecker because it is undamaged when the rest of the group is feather pecked is appropriate. Birds with a pecker in their group were more pecked than birds in groups without peckers. Although this was not a significant difference over the last ten weeks of the experiment the groups containing a pecker did have a consistently higher score than the groups without. Also it must be remembered that the condition of the feathers of the pecked birds was very much worse than that of the peckers when the experiment first began and thus the pecked birds would be a better stimulus to each other than the birds with perfectly intact feathers. It might therefore be expected that the pecked birds would indulge in more pecking than the perfect birds. The analysis of the increase in pecking during the first nine weeks of the experiment showed that this was not the case.

It cannot be argued that the pecked birds were so badly denuded in the first place that they would not increase their score since the mean score for this group at the beginning of the experiment was 2.1 when, theoretically, it was possible for them to reach a score of 8.0. Also as can be seen from Figure 3.2. the group did increase their score during the experiment.

The high score obtained by the groups of three peckers shows again that it is quite possible for peckers also to be pecked. Perhaps the important variable is whether there is more than one pecker in a group, if not then the pecker should remain fully feathered. If there is more than one pecker per group then it is as likely that a bird involved in pecking will be pecked as frequently as any of the other group members. The original experiment from which these birds were drawn contained many cages in which all the birds were badly damaged and a few where no birds were damaged. This suggests the presence of several peckers in a cage in the first instance and no peckers present in the second instance.

Another factor is that feather pecking may have a considerable learned or imitative component and since the birds used here were twenty-four weeks old when they were first grouped it is possible that the habit could have been learned long before the groups were arranged and thus the difference between the two types would already be partly overlayed by learned behaviour. Thus it would probably be more accurate to consider birds not as peckers and non-peckers but rather as initiators who start the pecking in the first instance and others respond to the stimuli made for them by the initiators. To find support for this birds would have to be separated very early. as soon as feather pecking appeared, and their feather pecking behaviour monitored in two separate groups.

In summary, the results from this experiment add further support to the view that the feather pecking behaviour of the fowl does differ between individuals but at what point this develops and on what factors it depends requires further investigation.

EXPERIMENT 4.

It was mentioned in the discussion of Experiment 3 that birds might be classified either as peckers or pecked. suggesting two distinct types, or they might be termed initiators and imitators suggesting that although only some birds begin pecking other birds in the group imitate their activity. In the latter case many birds that would not normally show pecking behaviour would do so as a result of learning from other individuals. If feather pecking was prevented from developing by the removal of the pecking and pecked individuals each time a new bout began this would reduce the opportunity for learning by the remainder of the group. It would also make it possible to see whether groups of peckers and pecked birds could be reared separately and retain their different behavioural characteristics.

The aim of this experiment was therefore to see whether it was possible to distinguish peckers and pecked birds early in life. and if so whether the birds retained these characteristics until adulthood or whether feather pecking patterns changed with age.

Method

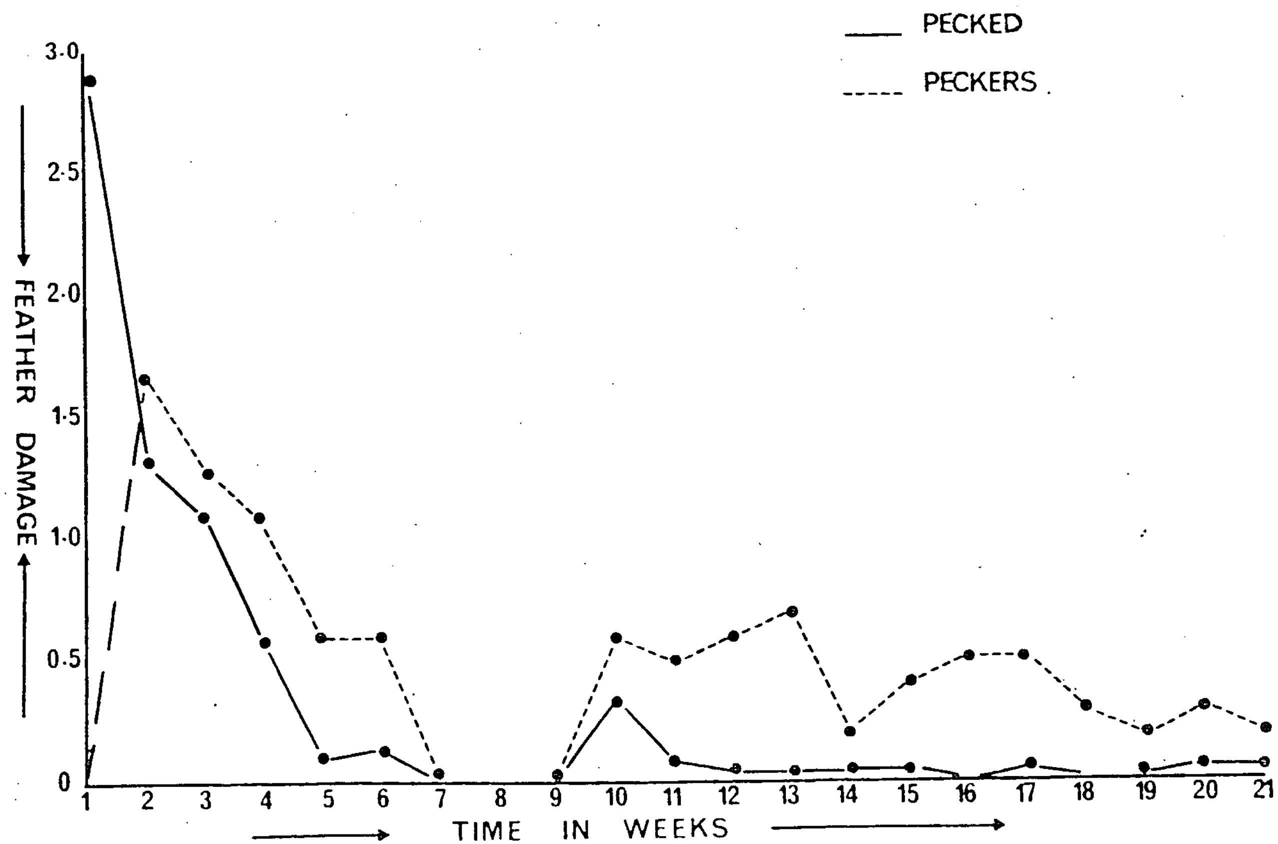
Subjects

Sixty day old chicks were divided into four single sexed groups of fifteen, there were two female groups and two male groups and the birds were treated exactly as described in Chapter 2. A group of fifteen was used since it was thought possible that in a group of only five birds there might be no potential peckers present whereas in a group of fifteen birds it would be much more likely that there would be both potential peckers and pecked.

Division of groups

The birds were left comparatively undisturbed until feather pecking began at fifteen days of age. With each new incident of feather pecking observations were carried out until both the pecker and the pecked birds had been identified. the birds in question were then moved to separate

Figure 3. 3. Experiment 4. Mean amount of feather damage suffered by peckers and pecked, weeks 1 - 21.



cages. The intention was to have three subgroups, each in a separate cage, from each original group; one of birds showing pecking behaviour, a second of birds showing pecked behaviour and a third of the birds that were unaffected in either way, these were designated neutrals.

At five weeks of age the birds were moved into battery cage accommodation and at seven weeks the birds were regrouped and the neutral birds were divided between the peckers and pecked cages. This was done to increase the density to see if this had any effect on the incidence of feather pecking in either the peckers groups or the pecked.

Feather damage.

A daily score was made of the state of the plumage of all the peckers and the pecked, starting at the point of transfer into the separate sub-groups and continuing until the second week after the transfer when scoring was reduced to once a week, since feather pecking had declined a great deal. The scoring system described in Chapter 2 was used. Once new outbreaks of feather pecking had ceased there were thirty-two neutral birds, sixteen pecked birds and twelve peckers.

Stimulus tests

Each bird was given a number of tests in an individual situation. The bird was placed by itself in a cage and left for approximately thirty minutes to habituate to the new surroundings. A stimulus object was then placed in the centre of the cage and observations were made of the number of pecks directed at the stimulus. Each trial lasted for 15 minutes and each of the four stimuli were presented on two separate occasions. The stimuli used were a) feathers in a block, b) green block, c) the dyed bird and d) the bloodied bird.

Results

Feather damage

Feather pecking began on day fifteen for one group of females and by day twenty-five there was feather pecking in all groups. Figure 3. 3 shows the mean damage score for the two types of bird over the whole experimental period. It can be seen that none of the peckers were damaged when they were first separated but by the end of the first week they too were showing appreciable damage scores. Quite the opposite effect can be seen for the pecked birds. in these groups all the birds were pecked, by definition when first put into the groups, but the amount of damage declined steadily, the time course presumably being controlled by the rate at which the feathers regrew. The difference between the groups was maintained until the seventh - ninth week when all pecking was resumed, both types of bird were involved, but the peckers again showed a higher level of damage than the pecked.

Stimulus tests

The results of these tests are shown in Tables 3.11 and 3.12. It was hoped to find that some stimuli, e.g. the feathers and the bird stimuli, were more attractive to the peckers than to the pecked thus supporting earlier findings. This, however, was not the case although the peckers did peck slightly more at the feathers in the block than the pecked, but they also pecked less at the two bird stimuli, the opposite of what had been expected.

Table 3.11. Experiment 4. Mean response to the stimuli, male and female groups combined.

Stimuli	Peckers	Pecked	Neutral
Block	0.54	2.75	1.9
Feathers	0.33	0.08	4.0
Dyed bird	2.26	6.92	1.8
Bloodied bird	2.87	13.8	12.3

The response of the neutral birds to the stimuli was not typical of either of the other two groups; like the pecked birds they had a higher response to the block and the blooded bird than the peckers but they also showed a small response to the dyed bird which was similar to the response the peckers gave to this stimulus, the response the neutrals gave to the feather stimulus was higher than either of the other two groups.

The differences between the sexes was shown mainly as an increase in pecking by the males in comparison with the females. They pecked almost twice as much as the females at all stimuli except for the green block.

Table 3.12. Experiment 4. Mean response to the stimuli showing different behaviour by male and female groups.

Stimuli	Male	Female
Block	1.08	2.10
Feathers	2.1	0.77
Dyed bird	4.3	2.08
Bloodied bird	13.2	8.2

Discussion

The overall results would appear to confirm that a distinction can be made between so-called peckers and pecked birds and that the former begin to feather peck early and continue to peck even when they are moved to groups without damaged birds. On the other hand birds that are pecked tend not to indulge in feather pecking themselves even though they are grouped with birds that present a normally effective stimulus of a bloody and featherless area. The groups of peckers in this experiment did inflict damage on each other although each bird was undamaged when first placed into the peckers group. This would suggest that if only one pecker is present in a group it remains undamaged but if there is more than one pecker per group then all birds could be damaged.

The true non-peckers in this experiment were probably those grouped together under the heading of "neutral", no feather pecking was seen at any point in these groups until they were incorporated with the peckers and pecked at seven weeks. The increase in density caused by the regroupings at seven weeks did not appear to affect the level of feather pecking observed suggesting that density in itself is not a relevant variable in the causation of feather pecking, rather the composition of a group of birds in terms of whether or not they are likely to indulge in feather pecking is of importance.

An interesting finding was that the incidence of feather damage declined to zero at seven weeks and began again at nine weeks for all groups. This would suggest either that unidentified environmental influences are involved or that specific age effects shown in all birds equally are to blame. There is no evidence in the present experiment to favour one explanation more than the other; however, there was no obvious change in the external environment.

The lack of statistical analysis on these results is due to the fact that such a large proportion of the feather damage scores from the individual birds were zero and in fact even the scores from the pecker group were lower than often found during this study. Feather pecking did not increase at point of lay as is often the case in commercially housed birds and by twenty-two weeks the mean feather damage scores were 0.1 and 0.2 for the pecked and peckers respectively when commercially kept birds of the same strain are often considerably denuded.

The results of the individual tests appear to provide very little information regarding the type of stimuli that are effective in eliciting feather pecking behaviour. The bloodied bird produced a greater response from the pecked birds and the neutrals than from the peckers and in fact this last type of bird showed little interest in any of the stimuli. It seems that simply presenting a stimulus regardless of other conditions prevailing is not conducive to finding out which have peckable properties and which do not. From subjective observations it appeared that the testing of birds in isolation from their cagemates made them very disturbed and reduced their response to the stimuli.

The overall finding of this experiment, is that birds can be separated into those that feather peck and those that do not, and that of the latter type many which do not peck are the ones which suffer the first pecking damage. Why there are some birds which do not appear either to be pecked or to do the pecking is not clear unless it is merely a question of chance.

EXPERIMENT 5.

The results of the last experiment suggested that on the whole birds which were pecked did not peck each other if they were housed together but that groups of peckers did damage each other. However, the number of birds in the experiment was fairly small and the results not totally conclusive and for this reason the experiment was repeated using ninety birds, all female. Females were used since in commercial situations it is only they which are kept in cages for a long period and thus any results from an experiment using mixed sexes would be less relevant. The stimuli used in the tests were also different since those used in the previous experiment had not been found to be particularly effective in distinguishing between the groups.

Method

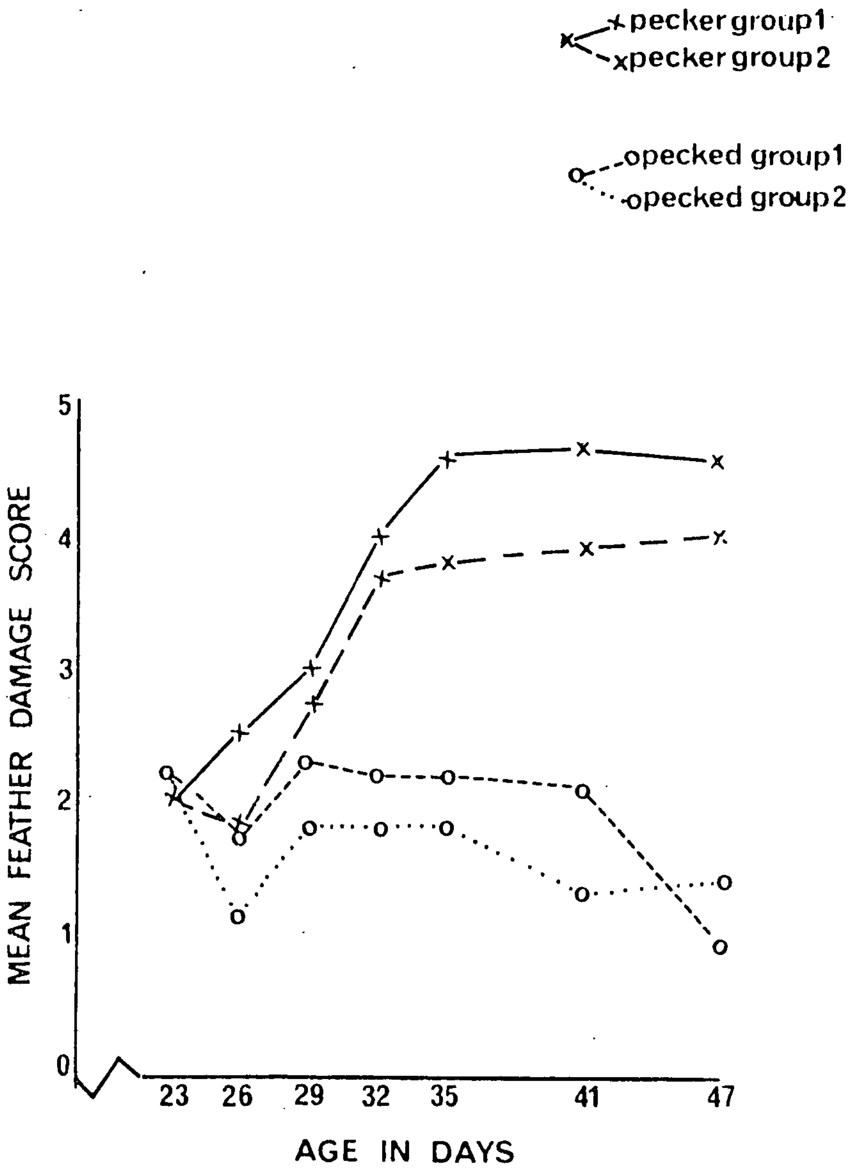
Subjects

Ninety day old female light hybrid chicks were obtained and treated as described in Chapter 2. Initial group size was fifteen.

Division of groups

As in Experiment 4 no observations were made until feather pecking began although a careful watch was kept so that the

Figure 3. 4. Experiment 5. Mean feather damage score for the two types of bird.



participants in any bout of pecking could be distinguished as soon as possible. Once feather pecking began a short but intensive observation period ensued to identify the bird or birds doing the pecking, and then both the damaged and damaging birds were placed in separate groups. Unlike Experiment 4 there were no specific sub-groups for each original group, instead any birds showing pecking behaviour were put into one cage until there were ten birds present and then a second cage of peckers was started; the pecked birds were treated similarly. Eventually two groups of feather peckers, a total of thirteen birds, and two groups of feather pecked, a total of nineteen birds, were separated, the remaining fifty-eight birds were not affected by feather pecking.

Observations

As soon as birds began to be separated into peckers and pecked general observations were begun on a daily basis on these new sub-groups. The separated birds were weighed weekly and the size of their combs measured. A score was made every two to three days on the amount of feather pecking damage suffered by the birds in these selected groups, using the same system as described in Chapter 2.

Stimulus tests.

Group stimulus tests (Chapter 2) were also made. This system replaced the individual tests of Experiment 4 since it had been noticed that the birds were disturbed by the change in their environment and the lack of companions. The stimuli presented were the feathered block, a dead bird of the same age and strain as the experimental birds and a bird with a small area bare of feathers at the base of the tail, this bird was also of the same age and strain as the experimental ones. Each of the stimuli were presented on two separate occasions and the dead bird stimulus was presented for a further two tests since this was the only stimulus that appeared to elicit a different response from the sub-groups.

Results

Feather damage.

Figure 3.4. shows a record of the feather pecking damage suffered by the separated groups over the five weeks of the experiment. It can be

Figure 3.7. Experiment 5. Mean comb area (length x height).

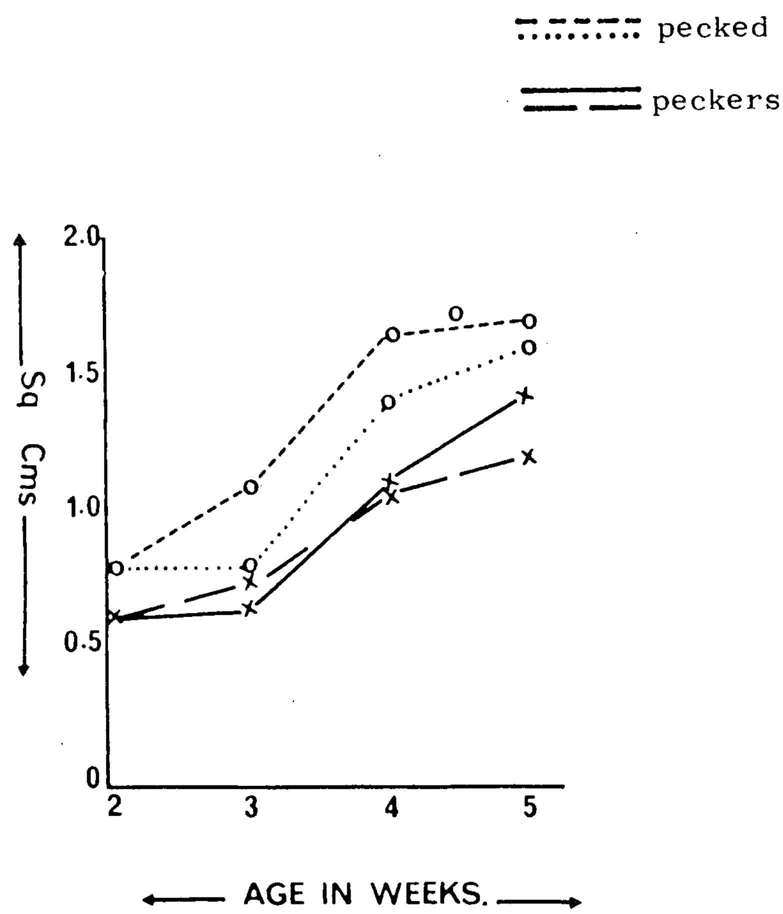


Figure 3. 6. Experiment 5. Mean weights of the birds in the two types of groups.

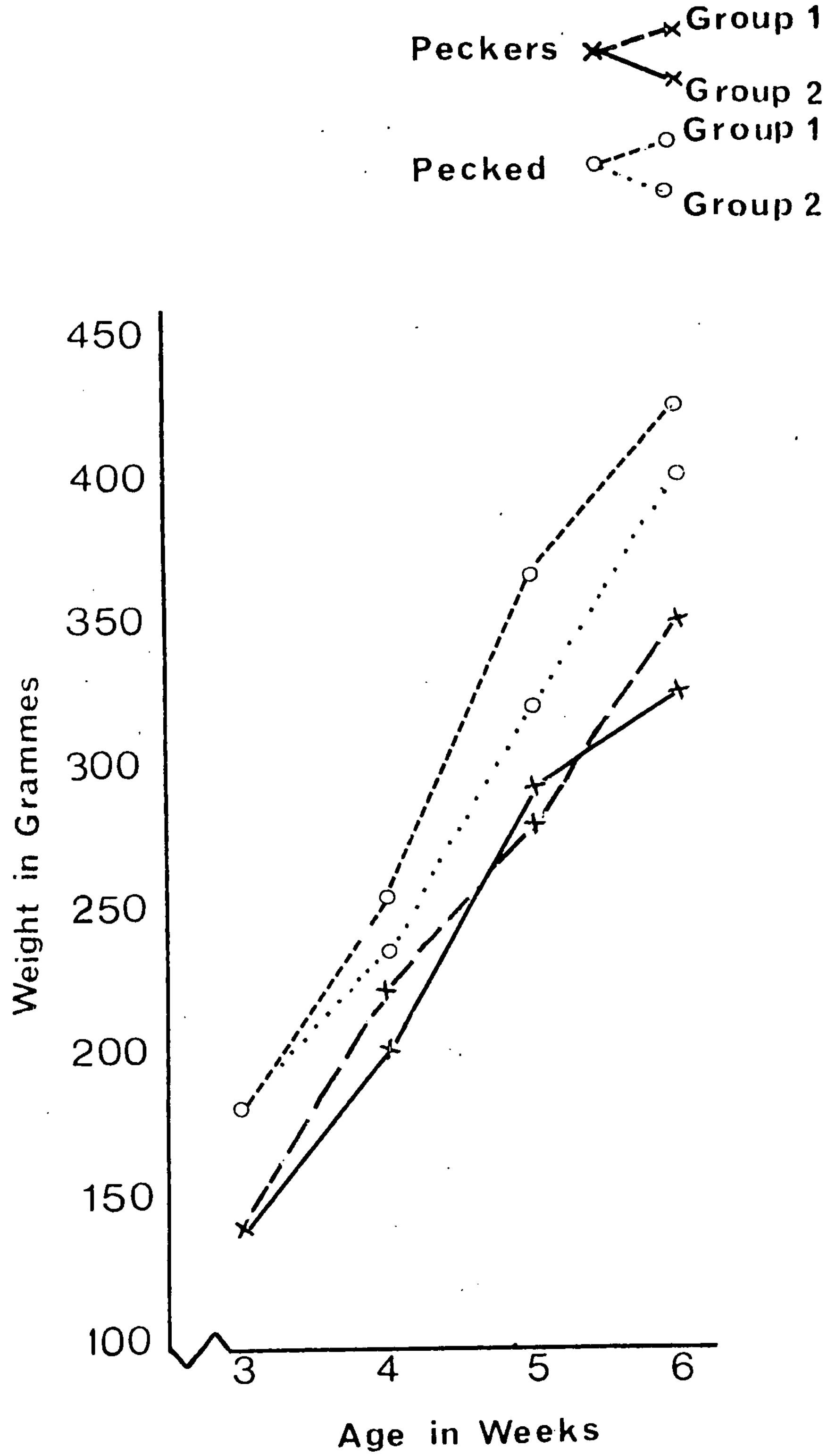
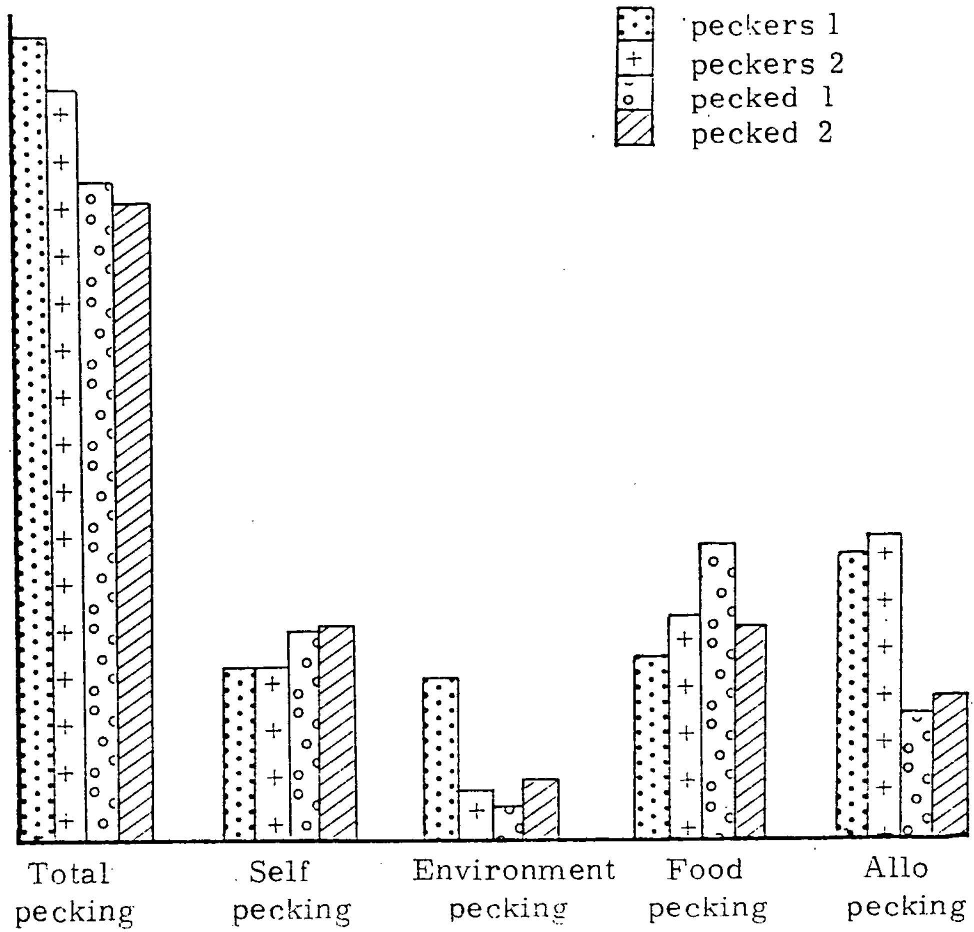


Figure 3.5. Experiment 5 Pecking behaviour recorded during general observations. Group means.



seen that the peckers had a low score initially but that this soon rose to one depicting considerable damage. The pecked ones, on the other hand had a score that was gradually reduced from its initial level of 2. 5 to a mean level of 1. 25. The scores appear to be constantly changing over the first few days since this was the time when new birds were being added to the groups and so the scores fluctuated independently of the behaviour of the group that they had joined. During this period there was no difference in the amount of damage suffered by the two types of bird. Once the groups were firmly established the difference in feather damage became very apparent, ($U = 6.0$; $p < 0.002$).

General Observations.

The general observations showed a difference in the pecking behaviour of the groups. The peckers did more pecking in total than the pecked birds ($U = 76.5$; $p < 0.02$). This could probably be accounted for by the great difference in allopecking, the peckers had mean scores of 4.1 and 4. 4 whereas the pecked scores were 1. 8 and 2. 1 ($U = 45$; $p < 0.002$). The pecked birds showed higher scores for both self directed and food pecking, however, these differences were not large. The scores for environment pecking are anomalous since one of the pecker groups did a great deal of this type of pecking, while the remaining three groups had very similar but much smaller scores ($U = 113$; $p < 0.05$). Figure 3.5

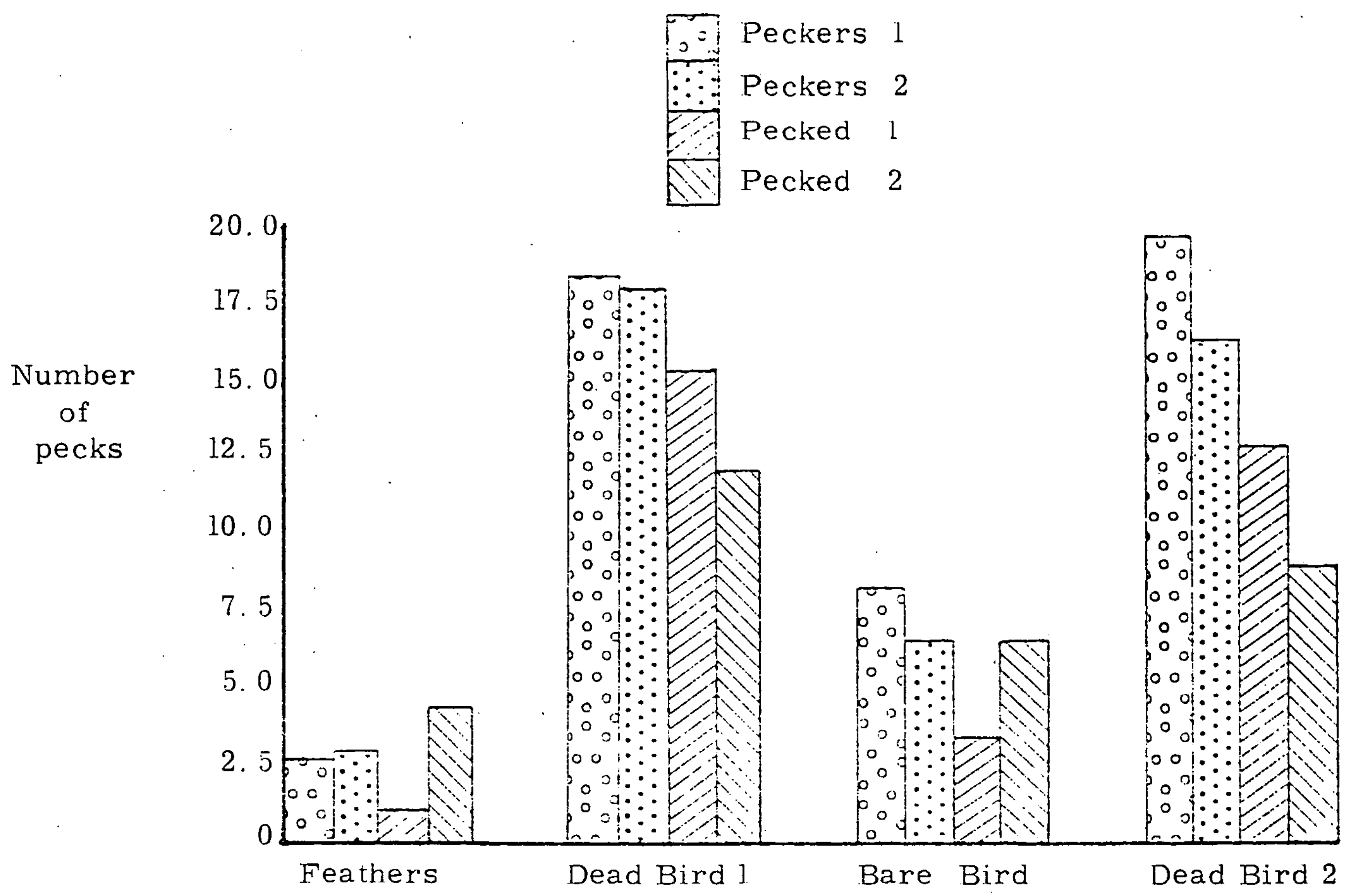
Weights.

The results of the weekly weighings, see Figure 3. 6. showed that the peckers were consistently lighter than the pecked groups, this was evident from the first of the weighings at seven days and remained so until the end of the experiment at seven weeks of age, ($U = 9.5$; $p < 0.09$).

Comb Size.

Figure 3. 7 shows the growth of the combs for the two types of birds, pecked birds had the largest mean area of comb but the difference was not significant ($U = 13$, $p < 0.08$). The size of the combs was estimated by measuring both the length and height and multiplying the two together. This was thought to be an adequate measure since the shape of a developing comb in this particular strain is more or less that of a rectangle. Breneman (1951) used a comb measure of length x height

Figure 3.8. Experiment 5. Mean number of pecks directed at the stimuli.



divided by two, this assumes that the comb is a triangle which may be so for adults but was thought not to be the case for chickens aged 2-7 weeks.

Stimulus Tests.

The stimulus tests did show an interesting result in so far as the peckers made more response to the dead bird stimuli on both its presentations than the pecked birds ($U = 1.5$; $p < 0.1$, and $U = 1.0$; $p < 0.02$). The response of the peckers to the bare bird was slightly more than that of the pecked but they both responded equally to the feathers in the block stimulus. Figure 3.8.

Discussion

The main finding of this experiment was that birds that are separated as young chickens on the basis of certain characteristics of pecking behaviour, retain these patterns at least until seven weeks of age even though the surroundings and the individuals at which they pecked were changed at the initial separation. These results support the findings of Experiment 4.

It would also appear that pecked birds are heavier than those that do the pecking and have slightly larger combs, the significance of this is not obvious but is not what would be expected.

The pattern of pecking behaviour obtained in the general observations also confirms earlier findings that the total amount of pecking behaviour does not differ to any great degree but that the objects pecked at do differ between the groups. The peckers indulged in more allopecking that the pecked which appeared to make up the difference by doing more preening, an activity presumably well stimulated by the feather and tissue damage suffered by these birds. Why one of the groups of peckers had such a high score for environment pecking is not clear, it was possibly due to a few individuals indulging in repetitive pecking of the floor or some other area of the cage, such activity has frequently been observed in caged birds. In earlier experiments the pecked have directed more of their pecking towards the environment than have the peckers.

The results of the stimulus tests suggest that a bird, whether upright and moving or prone, is a better stimulus for eliciting pecking than a collection of feathers of a similar kind. However, neither movement of the stimulus bird nor normal behaviour seem to be important factors since the dead fully feathered bird was a more effective stimulus on all occasions than the live bird with a patch of bare feathers at the base of its tail. It would seem that the dead bird stimulus had properties that neither the feathers in the block nor the live bird had but which perhaps are shared by pecked birds.

EXPERIMENT 6

The findings of the two previous Experiments, 4 and 5, showed that if birds were separated as young chicks on the basis of certain characteristics of pecking behaviour they retained these characteristics until at lease seven weeks of age. The aim of the present experiment was to see if this dichotomy continued for a longer time period, in fact up to point of lay. In the commercial situation outbreaks of feather pecking often occur around point of lay, between sixteen and twenty weeks (Hughes, 1973) and so it was thought relevant to determine whether the outbreaks of feather pecking that occurred early in life involved the same birds in the same roles as in any later outbreaks.

Method

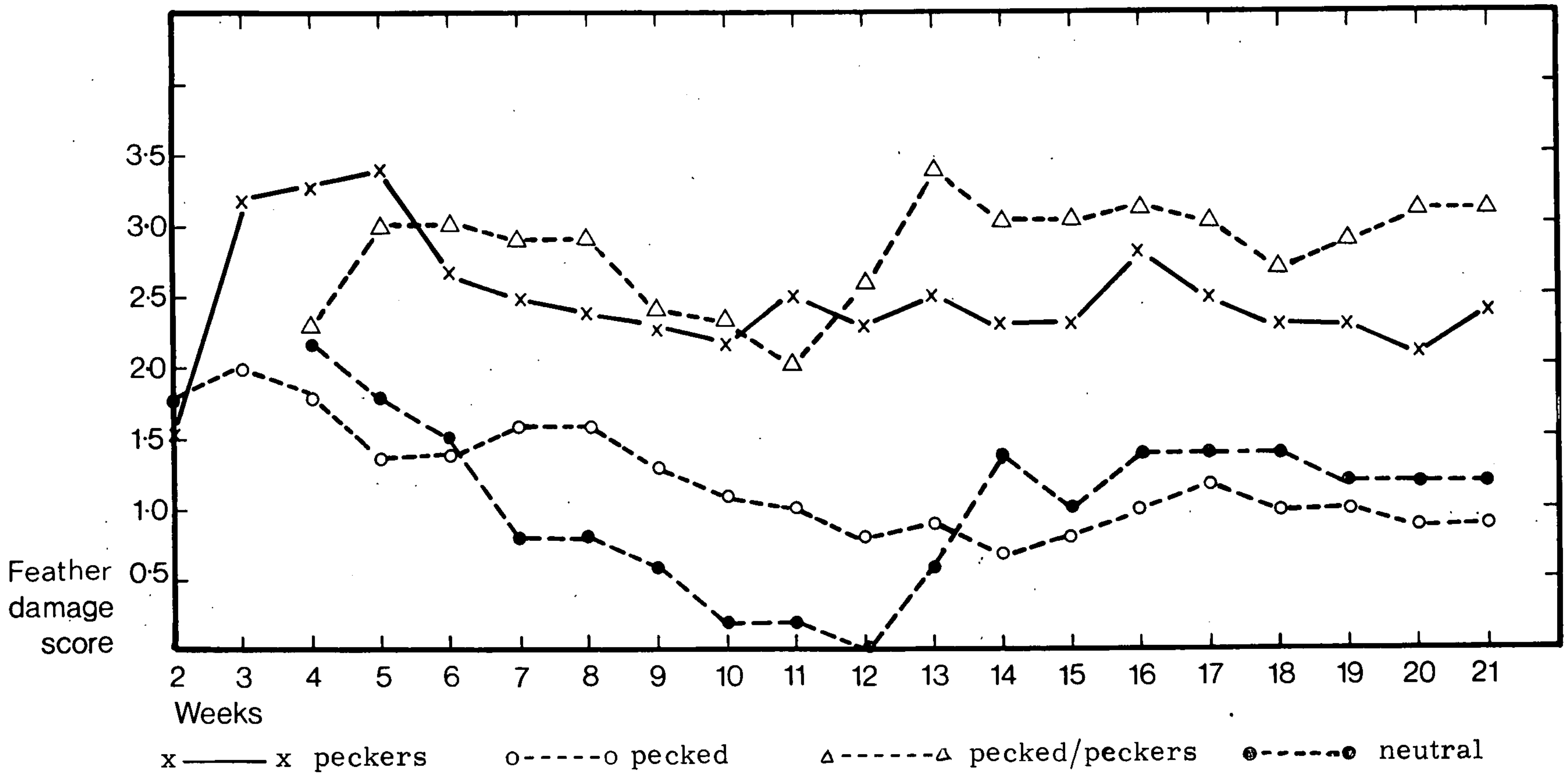
Subjects

Sixty female light hybrids were obtained at day old and randomly placed into four groups of fifteen birds. Rearing methods were as described in Chapter 2.

Group Divisions.

As in Experiments 4 and 5 intensive observations were conducted once feather pecking had begun and the peckers and pecked involved in

Figure 3.9. Experiment 6. Mean feather damage score.



each incident were identified and removed to separate cages. At the end of three weeks all but five birds were involved in feather pecking either as pecker or as the pecked. The original sixty birds were grouped as follows, four groups of peckers each containing six birds, two groups of pecked each containing six birds, one group of seven pecked birds that had also shown pecking behaviour and one group of five neutral birds that did not appear to be involved in feather pecking at all at that time. The remaining twelve birds dropped out the experiment, either through accident or disease unrelated to feather pecking.

Feather Damage

The state of each bird's plumage was scored weekly between weeks two and twenty using the eight point scale described in Chapter 2.

Egg Record

A total of the number of eggs laid by each group during the first laying week was recorded.

Results

Feather Pecking

Feather pecking began on day eight and fresh outbreaks continued to occur until the third week. See Figure 3. 9. Throughout the experiment the scores of feather damage were considerably higher for the groups of peckers than for the groups of pecked or neutral birds, even though when initially grouped the peckers were all quite damaged. The pecked and neutral groups also sustained some feather damage, but never at such a level as the peckers. The pecked birds were of course damaged before they were regrouped.

In this experiment one group was composed of birds which had initially been pecked, but having been grouped with other pecked birds were observed to indulge in pecking themselves. This group was not formed until week four and although their level of feather damage was very similar to the other groups of peckers at week five it was somewhat higher by the end of the experiment.

The neutral birds were those that by the end of the third week did

Table 3.13. Experiment 6. Comparison of feather damage over three time periods.

Weeks	2 - 12		13 - 20		1 - 20	
Groups	$\bar{X}$	P	$\bar{X}$	P	$\bar{X}$	P
Pecked	1.2	***	1.1	***	1.1	***
Peckers	2.4		2.4		2.4	
Pecked	1.2	+	1.1	*	1.1	+
Pecked/ Peckers	2.5		3.0		2.8	
Pecked	1.2	NS	1.1	NS	1.1	NS
Neutral	0.5		1.3		0.9	
Peckers	2.4	NS	2.4	NS	2.4	NS
Pecked/ Peckers	2.5		3.0		2.8	
Peckers	2.4	***	2.4	+	2.4	**
Neutral	0.5		1.3		0.0	

\+ Significant at the 0.1 level.

* " " " 0.05 "

** " " " 0.01 "

*** " " " 0.001 "

not appear to be involved in feather pecking in any way. There were only five of these birds and although they did not appear to indulge in much feather pecking there were peaks at four and thirteen weeks when they were at least as damaged as the pecked groups.

Mann Whitney U tests were carried out on the mean score of each bird within the separate groups. Computations were done for three time periods, a) the full nineteen weeks of the experiment, b) weeks two - twelve and c) weeks thirteen - twenty. See Table 3.13.

Taking the results over the whole period the difference in the amount of damage received by the peckers compared with the pecked birds was considerable. There was also a significant difference between the peckers and the neutral group, but there was no difference in the extent of damage found between the peckers and the pecked/peckers. There was, however, a difference between the pecked birds and the pecked/peckers over this period which verged on the significant, but no difference between the pecked groups and the neutral birds. The position was similar for the shorter time period of two - twelve weeks and at on set of lay.

Egg Production

During the last week of the experiment the birds began to lay. All groups except the pecked/peckers had produced at least one egg by the end of the twenty-first week, but even in such a short period there was considerable differences in production. See Table 3.14 .

Table 3.14. Experiment 6. Egg production for the first laying week. (week 20).

	Feather Pecking Groups					Non-feather pecking groups		
	peckers				pecked/	pecked		
Groups	1	2	3	4	peckers	1	2	neutral
N	6	6	6	6	7	6	6	5
number of eggs	3	1	2	5	0	3	9	10

The five groups containing peckers and pecked/peckers produced a total of only eleven eggs over this period while the three groups of pecked birds and neutrals produced twenty-two eggs. ($U = 1.5$; $p<0.05$).

Discussion

The results of this experiment support the earlier finding that birds can be separated into groups of feather peckers and non-feather peckers at an early age and can be kept in groups of similarly behaving individuals. The present results also show that the difference in behaviour is maintained at least until the birds are sexually mature and have begun to lay. It would thus appear that a feather pecking chick is a feather pecking adult and a pecked chick is a pecked or at least non-pecking adult.

It is interesting that the group of birds which were pecked but which also developed pecking behaviour a few weeks later inflicted more damage on each other than even the birds that had been chosen as peckers initially. Whether this suggests that selection at a slightly later date is more accurate than selection practiced as soon as feather pecking appears or whether there is some other physical or behavioural reason is not clear. Perhaps these birds damage more easily or do not respond to being pecked in a manner that would deter repeated peckings and that is why they were identified originally as pecked birds. However, the difference between the peckers and the pecked/peckers was not particularly large, although it was consistent after the thirteenth week, and so to stress a basic difference between the birds is unnecessary.

The behaviour of the neutral birds is somewhat contradictory. During weeks one and three there was no pecking at all involving these birds, but by the fourth week a mean score of 2.2 for feather damage was recorded. It was not at all obvious which birds in the group were responsible for the pecking and so the birds were left together. By week eleven the mean group score had dropped to zero which appeared to justify leaving the birds together as a group of neutrals, however, a sharper rise in feather damage followed this very low level and the group finished the experiment with a score slightly, but not significantly, higher than the pecked birds.

All four types showed a rise in the amount of feather damage between weeks ten and thirteen, but it was only among the neutrals and pecked/peckers that this increase was a lasting one. There were no apparent changes in the external environment that could account for this increase in the amount of feather damage and so it is tempting to invoke changes in the internal environment to explain the rise. It would seem possible that the increase at this point can be equated with the increase in feather pecking that frequently appears under commercial conditions around point of lay although in the present experiment no vent pecking was observed.

The proportion of birds involved in feather pecking in this experiment was particularly large. Only five birds out of forty-eight were not affected in any way by feather pecking during the first few weeks and even these five neutral birds damaged each other to some extent. Of the remaining forty-three birds only twelve were primarily pecked rather than peckers. In other similar experiments, for example Experiment 5, the proportions were very different with fewer peckers and considerably more neutral birds. Whether these differences are dependent solely on random factors or whether they are related to other more fundamental influences has not yet been determined although some attempt at investigating these aspects of the problem will be described later.

Egg production began during the last week of the experiment, week twenty, and the only group not to have laid in this week were the pecked/peckers, the group with the highest feather damage score. Analysis showed that the groups of pecking birds laid significantly fewer eggs during this first week than the pecked and neutral birds. No attempt was made to follow egg laying to a later date nor to determine hormone levels in the birds in the different groups. However, it would seem plausible that if there were a difference in hormone level it would also influence other forms of behaviour possibly including feather pecking. This point is returned to elsewhere in this thesis.

General Discussion

These first six experiments were aimed at discovering the pattern of feather pecking as it appeared in the conditions of the experimental environment. Birds of both sexes were used and with one exception the birds were obtained at day old so that their rearing conditions were controlled from the beginning. In the experiment using adult birds the previous experiences of the birds were known and allowed for.

The main factor to emerge was that not all birds are equally involved in an outbreak of feather pecking; only some birds appeared to be responsible for the pecking and not all birds were pecked. Some seemed to be quite uninvolved either in the pecking or in being pecked while others could be involved in either one or both aspects of the behaviour. Feather pecked birds housed together tended not to continue the feather pecking behaviour and their feather damage gradually decreased. Even Experiment 3 where older birds which had been in contact with feather pecking for most of their lives were used showed that feather pecked birds housed together did less feather pecking than peckers housed together or a single pecker and two pecked birds. Birds that were observed to do the feather pecking continued with this behaviour even when moved to groups comprised only of peckers and when thus housed their score of feather damage increased.

Experiment 6 showed that the separation of birds into different groups on the basis of their pecking behaviour between weeks two and four was still accurate at twenty weeks of age and thus the feather pecking seen in very young chicks would seem to be related to the feather pecking that occurs in adult birds.

The total amount of pecking, as measured by the scores obtained during general observations, did not usually differ between the types of bird but it appeared that the objects at which they pecked differed. The feather pecking birds spent a large proportion of their time pecking at cage mates whereas the feather pecked birds spent more time pecking at objects in the environment, themselves and food.

This finding suggests that feather pecking is not purely the result of an unsatisfied pecking drive as suggested by Hoffmeyer (1969); in which case it might be expected that birds would distribute their pecks equally. It would seem instead that factors directing the pecking are responsible for feather pecking rather than a non-specific "need" to peck.

It might appear obvious that some particular stimuli elicit feather pecking, or that there is some particular behaviour that gradually develops into feather pecking. Equally, different stimuli might result in different responses from the birds which pecked and those which did not or were themselves pecked. Of the stimuli presented in these experiments not many produced results which distinguished between the types of birds. In Experiment 1 the feather pecking groups did appear to peck at bird-like stimuli while the non-feather pecking groups pecked at the non-bird-like ones. In Experiment 5 it was also found that the feather pecking birds pecked significantly more at both the dead bird stimulus and the pecked bird stimulus, but the non-feather pecking groups did not show any great preference for the non-bird-like stimuli as might have been expected. Experiment 2 also showed a difference in the response to some of the stimuli by the two types of bird but Experiment 4 produced quite indistinct results. Thus the influence and importance of stimulus variables as tested so far do not appear to be critical but it is quite possible that other aspects of the relevant stimuli would produce a more obvious distinction between the groups.

Like so much other work on feather pecking the results obtained in one experiment were not always repeatable in another, for example, the sex differences and the differing responses to the stimuli in Experiments 1 and 4. It is difficult to know what to attribute these contradictions to, the rearing and environmental conditions of the birds were as similar as possible in all experiments, the birds were of the same strain and the same age at the beginning of the experiments. It is possible that there might be within strain variation relating to feather pecking and associated behaviour and in fact only some such explanation would be adequate to explain the variability of the results. Schaible (1947) appeared to have similar problems, "It was recognised at the beginning that one of the most difficult problems in studying cannibalism would be the reproducibility of the results".

One possibility would be that feather pecking is influenced by the hormonal condition of the birds. The evidence from the experiments reported so far shows that males were more active in feather pecking than females and that birds in pecker groups laid fewer eggs during their first week of production than those in pecked or neutral groups. This combined with the often quoted observation that feather pecking frequently rises sharply just before the onset of lay, implicates gonadal hormones in the occurrence of feather pecking.

Since the birds were housed in groups noneof their behaviour could have been said to be totally independent but could have been influenced by the behaviour of other birds in the group. Thus social facilitation might account in part for some of the unusual and non-reproduceable results, for example, one bird might begin to feather peck and then others in the group would imitate its behaviour. similarly one bird might respond to a stimulus placed in the cage which would encourage other members of the group also to respond. Where there is the opportunity to feather peck there is always the possibility of social facilitation. The implications of this were discussed in Chapter 2.

As a result of these first six experiments it became clear that a large number of factors could be involved in the development of feather pecking and since it seemed probable that the investigation of just one of these factors would lead to a very unbalanced view of the problem it was decided to investigate several of the major variables in the hope that their relative contributions could be evaluated.

CHAPTER 4

THE RELEVANCE OF STIMULI IN THE FEATHER PECKING SITUATION.

The experiments described in Chapter 3 suggested that not all birds were equally likely to indulge in feather pecking. There was no obvious reason for this since strain and environmental conditions were kept as similar as possible for all birds.

It thus seemed possible that feather pecking might develop only if the correct stimuli were present. Perhaps a damaged bird or just a bird with a feather or piece of down out of place or the natural appearance of the feathering at various phases of development would be enough to elicit the first pecks. These would be out of curiosity, but once they had been reinforced by the removal of feathers or the taste of blood then these exploratory pecks might change into a full outbreak of feather pecking. If, on the other hand, these eliciting stimuli never appeared or were not responded to for some reason then it would be possible to rear birds without the appearance of this behaviour pattern.

Some stimuli were tested in the earlier experiments and although there was the suggestion of a relationship between certain types of stimuli and the pecking propensities of the birds, no really convincing results were obtained. Thus it was decided to try and investigate the properties of a stimulus that were necessary to elicit pecking behaviour. Four experiments were conducted with this specific aim.

EXPERIMENTS 7 and 8.

These experiments were designed to compare the effects of seven stimuli on the pecking behaviour of chicks, both feather peckers and feather pecked. Since experiments had been run in which no feather pecking had occurred despite "ideal" conditions such as high light intensities and high temperatures it was decided to use a medium hybrid strain of hen that was reputed to be a rampant feather pecker, the Hubbard Golden Comet, as well as the light hybrid used in earlier experiments. In this way it was hoped that an outbreak of feather pecking would occur at least in the medium hybrids and so comparisons could be made between peckers and pecked birds. It was also thought that the response of the two strains to the stimuli might differ in a way that could be related to the later feather pecking behaviour.

Both experiments were conducted in exactly the same manner and produced the same results and so it was decided to describe them together.

Method.

Subjects

Forty chicks were used in each experiment. They were drawn from a population of one hundred and twenty females, sixty medium hybrids, Golden Comets, and sixty light hybrids on both occasions.

The flock was obtained on day one and housed and reared as described in Chapter 2, except that half of the birds, thirty of each strain, were in "pens" and the other half were in the cages described previously. The pens were of the same construction and dimensions as the cages but instead of wire floors they had a solid wooden floor which was covered with approximately 2 cms. of wood shavings. The birds were kept in separate strain groups of fifteen in both the pens and the cages.

Observations.

For the observation periods, the cages and pens were split in half by hardboard partitions, so that there were two square areas with 38 cm. sides. A random sample of five birds from each of the groups was placed in one of the sections of the home cage or pen and thereafter the same five birds were used for each stimulus test. Eight such sub-groups were used providing forty experimental animals from the possible one hundred and twenty. Food and water were always available and the birds were given fifteen minutes to acclimatise to the new situation before observations began.

General observations of the groups of five birds were made twice weekly starting at the beginning of the second week and continuing until the birds were seven weeks old. A total of ten observations, each lasting ten minutes, was made on each group.

Stimulus observations were also made on the groups. Each stimulus was presented six times over a period of three weeks for five minutes at each presentation.

The stimuli used were all "mock" birds as described in Chapter 2 and shown in Figure 2. 2 and 2. 3. The reason for using only mock birds was that in Experiment 2 the response to the mock bird was far greater than to any other of the stimuli and thus it was hoped that these models would elicit a large enough response to make the results reliable. Further, the mock bird was by far the most realistic of the stimuli so that the results obtained would possibly be more relevant to the real situation than results obtained from the presentation of spotty pieces of wood!

The variables considered in this experiment were texture, colour and contrast. Seven different models were used, three of different textures, two of different colours and two involving contrast.

The stimuli used to test the relevance of different textures of feathering in the pecking situation were all white models covered with feathers from an adult light hybrid. In one case the feathers were very fluffy since the underdowny feathers were mainly used, a second bird was very sleek since the upper smooth feathers were used and were glued firmly to the cloth form and a third bird model was of an intermediate texture made of a mixture of downy and top feathers and looking as much as possible like a young chick.

To test the effects of colour on pecking behaviour two models were made with the normal, intermediate, texture and then dyed, one green and one red. Coloured inks were used for dyes and the two colours were

Table 4.4. Experiment 8. The number of pecks directed at the models by birds in the two strains and environments. The 'U' values and significance levels are also shown.

	Pens				Cages				Medium Hybrid				Light Hybrid			
Stimuli	Med. hybrid	Light hybrid	'U'	P	Med. hybrid	Light hybrid	'U'	P	pens	cages	'U'	P	pens	cages	'U'	P
Normal	55	98	34.5	*	73	117	60.0	NS	55	73	57.5	NS	98	117	69.0	NS
Sleek	60	92	41.0	+	145	103	51.0	NS	60	145	19.5	***	92	103	67.0	NS
Fluffy	56	114	19.5	***	102	139	65.0	NS	56	102	40.0	+	114	139	71.0	NS
Red	58	177	15.5	***	93	190	42.0	+	58	93	45.5	NS	177	190	71.0	NS
Green	97	153	43.5	NS	82	257	20.5	***	97	82	68.5	NS	153	257	40.5	+
Red contrast	46	82	39.0	+	98	96	60.0	NS	46	98	24.0	**	82	96	71.0	NS
Green contrast	58	79	46.0	NS	74	219	25.5	**	58	74	63.0	NS	79	219	28.5	**

+ Significant at the 0.1 level.

* " " " 0.05 "

** " " " 0.02 "

*** " " " 0.002 "

Table 4.3. Experiment 7. The number of pecks directed at the models by birds of the two strains and environments. The 'U' values and significance levels are also shown.

	Pens				Cages				Medium Hybrid				Light Hybrid			
Stimuli	Med. hybrid	Light hybrid	'U'	P	Med. hybrid	Light hybrid	'U'	P	pens	cages	'U'	P	pens	cages	'U'	P
Normal	67	125	41.0	+	92	183	28.5	**	67	92	64.5	NS	125	183	46.5	NS
Sleek	62	165	15.0	***	96	234	12.0	***	62	96	42.5	NS	165	234	43.5	NS
Fluffy	56	185	10.5	***	88	256	20.5	***	56	88	70.0	NS	185	256	41.0	+
Red	94	114	57.0	NS	89	91	71.0	NS	94	89	64.0	NS	114	91	56.0	NS
Green	58	227	1.0	***	65	213	25.5	**	58	65	71.0	NS	227	213	69.0	NS
Red contrast	63	122	18.0	***	111	193	31.0	**	63	111	49.0	NS	122	193	30.5	**
Green contrast	75	144	35.0	*	114	228	24.0	**	75	114	53.0	NS	144	228	34.0	*

+ Significant at the 0.1 level.
* " " " 0.05 "
** " " " 0.02 "
*** " " " 0.002 "

Table 4.2. Experiment 8. Number of pecks made at the stimuli during six 5 minute observation periods.

Stimulus		Number of Pecks.			
		Medium Hybrids		Light Hybrids	
		Pens	Cages	Pens	Cages
N	Normal	55	73	98	117
S	Sleek	60	145	92	103
F	Fluffy	56	102	114	139
R	Red	58	93	177	190
G	Green	97	82	153	257
RC	Red contrast	46	98	82	96
GC	Green contrast	58	74	79	219

Significance of individual comparisons, U - values.

N v S	NS	36.0 *	NS	NS
N v F	NS	NS	NS	NS
S v F	NS	NS	NS	NS
N v R	NS	NS	31.5 **	43.0 +
N v G	NS	NS	37.0 *	30.5 **
N v RC	NS	NS	NS	NS
N v GC	NS	NS	NS	38.0 +
R v G	NS	NS	NS	NS
RC v GC	NS	NS	NS	32.5 *
RC v R	NS	NS	24.0 **	39.0 +
GC v G	NS	NS	29.0 *	NS

+ Significant at the 0.1 level.
* " " " 0.05 "
** " " " 0.01 "

Table 4.1. Experiment 7. Number of pecks made at the stimuli during the six 5 minute observation periods.

Stimulus.		Number of Pecks.			
		Medium Hybrids		Light Hybrids	
		Pens	Cages	Pens	Cages
N	Normal	67	92	125	183
S	Sleek	62	96	165	234
F	Fluffy	56	88	185	256
R	Red	94	89	114	91
G	Green	58	65	227	213
RC	Red contrast	63	111	122	193
GC	Green contrast	75	114	144	228

Significance of individual comparisons, U - values.

N v S	NS	NS	NS	42.0 +
N v F	NS	NS	NS	41.5 +
S v F	NS	NS	NS	NS
N v R	NS	NS	NS	32.5 *
N v G	NS	NS	29.0 **	NS
N v RC	NS	NS	NS	NS
N v GC	NS	NS	NS	NS
R v G	43.0 +	NS	17.0 ***	30.0 **
RC v GC	NS	NS	NS	NS
RC v R	NS	NS	NS	24.5 **
GC v G	NS	44.0 +	36.0 *	NS

+ Significant at the 0.1 level.
* " " " 0.05 "
** " " " 0.01 "
*** " " " 0.001 "

Figure 4 2. Experiment 8. Number of pecks directed at the seven stimuli by birds of both strains in both environments.

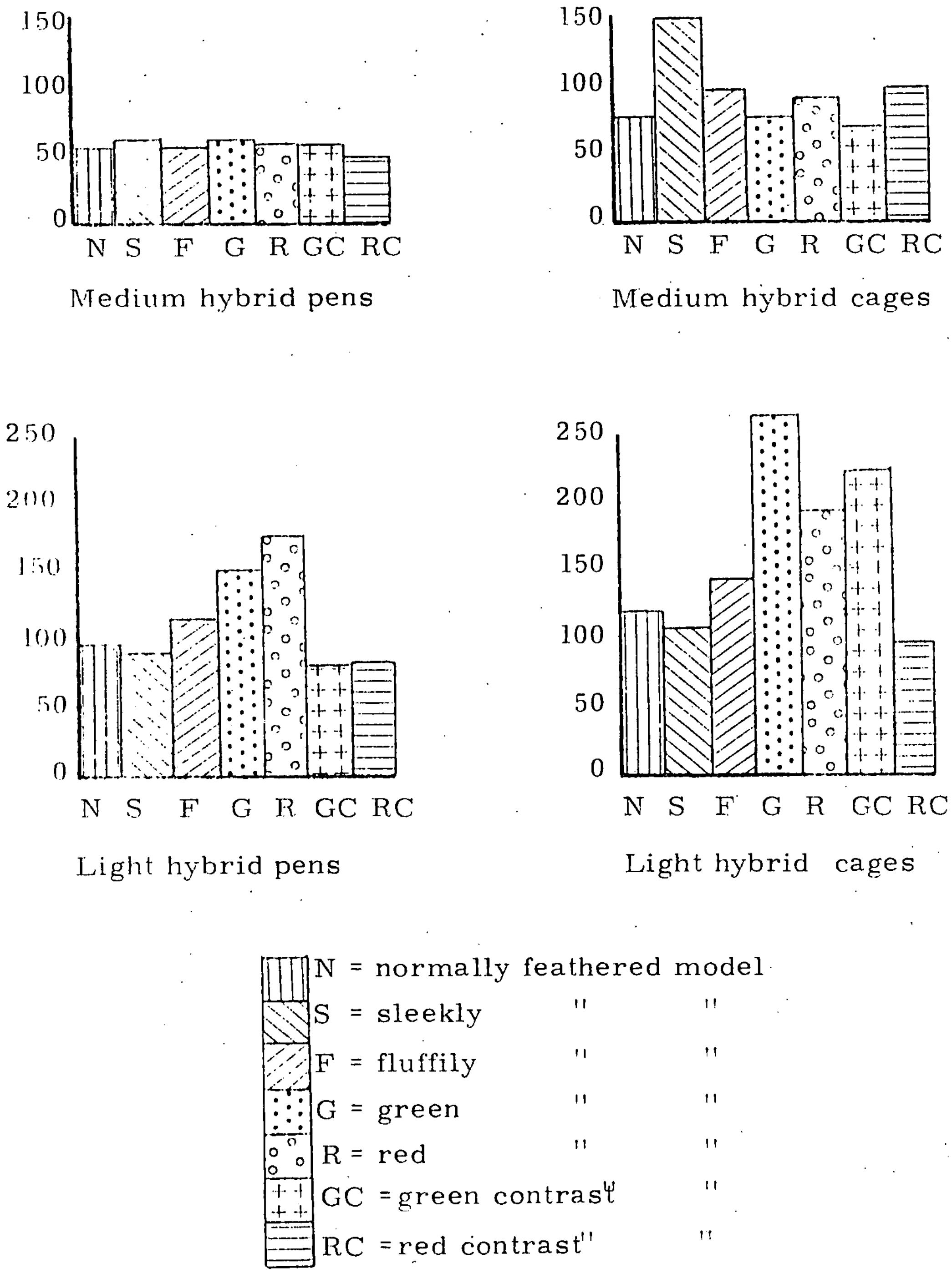
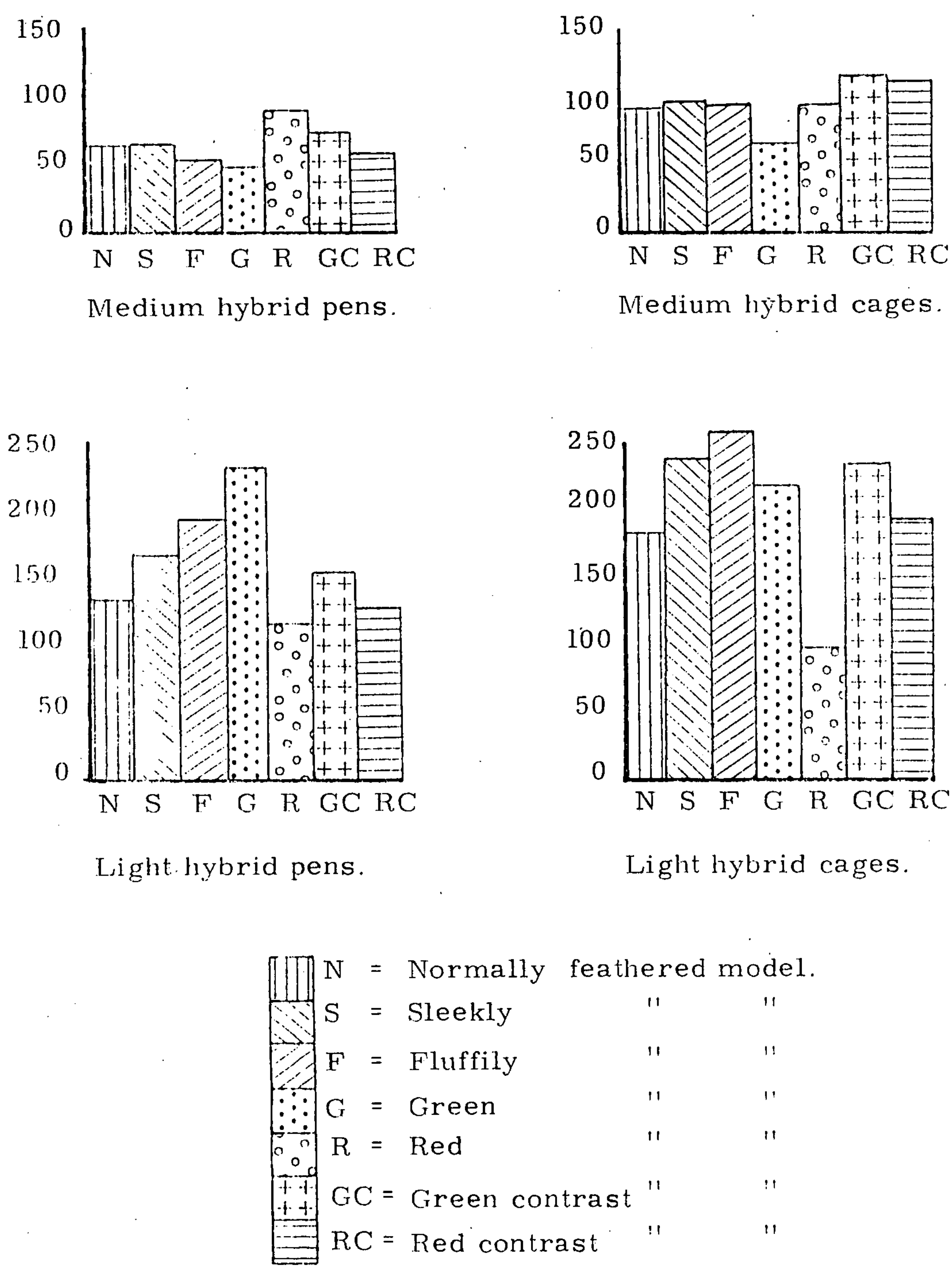


Figure 4.1. Experiment 7. Number of pecks directed at the seven stimuli by birds of both strains in both environments.



matched for intensity.

The two stimuli to test the importance of contrast in the pecking situation were again normally feathered model birds but with either a single red or a single green feather attached to the back of the model. These feathers were also dyed with inks.

Results.

Feather damage.

No feather pecking was observed at any time during the experiment in any of the groups and so it was not possible to compare the behaviour of the feather peckers, feather pecked and neutrals towards the stimuli as had originally been intended.

Stimulus Effects.

The number of pecks directed at the stimuli are shown in Table 4.1 and 4.2 and Figures 4.1 and 4.2. In general the birds in cages responded more than those in pens but the greatest difference was between the two strains, Tables 4.3 and 4.4. The medium hybrids showed a low level of response to all the stimuli and there was no difference in the number of pecks directed at any of them by any of the groups. The light hybrids showed a greater response and the number of pecks the stimuli received did vary to some extent. The discussion of these results will thus only be concerned with the behaviour of the light hybrids.

Texture. The only consistent effect was that the fluffy bird received more pecks than either the sleek or normal bird. This difference verged on significance in only one instance, the light hybrid cages in Experiment 7.

Colour. Again there are no very consistent or marked effects. The green model received more pecks in all instances compared to the normal model but this was only true in some instances with the red model. Similarly in three of the groupings more pecks were made at the green model than at the red but in the light hybrid pens the red model received more pecks than the green.

Contrast. The effect of contrast, of either colour, when compared with the normal model was not at all marked neither did it seem to be particularly effective in comparison to the all coloured models. However, it is interesting that the caged birds responded more to the contrast models than those living in pens.

General Observations.

The result of the general observations will be discussed more fully in Chapter 6 since the findings relate more to the relevance of the environment in the feather pecking situation than to the present experiment. However, it is interesting to find that the medium hybrids had a higher score for the total amount of general pecking than the light hybrids, and that birds in pens had higher totals than birds in cages, quite the opposite to the responses to the stimuli. See Tables 4.5 and 4.6. When allopecking alone is considered it can be seen that in both strains those in cages did more pecking of this type than those in pens.

Table 4.5. Experiment 7. The total number of pecks and the number of allopecks observed during six general observation periods.

Strain	Medium Hybrids			Light Hybrids		
Environment	Pens	Cages	P	Pens	Cages	P
Total amount of pecking	913	652	**	739	590	NS
Amount of allopecking	12	68	NS	25	59	NS

** Significant at the 0.002 level.

Table 4.6. Experiment 8. The total number of pecks and the number of allopecks observed during six general observation periods.

Strain	Medium Hybrid			Light Hybrid		
Environment	Pens	Cages	P	Pens	Cages	P
Total amount of pecking	821	760	NS	782	583	*
Amount of Allopecking	8	89	NS	20	21	NS

* Significant at the 0.02 level.

Discussion

The results of this experiment show primarily that neither the outline, texture, colour or contrast of the models was particularly effective in eliciting consistently different levels of pecking behaviour from the birds. None of the models possessed stimuli that singled it out as being particularly attractive to peck.

Far more relevant to the level of the response was strain. The light hybrids responded much more to all the stimuli than the medium hybrids. This was not the result that was anticipated since it was assumed, perhaps naively, that a strain normally very active in feather pecking would also be active in its response to the stimuli.

The effect of the environment on pecking behaviour will be discussed in more detail in Chapter 6, but it is interesting that birds in cages responded more to the contrast model than those in pens. Presumably in cages there were very few contrasting elements in the environment whereas in pens the shavings, bits of paper from food sacks and droppings of various colours all collected on the solid floor and so 'contrast' was a normal feature of this environment.

Although none of the stimuli tested were particularly effective in eliciting pecks it seems unlikely that the objects of feather pecking are totally unimportant as regards whether or not they receive pecks. It can only be assumed that some variable other than those tested here is involved. This will be investigated in the following two experiments.

EXPERIMENT 9.

Since the stimuli in Experiments 7 and 8 were unsuccessful in eliciting variable amounts of pecking although they contained a number of different visual attributes, it was thought that the response of the stimulus on being pecked might be a relevant factor in encouraging or discouraging pecking. It was, therefore, decided to investigate the peck-eliciting properties of stimuli from which birds could remove pieces by pecking, to compare soft with solid stimuli and finally stable stimuli with ones that 'moved' when pecked.

Method.

Subjects.

Fifty-six day-old light hybrid chicks were obtained from the Poultry Research Centre stock farm. They were housed and reared exactly as described in Chapter 2. When feather pecking began at thirty-eight days the chicks were separated into groups of peckers and pecked. By the time all the birds had been regrouped there were two groups of peckers, two groups of pecked birds, one of birds that had been pecked but were also showing pecking behaviour and one group of birds not involved in feather pecking at all.

Stimulus Observations

The tests were conducted as in Experiments 7 and 8. The stimulus was placed in the centre of the home cage and the number of pecks directed at it was recorded. In the case of the bird-shaped stimuli, the area pecked was also recorded. There were ten possible areas that a bird could be recorded as having pecked; beak, comb, eye, head, neck, back, side, tail, leg and foot. See Figure 4. 3.

Each stimulus was presented three times in random order to each of the eight groups, although the restriction was imposed that no stimulus should be presented more than once in any one day to the same group. The tests were of five minutes duration and three tests were given to each group on each day of the experiment. There were never less than two hours between tests in any one group.

Stimuli.

Six stimuli were used in the experiment, two rectangular blocks, 7. 5 cms. x 10 cms. x 3 cms. One was made of pine and the other of balsa wood, see Figure 4. 4. Both blocks had six coloured spots placed at random on the upper surface, the dots were of blue, red and yellow poster paint, two of each colour. These spots were used as a control for the coloured areas on the bird-shaped stimuli. All four of the remaining stimuli were in the shape of a bird and were approximately the same dimensions as described in Chapter 2, see Figure 4. 4. Two of the models were wooden, one balsa and the other plywood. These were almost identical although the balsa bird was a slightly lighter colour and was soft enough for the chicks to remove pieces from it. It was not possible to remove pieces from any part of the plywood stimulus. The third model bird was made of cream cloth and stuffed with cotton wool. This gave a smooth though bird-coloured outline and was soft to peck at; it was also possible for the chicks to take hold of the corners of the cloth, for example at the tail and edge of the back. The fourth model was also made of cloth and stuffed but it was then covered with the feathers from an adult light hybrid. This model had all the properties of the previous one and in addition there were many more surfaces that could be pecked. The third and fourth models had balsa wood beaks which were replaced as soon as they became badly

Figure 4.3. Experiment 9. Diagram of a bird showing the ten separate areas used for recording pecks directed at the stimuli.

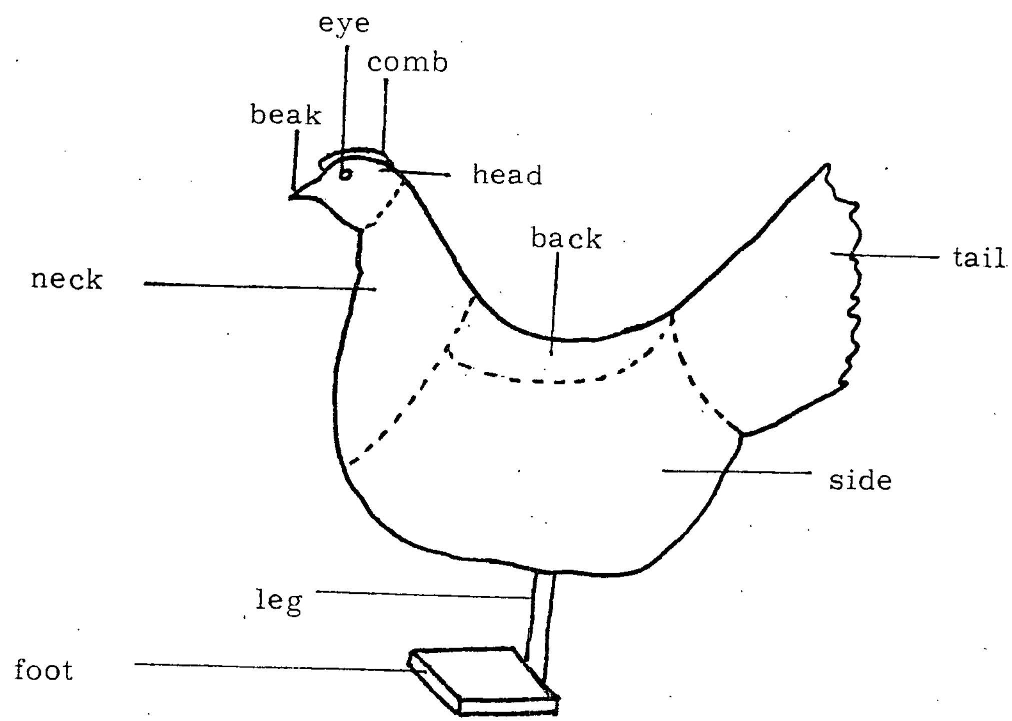


Figure 4.4. Stimuli used in Experiment 9 and 10.

Key

1. Pine block.
2. Balsa block.
3. Balsa bird.
4. Plywood bird.
5. Cloth bird.
6. Feathered bird.

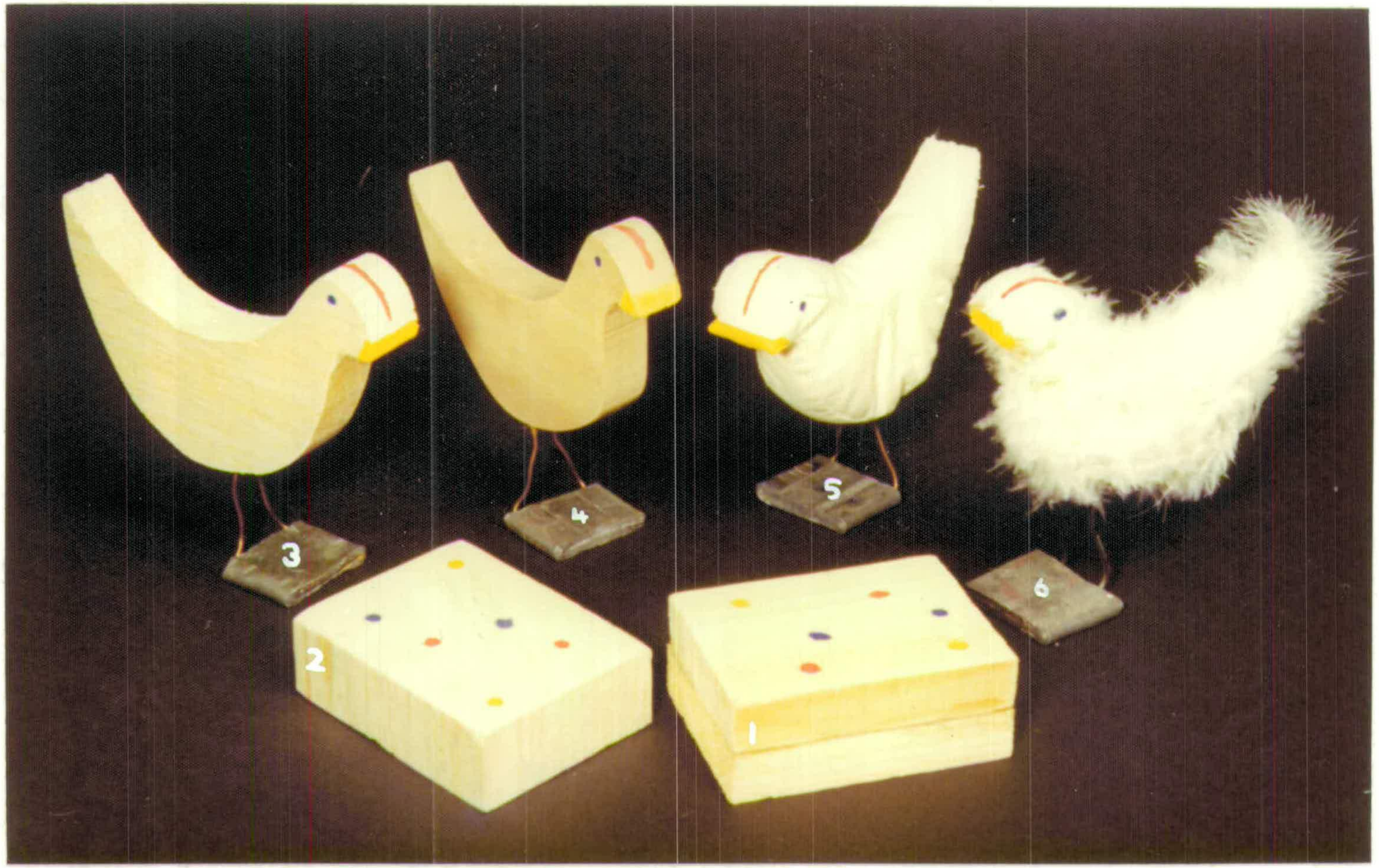


Table 4.8. Experiment 9. A comparison of the response to the six different stimuli. All groups combined.

	Pine Block	Balsa Block	Ply Bird	Balsa Bird	Cloth Bird	Feather Bird
Pine Block						
Balsa Block	← 0.004					
Ply Bird	NS	↑ 0.01				
Balsa Bird	NS	↑ 0.02	NS			
Cloth Bird	NS	↑ 0.002	NS	NS		
Feather Bird	NS	↑ 0.001	NS	↑ 0.04	NS	

← or ↑ indicates stimulus receiving most pecks.

Significance levels calculated by the Mann-Whitney 'U' test.

Table 4.7. Experiment 9. Total number of pecks directed at the stimuli over the four tests. Group Means.

STIMULI	GROUPS Neutral	Pecked/ Peckers	Pecked 1	Pecked 2	Peckers 1	Peckers 2	Total
Pine Block	14.0	22.4	14.5	10.0	13.7	12.6	87.2
Balsa Block	32.6	42.4	27.2	21.7	20.2	23.5	167.6
Ply Bird	0.5	28.2	10.1	13.4	6.9	14.2	73.3
Balsa Bird	8.3	41.2	17.7	19.3	15.6	14.0	116.1
Cloth Bird	0.75	20.7	12.0	13.8	13.7	13.5	74.45
Feathered Bird	0.0	11.7	13.5	15.6	11.4	8.6	60.8
TOTALS	56.15	166.6	95.0	93.8	81.5	86.4	579.45

damaged as were the stimuli made completely of balsa wood, the block and the bird. The two blocks did not move when pecked, whereas the bird models rocked backwards and forwards and were generally less firmly positioned. Thus the blocks also had the attribute of 'stability' when being pecked.

Group numbers.

Observations were begun before all the birds had shown whether or not they were going to be involved in feather pecking and thus before they had all been regrouped. This meant that the number in each group varied from time to time, the minimum number of birds involved in the tests was forty-six on day one of the observations, and the maximum number of fifty-one by the last day of the observations. The reason for beginning the tests before all the birds had been regrouped was that feather pecking at this early stage is very unpredictable and it seemed important to test the birds while feather pecking was rampant rather than waiting until the groups had stabilised, by which time the feather pecking activity of the birds might have been reduced and any differences between the groups lost.

Results.

Stimulus Effects.

Analysis of the pecking scores showed that there were distinct differences in the number of pecks that were aimed at the various stimuli. In Tables 4.7 and 4.8 it can be seen that the model receiving most pecks was the balsa block followed by the balsa bird, these two stimuli together receiving almost as many pecks as the others combined. Of these four stimuli the pine block was pecked at most followed by the cloth bird and the pine bird and with the feathered bird as the least preferred of the stimuli. The results are expressed as means to allow for the change in numbers in some of the groups.

Body areas.

When the number of pecks aimed at each part of the model birds by all the groups was analysed it was seen that there was

Table 4.10. Experiment 9. A comparison of the total amount of pecking directed at the models by the six groups.

GROUPS

	Neutral	Pecked/ Peckers	Pecked 1	Pecked 2	Peckers 1	Peckers 2
Neutral						
Pecked/ Peckers	← 0.02					
Pecked 1	NS	↑ 0.05				
Pecked 2	NS	↑ 0.03	NS			
Peckers 1	NS	↑ 0.01	NS	NS		
Peckers 2	NS	↑ 0.05	NS	NS	NS	

↑ indicates group doing most pecking.

Significance levels calculated by the Mann-Whitney 'U' test.

Table 4.9. Experiment 9. The areas of the bird models ranked according to the number of pecks received, (rank inversly related to number of pecks).

Area	Ply bird	Balsa bird	Cloth bird	Feather bird	Overall rank
Beak	1	3	1	1	1
Comb	8	10	8	3	7.5
Eye	5	5	2	6	4
Head	10	9	10	8	10
Neck	6	8	9	7	9
Back	7	4	6	10	6
Side	3	1	5	4	3
Tail	2	2	3	2	2
Leg	9	7	4	9	7.5
Foot	4	6	7	5	5

approximately the same proportion of pecks to each area regardless of the various different qualities of the stimuli. Thus the beak of any of the model birds received proportionately more pecks than the foot of any of the models. Analysis by Kendalls coefficient of Concordance (W) shows that the pecks received by the different areas across stimuli were positively correlated ($W = 0.7$ significant < 0.01). See Table 4.9.

The size of the areas differed considerably but this did not appear to be an important variable. If anything size was inversely related to the number of pecks an area received. Therefore no correction for size was made before comparing the pecking scores for the different areas.

Stability.

In the two instances where there were blocks and birds made of the same material the blocks were pecked at more than the birds. This suggests that the stability of a stimulus is of some importance in controlling the number of pecks it receives. However, it is not the major factor since bird shapes of balsa wood, from which pieces could be removed, were pecked at more than blocks made of pine, from which pieces could not be removed.

Group effects.

Finally, the behaviour of the different groups towards the models. From Table 4.7 it can be seen the birds that had shown no involvement in feather pecking at all, neutrals, had the lowest score, whereas the pecked birds that had begun to feather peck had the highest score. The difference between the groups was significant ($W = 0.66$; $p < 0.01$). The two pecked and the two pecker groups had very similar scores although in both instances those of the pecker groups were slightly lower. A statistical comparison of the groups is shown in Table 4.10.

Discussion.

The main variable being tested with the six models was "removability", in other words, whether or not it was possible for the chicks to remove pieces from the stimulus object. The balsa models were the main stimuli with this attribute although the feathered bird had feathers and parts of feathers that could be removed. Removal of pieces from the feathered bird however, required the chicks to pull much more strongly than they had to at the balsa models for a similar result. Shape and texture were also involved to a certain extent. From the results it would seem that removability is the main factor influencing whether or not a stimulus is pecked by a group of birds. The shape of the stimulus may not be particularly important since a rectangular block was pecked more frequently than a bird-shaped object. It would appear that being able to remove particles from the stimulus is rewarding and results in further pecking whereas pecking at visually prominent or contrasting areas is not of primary importance.

The amount of pecking at the plywood, cloth and feathered bird stimuli seemed to differ little. It is interesting that the most bird-like of the stimuli, at least to the human observer, the feathered bird, was the least pecked even though it had many parts that appeared to be very likely to attract pecks, for example long tail feathers and loosely attached feathers which would have been possible to pick up and pull off had the birds pecked with their normal vigour. Similarly the cloth bird had areas that could be taken hold of and pulled and shaken much more than could the wooden bird.

It is conceivable that the chicks responded to the feathered model as if to a live but unfamiliar chicken On subjective impressions this was not the case, strange birds were either ignored or responded to inquisitively, the stimulus was avoided on occasions but it was not ignored. An alternative explanation for the lack of pecks directed at the feathered stimulus could be that it was so similar to the live chicks that it did not arouse very much exploratory pecking and yet at the same time it did not have the properties that incite feather pecking. The results of the experiment do not indicate which of these explanations is the more likely but they do make clear that feathers attached to a bird-like form are not enough in themselves to attract very much of any sort of pecking.

The stability of a stimulus was an important influence on the pecking behaviour of the birds. Blocks were pecked at much more continuously and intensively and often in the same place by one individual over the whole of the test period. When chicks pecked the bird models they did not peck so intensively and changed the areas at which they pecked. On occasions the bird stimuli were knocked over and were then pecked at more continuously and in a similar way to the blocks, very vigorously, often with birds standing on top of the stimulus.

The finding that the different areas of the bird stimuli were not pecked at with equal frequency and that the response to the different areas between all the bird models was approximately the same is very interesting. For example in the case of all the stimuli except the balsa bird the most pecked areas was the beak, similarly one of the least pecked areas for all groups was the head. In the latter case the areas was made of different materials in all four of the different models so that the low rate of pecking could not be due simply to the avoidance of one particular material. Conversely three of the four beaks were made of balsa wood, the exception was the plywood bird, and yet all but the balsa bird stimulus had the majority of the pecking directed to this area. Thus it would seem that in the case of individual areas being pecked the material used in the construction of that areas was not necessarily of any great importance.

The different areas of the models varied from each other in a number of ways, for example, the shape, height, availability and conspicuousness. The beak and the tail were the most frequently pecked areas, these were similar in basic shape, could be reached by a number of birds at the same time, were in equivalent positions and at equivalent heights and were two of the most prominent portions of the stimulus. Of the two areas, the beak was pecked slightly more than the tail, perhaps because the beak was painted yellow and was thus even more conspicuous, whereas the tail was the same colour as the rest of the model. The two least pecked areas were the head and neck; in height, availability, conspicuousness these areas would appear to be similar to others such as the back and side and yet they were responded to less. The most obvious conclusion would seem to be that, as in normal feather pecking, these areas are simply not targets for the pecks, possibly because they are usually associated with aggressive pecking.

If the features of the remaining six areas of the stimuli are analysed, it can be seen that in several instances there are similarities between the areas that received similar amounts of pecking. Arranging the areas in pairs by considering the rank of the number of the pecks directed at that area on all the models, see Table 4.9, comparisons can be made. The beak and the tail, rank 1 and 2, have already been mentioned, leaving aside the eye and side ranks, 3 and 4 for the moment, it can be seen that the foot and back have ranks of 5 and 6. These two areas are quite different in height but they both had flat and reasonably stable surfaces and both were accessible to a number of birds at a time. The foot was made of lead in all the models whereas the material the back was made of differed in all four models so that it would not appear that the type of material was vital to the amount of pecking received. The legs and the comb had a tied rank of 7.5 and yet they would appear to be rather dissimilar. They were different in height, in material, in colour and in structure, however, they were similar in shape both being, in effect, a long thin line. It is interesting that the eye was painted onto the model in a very similar position as the comb and yet was pecked a great deal more; on the other hand it was a very different shape. Goodwin and Hess (1969) found that chicks showed a pecking preference for small round objects rather than elongated shapes such as rectangles or diamonds. It would seem that the present results are in agreement with his findings and that the shape of an area is also a factor that must be taken into account when considering the amount of pecking directed towards it.

The only two areas that did not appear to have some feature in common were the side and the eye, rank 3 and 4 respectively. These were dissimilar in shape, size, colour, availability and stability and so it is uncertain why they should receive a similar amount of pecking. However, it is obvious that there is not a single property of the stimulus that affects pecking and so presumably the side and the eye simply reach the same level but on different continua.

To summarize, it appears that the shape, prominence and accessibility of an area are all important factors in eliciting pecks.

Finally the behaviour of the different groups of birds must be considered. No dichotomy was found in this experiment between the peckers and the pecked birds in their reaction to the stimuli and both these types of birds showed a moderate response. The pecked birds that were later reclassified because of their pecking behaviour however, showed a very high response to the stimuli. One explanation would be that feather pecking often occurs in phases that last for approximately two weeks and birds that had only recently begun to feather peck would be in the middle of a phase and thus very responsive to all stimuli. Conversely the birds that had been classified earlier in the experiment would have passed this very high responding stage. Although this is only speculation it does fit with the observed behaviour patterns.

The question still remains to be answered whether or not the pecking directed towards the stimuli is in any way related to feather pecking. The fact that the areas on the models most avoided are those areas not frequently involved in feather pecking at this age coupled with the greater activity of the pecked/pecker group would suggest that there was some link between feather pecking and stimulus pecking. However, the lack of interest in the feathered model remains anomalous.

Summary

The main finding of this experiment was that the stimuli made of balsa wood were pecked at more frequently than the other stimuli. This suggests that being able to remove particles from the stimulus was more rewarding than pecking at a non-destructible surface. It was also evident that certain areas of the stimuli were pecked more than others, and in this case the prominence of the area, its shape and its availability were thought to be of prime importance in deciding how much pecking was directed at each area. The different groups also responded at different levels to the stimuli.

EXPERIMENT 10.

The results of Experiment 9 showed fairly conclusively that an easily destructible stimulus was responded to at a higher rate than a non-destructible stimulus regardless of other qualities such as texture or resemblance to a real chick. There is little information in the literature on the fowl or any other species which suggests that the removal of pieces from a non-food stimulus has rienforcing properties. Hoffmeyer (1969) did report that pheasant chicks reared in isolation will peck at and tear pieces of newspaper but this type of behaviour has not been reported for group reared animals. It therefore seemed important to try and repeat the findings of Experiment 9 and especially since in earlier experiments in this study (Chapter 3), responses to stimuli were found to change with different batches of birds.

Method

Subjects

Fifty day old light hybrid chicks were obtained from the Poultry Research Centre's stock farm and housed and reared as described in Chapter 2.

The chicks were divided into four groups, A, B, C and D. A and D each contained thirteen birds and B and C twelve birds. Two chicks from group D died before the experiment began thus reducing the total to forty-eight. No birds were added to group D from group A since it was thought that the birds would be regrouped

Table 4.11. Experiment 10. Number of pecks by each group directed at the stimuli over the four tests. Group means.

STIMULI	GROUPS A	B	C	D	TOTAL
Pine block	13.08	26.42	24.25	25.36	89.11
Balsa block	16.08	36.92	32.0	35.55	120.55
Ply bird	11.37	8.92	18.25	16.91	55.45
Balsa bird	15.46	25.67	22.83	24.64	88.6
Cloth bird	12.46	11.92	15.17	17.56	57.11
Feathered bird	3.77	8.58	15.75	18.18	46.28
TOTALS	72.22	118.43	128.25	138.2	457.1

when feather pecking occurred. In fact there was no feather pecking and so the numbers of birds in each group remained uneven.

Stimulus observations.

These were carried out as in the previous experiment but with one or two modifications. As mentioned, there was no feather pecking and so the tests were carried out on the group as they were originally formed on the day of the chicks arrival.

In this trial each stimulus was presented four times and not six as previously. All other details regarding the method of presenting the stimuli were as for Experiment 9.

Stimuli.

The stimulus objects were the same as those used in Experiment 9, except that the models were fixed to the floor of the cage so that they could not be knocked over onto their sides and so become block-like, and the blocks were fixed so that they could not be turned upside down and the spots hidden. The fastening was not firm enough to prevent slight movement and the bird models could still be rocked if pecked sharply.

A modification was also made in the details recorded in the tests using blocks. A note was made of whether a peck was directed to one of the spots painted on to the block or onto the background.

Results.

Stimulus Effects.

The results confirmed the findings of Experiment 9. the balsa stimuli were generally preferred and more frequently pecked than the other stimuli. In this experiment, however the birds also pecked alot at the wooden block. Table 4.11. shows the mean number of pecks delivered by the groups at the stimuli. It can be seen that the model receiving most pecks was the balsa block with the balsa bird and the pine block coming equal second. The number of pecks made at the three remaining stimuli was about half as many as those made to the first three. The cloth bird received more pecks than the wooden bird and the feathered bird had the lowest score of all. Table 4.12 shows a comparison of the responses to all the stimuli, the levels of significance were computed using the Mann Witney U Test.

Table 4.12. Experiment 10. A comparison of the response to the six different stimuli, all groups combined.

	Pine Block	Balsa Block	Ply Bird	Balsa Bird	Cloth Bird	Feather Bird
Pine Block						
Balsa Block	← 0.1					
Ply Bird	↑ 0.05	↑ 0.05				
Balsa Bird	NS	↑ 0.1	← 0.05			
Cloth Bird	↑ 0.05	↑ 0.02	NS	↑ 0.02		
Feather Bird	↑ 0.05	↑ 0.02	NS	↑ 0.05	NS	

↑ indicatesthe stimulus receiving most pecks.
(Significance levels calculated by the Mann Whitney 'U' Test)

Table 4.14. Experiment 10. Mean ranks of the amount of pecking aimed at different areas of the models in Experiments 9 and 10.

Area	Experiment 9	Experiment 10
Beak	1	5
Comb	7.5	9.5
Eye	4	3.5
Head	10	8
Neck	9	9.5
Back	6	9.5
Side	3	3.5
Tail	2	1
Leg	7.5	7
Foot	5	2

Table 4.13. Experiment 10. The areas of the bird models ranked according to the number of pecks received. (Rank inversly related to the number of pecks).

Area	Ply wood bird	Balsa wood bird	Cloth bird	Feather bird	Overall rank
Beak	5	5	4	3	5
Comb	9.5	10	9	9.5	9.5
Eye	4	6	3	2	3.5
Head	8	7	8	7	8
Neck	9.5	9	10	9.5	9.5
Back	7	3	6	6	6
Side	3	2	5	5	3.5
Tail	2	1	1	1	1
Leg	6	8	7	8	7
Foot	1	4	2	4	2

Body Areas

When a comparison was made of the number of pecks directed at different areas of the stimuli it was found that certain areas did receive more pecks than others and this was similar for all models regardless of which material they were made. See Table 4.13. Analysis by Kendall's Co-efficient of Concordance (W) shows that the pecks received by the same areas on different stimuli were positively correlated, ($W = 0.7$; $p < 0.01$). These results again match those of Experiment 9 and as can be seen in Table 4.14 the rank of the amount of pecking directed at each area was very similar for the two experiments, Spearman rank correlation co-efficient = 0.79; $p < 0.01$.

Block spot v background.

An interesting result was obtained when the scores of the pecks directed at the two blocks were analysed, Table 4.15. It was found that the number of pecks directed at the spots painted on to the blocks differed depending on the type of wood the block was made of. The pine block was pecked more frequently on a spot than on the background, the balsa block on the other hand was pecked more frequently on the background than on the spots. ('U' = 19; $p < 0.1$).

Table 4.15. Experiment 10. Amount of pecking directed at the block stimuli.

Groups n		A 13	B 12	C 12	D 11	Totals
Pine Block	Spot Background	90 80	112 205	121 222	169 110	492 385
Balsa Block.	Spot Background	76 133	110 333	169 215	220 171	532 862

Group Effects.

The behaviour of three of the groups, B, C and D, towards the stimuli was very similar whereas the birds in group A pecked considerably less than the others. Table 4.16. There was no obvious explanation for this finding.

Table 4.16. Experiment 10. A comparison of the total amount of pecking directed at the models by the four groups.

Groups

	A	B	C	D
A				
B	NS			
C	← 0.002	NS		
D	← 0.001	NS	NS	

↑ indicates the group showing greater pecking behaviour.

(Levels of significance calculated by the Mann-Whitney 'U' Test)

Disscussion

The results of this experiment substantiate the findings of Experiment 9, that an object from which pieces can be removed by pecking is more frequently pecked at than one that does not have this property. Further, the shape of the object is of no great relevance in deciding whether or not it shall be pecked and any attempt to make the object more life-like either in the appearance or texture of its surface does not increase the amount of pecking directed at it, but it may quite possible have the reverse effect.

One result that was slightly different between the two experiments was the amount of pecking directed at the pine block. This stimulus was pecked at quite highly in both experiments but in the present experiment its score was equal to that of the destructible balsa bird. The only likely explanation is that in this experiment the stimuli were fastened to the floor of the cage and so the bird shapes could not be knocked over and pecked at like a block but remained upright. They were also not especially stable, making the removal of pieces much more difficult, and perhaps making the stimulus less attractive. The effect of fastening the block down, however was to make it a more attractive stimulus since it would never be turned over and thus the spots on the upper surface would always be visible. This was not always the case in Experiment 9, and it also meant that the block was even more stable than before. In general the results of these experiments support Hoffmeyer's (1969) theory that the rewarding factor in feather pecking is not simply the pecking act but also ingesting and swallowing the pieces of feather or skin. However, it would seem that there is a limit to the effort a chick will expend to remove pieces of the stimulus and beyond that they find that pecking a stable but indestructible object preferable.

The alteration in the recording system showed that the attention paid to the spots on the block stimulus varied according to the material of which the block was made. It seemed that pecking at the pine block was very largely directed by the position of the spots and many more pecks were made at spots than at the background. On the other hand the spots on the balsa block were pecked at less than the background. Here again an explanation can only be suggested rather than proved, but it has been shown by many workers e.g. Goodwin and Hess 1969, Hoffmeyer 1969; that chicks will peck at contrasting spots in the environment without any food reward being involved and it would seem that the pecking at the pine block is probably of this type and thus it is to be expected that the majority of pecks were directed at spots rather than the background. On the other hand the balsa block had the property of removability and once this was discovered it appeared that the main reinforcement for the pecking at the block was to remove pieces from it. Thus the spots on the balsa block were superfluous since wood was removable from the block at any point and if anything, the painted areas would prevent the removal of wood, not facilitate it.

Finally the difference in behaviour towards the stimuli by the four groups should be considered. Observations throughout the experiment suggested that the birds in group A were either afraid of or uninterested in the stimuli. On eight different occasions the observer commented after a test that the birds in this group appeared to be wary or afraid of the stimulus. This only occurred eight times for the other three groups together. As a result of this wariness the birds in group A approached and pecked the stimulus far less. The response of group A was also frequently lower than the other groups even when there were no overt signs of fear or avoidance. This could be explained on the grounds of social facilitation, or as in this case "social restraint"; thus if one or more birds were alarmed by the stimulus and conveyed this to the remainder of the group it is possible that investigation of the stimulus would be severely restricted. Conversely it must be accepted that the behaviour of groups that did peck the stimulus might also be influenced by the activities of only one or two members. If social facilitation or restraint is not to be invoked as an explanation then it must be assumed that all the birds of group A were either uninterested or afraid of the stimulus and were all behaving independently. Although this could have been the case there is no evidence to support it.

General Discussion

The problem now is what relevance any of these results have in relation to whether or not birds become feather pecked or feather peckers. Extrapolating from the findings of Experiments 9 and 10 it would seem that birds that are feather pecked should be easily destructible; their feathers should be easier to remove or they should be easier to injure and they should make little or no response when they are pecked. It is in fact true that many birds stand perfectly still when they are feather pecked and accept the damaging attentions of their cagemates. It would thus be quite conceivable that birds in a group would learn which of their number did not respond when pecked, in other words behave like a block stimulus, and these birds would then be sought out as targets for the majority of pecks administered in that group. Anecdotal evidence from a slightly different source supports this view. When an outbreak of toe pecking occurred in a batch of otherwise healthy birds it was noticed that only some birds were affected, these birds were removed to separate cages so that the wounds could heal but when they were returned to their original groups they were all without exception repecked on the toes within hours and in many cases within minutes of being placed back in their cages. This happened on several occasions with different batches of chicks and often a group that was no longer engaged in toe pecking would begin again when a once-damaged cagemate was returned even if all evidence of its previous wounds had disappeared.

Similar, though less dramatic situations, occurred with birds involved in feather pecking and Neal (1956) also experienced this situation with adult hens involved in feather pecking.

This type of occurrence would suggest that birds learn not only visual but also other properties of their cagemates such as whether they are rewarding to peck at or whether certain areas of a particular bird are weaker than normal and so are easier to damage. The findings of Experiments 7 and 8 also suggest that the strain of the bird might influence whether or not the stimuli offered by cagemates were responded to and this in turn would influence the development of feather pecking.

The possibility of social facilitation mentioned in the discussion of Experiment 10 must not be overlooked. In this instance if the behaviour of group A in Experiment 10 is attributable to social facilitation, or restraint, it is quite possible that the behaviour of the neutrals in Experiment 9 is also due to the same cause. It could be supposed that under different conditions group A would not have been involved in feather pecking whereas the birds in the other groups would, but since no feather pecking occurred in any of the groups this suggestion cannot be tested. Fortunately in Experiment 9 there were five other groups whose behaviour can be considered and these groups behaved in an expected way suggesting that the lack of response from the neutrals was not a spurious result.

It is possible that social facilitation plays an important part in pecking behaviour and although it might not influence the continuation of the activity, individuals deciding for themselves whether or not to feather peck or feed, etcetra, it is very probable that the initial pecks made by all birds are encouraged by other members of the group. The ideal test for this would have been to place non-pecking birds among peckers and record whether or not pecking behaviour developed among the non-peckers. However, the appearance and disappearance of feather pecking was so unstable, it was impossible to be sure that if a non-pecker did begin pecking it was due to the influence of its cage-mates and not a natural occurrence that would have developed in any case. Further, by the time a bird had been selected with some degree of certainty as a non-pecker the pecking activity of all groups was usually on the wane and so the influence of these birds would have been of little significance. In short the unreliable nature of the feather pecking situation made the feasibility of this type of study very unrealistic.

If these suppositions about the behaviour of peckers and non-peckers are correct it should be possible to detect differences in the behaviour of birds before any serious feather or tissue damage occurs.

If on the other hand feather pecking is simply a matter of chance then it should not be possible to detect any difference in the behaviour before an outbreak occurs. The next set of experiments was therefore designed to see if it was possible to distinguish between birds on the grounds of their pecking behaviour, or on their response to being pecked before a serious outbreak of feather pecking occurred.

CHAPTER 5.

BEHAVIOUR FOLLOWING FEATHER PECKING INCIDENTS.

The results of the experiments described in Chapters 3 and 4 showed that not all birds indulged in feather pecking to an equal extent and that there are some types of stimulus objects that receive more pecks than others, those which have removable pieces and which remain fairly stable when pecked. Extrapolating from these findings it seemed possible that the reason why some birds were pecked more frequently than others was because they were more easily "destructible" and perhaps less responsive when pecked than other birds and thus provided a rewarding and stable target for the peckers.

It seemed important, therefore, to observe the reactions of birds following feather pecking encounters and to see if pecker and pecked birds could be distinguished in this behaviour.

Four experiments were designed to investigate this question. In Experiments 11, 12 and 13 the groups remained intact, whereas in Experiment 14 they were divided into separate groups of peckers, pecked and neutral. In Experiment 11 two different age groups of birds were used; in Experiment 12 activities following different types of allopecking were recorded; and in Experiment 13 extra stimuli were placed in the home cage. It was hoped that the manipulation of these variables would permit influences other than just the predisposition to peck or to be pecked on the pecking behaviour of these birds to be elucidated.

The method and results of the four experiments will be presented first followed by a general discussion of all the findings.

EXPERIMENT 11.

The aims of this experiment were several, firstly to see whether feather pecking was as prevalent in all birds, secondly, whether the activities following a pecking incident were different for pecked and pecking birds.

Since the role of aggression in feather pecking has not yet been established and since it was thought that redirected aggression might be involved it was decided to use two age groups of birds (a) young birds among which aggressive behaviour would be at a minimum since they were only fourteen days old at the beginning of the experiment and (b) older birds which were ten weeks at the beginning of the experiment and were therefore old enough for elements of aggression to be evident in their behaviour.

Method

Subjects

All the birds used in this experiment were female light hybrids. Five groups, numbered 1 to 5, of thirteen to fifteen birds were housed in cages as described in Chapter 2, these birds were fourteen days old at the beginning of the experiment. A further three groups, numbered 6 to 8, of twenty-five to thirty birds were housed in large pens, and were ten weeks old at the beginning of the experiment. The pens were 3m x 3. 6m; two thirds of the floor area was concrete covered with wood shavings, the remaining one third was made of wire mesh. The walls were of unpainted wood and there was a single entrance through a door with a window fitted with a one way screen. A 14-hour day was maintained and an ambient temperature of 70^{o}F.

Observations

The observations were conducted once a week for seven weeks, each group was watched for 15 minutes or until there had been ten pecking encounters, a total of seven hundred pecking incidents were recorded. Since the aim of the experiment was to determine the behaviour of the birds once they had been pecked or done some pecking, the information recorded fell into four categories. The identity of the bird that gave thè initial peck, called the Prime Agent, the identity of the bird which received the initial peck, call the Prime Recipient, and then the next act of both the birds.

$$\begin{array}{ccc} P.A. & \longrightarrow & P.R. \\ \downarrow & & \downarrow \\ A.A. & & R.A. \end{array}$$

Thus the first two pieces of information were always bird identifications, whereas the third and fourth pieces of information could refer either to another bird if the prime agent or prime recipients next act had been to peck at a cagemate, or it could be any one of the repertoire of pecks, for example environment, food, preening etcetera. If no response had been made within a period of two minutes this was recorded and then observations begun on a further bout of allopecking. All records were made on magnetic tape and later transcribed to a permanent form.

Illness.

At five weeks of age a bout of infectious bronchitis occurred and all groups were affected to a greater or lesser extent. Observations were suspended for the period of the illness and were resumed once the birds had recovered three weeks later. There were eleven deaths among the young birds due to bronchitis, this reduced the numbers to eleven in group 1, and twelve in the remaining four groups. There were twelve deaths among the older birds, eight in group 8 which reduced the number to twelve, and two in groups 6 and 7 which left eighteen and twenty respectively.

Results

Behaviour of individual birds.

A χ^2 test was carried out to determine whether the amount of times each bird acted as an agent or recipient was randomly distributed. In all groups this was found not to be the case. Rather,

Table 5.3. Experiment 11. Agent and Recipient activities following pecking incidents in the young and old birds separately. Values as in Table 5 2.

Age	Birds	Floor	Cage	Drinker	Food	Preen	Avoid	No Response	Other bird	Totals
Young	A	58	17	21	44	117	2	119	125	
	R	34	15	31	58	85	4	182	98	
	Total	92	32	52	102	202	6	301	223	1010
Old	A	47	0	2	7	13	3	62	58	
	R	25	0	5	8	16	60	54	31	
	Total	72	0	7	15	29	63	116	89	
	χ^2 1)	0.1	0.09	0.0	0.35	1.75	1.84	6.5	2.61	
	p	NS	NS	NS	NS	NS	NS	**	NS	

1) This χ^2 tests the heterogeneity between ages in the distribution of activities between A and R birds.

** Significant at the 0.01 level.

Table 5.2. Experiment 11. Agent and recipient activities following pecking incidents. The figures represent the totals of all groups over 7 x 15 minute observations.

Activities / Birds	Floor	Cage	Drinker	Food	Preen	Avoid	No response	Other bird	Totals
Agents	105	17	23	51	130	5	181	183	695
Recipients	59	15	30	61	101	64	236	129	695
χ^2	12.9	0.13	2.8	1.9	3.64	50.4	7.25	9.3	
P	***	NS	NS	NS	+	***	**	**	

+ Significant at the $p < 0.1$ level.

** " " " $p < 0.01$ "

*** " " " $p < 0.001$ "

Table 5.1. Experiment 11. The frequency of giving (A) and receiving (R) pecks for individual chicks housed in groups. Data based on 7 x 15 minute observation periods per group.

Group	n	No. of birds for which A > R		No. of birds for which R > A		No. of birds for which A = R
		Total	No.of sig. results	Total	No. of sig. results	Total
1	16	6	2	9	3	1
2	14	6	1	7	2	1
3	16	6	1	8	1	2
4	15	9	2	5	2	1
5	15	5	1	8	0	2
6	19	6	2	7	1	6
7	24	12	0	10	1	2
8	19	6	3	9	3	4
Totals	119	56	12	63	13	19

Effects Tested.

No. of significant results: Observed = 25; Expected (p = 0.05) = 5.95 χ^2 = 61.00 ***

Frequency of types: A > R = 56; R > A = 63. χ^2 = 0.41 NS.

Frequency of significant results for different types. A > R = 12; R > A = 13; χ^2 = 0.04 NS.

*** Significant at the 0.001 level.

a proportion of the birds were found to be either predominantly agents or predominantly recipients. See Table 5.1.

Behaviour following a pecking incident.

Table 5.2. shows the behaviour after each pecking incident. A considerable variation in behaviour between agent and recipient was found. Agents were observed to do more floor pecking and more allopecking immediately following a pecking incident, whereas recipients were found to make either no response or make a gesture of avoidance much more frequently than agents. The amount of pecking directed at food, cage and drinker did not differ between the agents and the recipients and neither did the amount of preening.

Effect of age.

When the patterns of behaviour of the old and young birds were considered separately the results shown in Table 5.3. were obtained. The χ^2 value comparing the overall patterns of the two age groups was highly significant ($\chi^2 = 123.3$; $p < 0.001$). When allowance was made for the different numbers of events recorded the young birds were found to peck more at the cage, drinker and food and to do more preening whilst the older birds did more floor pecking and avoiding. Allopecking and the absence of response accounted for similar proportions of the total in both age groups.

However only in the case of one type of behaviour, no response, was the distribution of activities between agents and recipients differ in the two age groups. In the young birds recipients behaved in this way more frequently than agents, whilst the occurrence in the older birds was virtually the same for both types. On the other hand although the heterogeneity χ^2 was not significant avoidance behaviour following a peck was virtually restricted to the older birds.

Correlation between agent and recipient behaviour.

In the most extreme cases in each group the number of times a bird was found to be an agent appeared to be negatively correlated with the number of times it was a recipient. For example, in group 1 black was a prime agent seventeen times and a prime recipient only three times, and in group 4 R2 was a prime agent twenty-one times and a prime recipient only four times. However, to analyse such data allowance must be made for the fact that a bird does not peck itself. To do this the recipient'score of the bird which had the highest agent score in each group was compared by χ^2 with an expected value. The expected value was calculated from the sum of all pecks except those given by the one bird being evaluated. Thus in group 1 the number of pecks minus those made by black were used to calculate the expected frequency of being a recipient.

Table 5.4. shows the result of this analysis - in no case did the main agent receive less pecks than expected and in two cases it received more, once in a group of young birds, group 5, and once in a group of older birds, group 7. These results were significant at the 0.01 and 0.001 levels respectively.

Table 5.4. Experiment 11. The amount of agent and recipient activity of the predominant agent in each group.

Group	Bird	No. times agent	No. times recipient	Expected no. times recipient	Significance level
1	bb	17	3	4.9	NS
2	10	16	4	6.8	NS
3	0	23	7	5.5	NS
4	RR	21	4	4.9	NS
5	bb	18	12	5.1	**
6	RR	9	1	1.9	NS
7	bb	13	8	14.2	***
8	YY	12	2	3.2	NS

** Significant at the $p < 0.01$ level.

*** " " " $p < 0.001$ level.

Feather damage.

There was not enough feather damage to allow comparison between it and agent and recipient behaviour.

EXPERIMENT 12.

The results of the last experiment supported the views expressed earlier concerning the distribution of pecking behaviour; however it was thought that by not distinguishing between barb pecking and feather pecking both in the primary and secondary pecking act some information relating to the behaviour of individual birds might have been lost. It is possible for example that some birds are feather peckers and others barb peckers, or that some birds attract feather pecking and others barb pecking. In this experiment records were made of the type of peck administered and received so that this could be related both to the birds involved in the prime pecking act and to the subsequent behaviour.

Method

Subjects

Four groups of light hybrids were used in this experiment. All details of their housing and management were as described for the groups of birds in Chapter 2.

Observations

These were conducted in the same manner as for the previous experiment the only difference being the recording of the type of peck, whether feather or barb, occurring in any incident. The observations lasted for 15 minutes in all groups and were carried out once a week for four weeks. Nine hundred and two pecking incidents were recorded during the experimental period between days fourteen and forty-two.

Table 5.6. Experiment 12. Agents and recipients activities following pecking incidents. The figures represent the totals of all groups over 4 x 15 minute observations.

After all types of pecking.

Birds \ Activities	Floor	Cage	Drinker	Food	Preen	Avoid	No response	Other bird	Total
Agents	42	16	13	13	126	1	326	365	902
Recipients	27	14	27	50	160	77	463	84	902
χ^2	3.26	0.13	4.9	21.7	4.04	74.1	23.8	175.9	
p	+	NS	*	***	*	***	***	***	

After feather pecking.

Birds \ Activities	Floor	Cage	Drinker	Food	Preen	Avoid	No response	Other bird	Total
Agents	36	14	9	6	111	1	250	144	571
Recipients	19	12	14	25	99	57	303	42	571
χ^2	5.25	0.15	1.09	11.6	0.69	54.1	5.06	55.9	
p	*	NS	NS	***	NS	***	*	***	

After barb pecking.

Birds \ Activities	Floor	Cage	Drinker	Food	Preen	Avoid	No response	Other bird	Total
Agents	6	2	4	7	18	0	72	221	330
Recipients	8	2	13	25	60	20	160	42	330
χ^2	0.29	0.0	4.76	10.1	22.6	20	33.4	121.8	
p	NS	NS	*	**	***	***	***	***	

+ Significant at the 0.1 level. ** Significant at the 0.01 level.
* " " " 0.05 " *** " " " 0.001 "

Table 5.5. Experiment 12. The frequency of giving (A) and receiving (R) pecks for individual chicks housed in groups. Data based on 4 X 15 minute observation periods per group.

Group	n	No. of birds for which A > R. Total	No. of birds for which A > R. No. sig. results	No. of birds for which R > A. Total	No. of birds for which R > A. No. sig. results	No. of birds for which A = R. Total
After both feather and barb pecking incidents.						
1	14	7	3	7	2	0
2	14	7	1	7	1	0
3	13	6	3	6	4	1
4	15	7	2	7	3	1
Totals	56	27	9	27	10	2
After feather pecking incidents						
1	14	6	1	7	2	1
2	14	7	1	7	2	0
3	13	6	4	7	3	0
4	15	6	2	6	1	3
Totals	56	25	8	27	8	4
After barb pecking incidents						
1	14	4	1	7	1	3
2	14	4	0	6	0	4
3	13	4	1	6	2	3
4	15	7	2	7	4	1
Totals	56	19	4	26	7	11

Effects Tested	All incidents	Feather pecking incidents	Barb pecking incidents
No. of significant results	$\chi^2 = 103$ ***	$\chi^2 = 73$ ***	$\chi^2 = 35.8$ ***
Frequency of types	$\chi^2 = 0.0$ NS	$\chi^2 = 0.08$ NS	$\chi^2 = 1.09$ NS
Frequency of significant results for different types	$\chi^2 = 0.05$ NS	$\chi^2 = 0.0$ NS	$\chi^2 = 0.8$ NS

See Table 5.1. for a fuller description of the effects tested.

*** Significant at the 0.001 level.

Feather damage.

Feather damage was again very slight and sporadic which made comparison with observed pecking behaviour impossible.

Results

The results of these observations, shown in Table 5. 5. confirm the findings of the earlier experiments.

Behaviour of individual birds.

There was a difference in the amount of agent and recipient behaviour associated with different birds. This was apparent when the total amount of allopecking was considered or when feather pecking and barb pecking were considered separately. As in Experiment 11 there was no difference in the observed number of either category.

Behaviour following a pecking incident.

Table 5. 6. shows the activities performed after each pecking incident. These results again resemble those from the previous experiment in that the activities vary between the pecker and the pecked bird. The agents peck more frequently at another bird and they peck more at the cage. The recipients on the other hand pecked more at food, more at the drinker, they show more preening, more avoidance behaviour and they make no response more frequently.

Comparison of the effect of feather pecking and barb pecking.

When allopecking is divided into feather pecking and barb pecking slight differences do appear. Preening is affected in that after feather pecking the amount of preening does not differ between agent and recipient but after barb pecking agents do significantly less preening than recipients. The direction of the difference is also reversed, after feather pecking agents preen more than recipients, after barb pecking recipients preen more.

The number of times a bird makes no response after a pecking incident also varies depending on the type of peck administered. The direction of the effect is the same but the magnitude of the

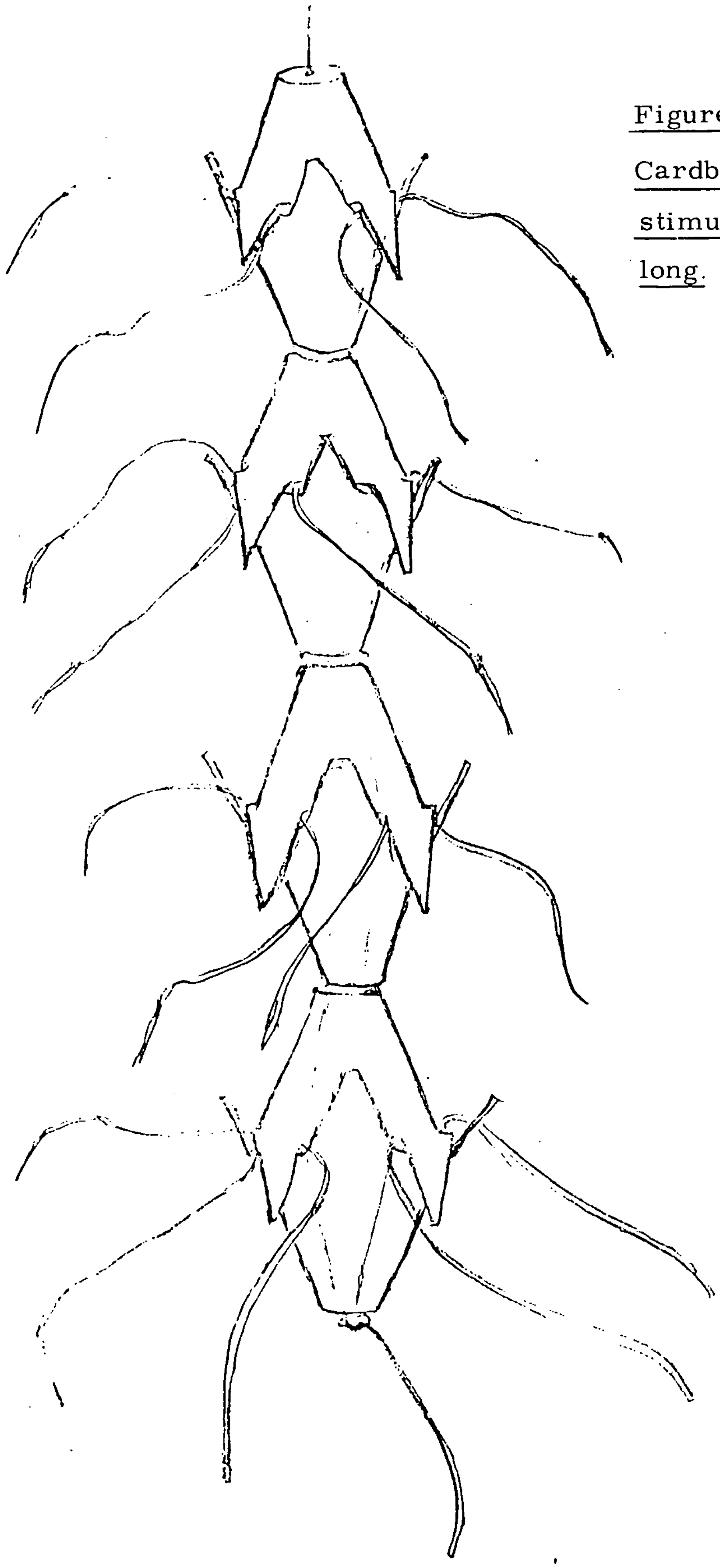


Figure 5.1. Experiment13. Cardboard and string stimulus approx. 26cm. long.

difference is big enough to be significant. After feather pecking the proportion of agents making no response compared with recipients is 1 : 1.212 but after barb pecking the proportion was increased to 1 : 2.222.

EXPERIMENT 13.

In both Experiments 11 and 12 birds were observed to do various amounts of neutral pecking, for example, pecking at food, the cage and preening. It was thought that this behaviour might involve some displacement pecking but it was difficult to distinguish between actual feeding and possible displacement feeding for example. In an attempt to identify displacement pecking an extra and neutral object was placed in some of the cages to see if this attracted pecks from one type of bird more than another or from some individuals rather than others.

Method

Subjects

One hundred and seventeen female light hybrid chicks were obtained at day old and were randomly assigned to one of nine groups, each of thirteen birds. Rearing was as described in Chapter 2.

Stimuli.

In groups 1, 4 and 7 two cardboard stimuli were hung in the cage from day four onwards. Groups 2, 5 and 8 had stimuli from day twenty-one onwards and groups 3, 6 and 9 acted as controls and so did not have any stimuli. The stimuli were made by threading eight sections cut from grey cardboard egg trays, in pairs, onto a piece of white nylong string. Between each pair of sections two pieces of white string 10cm. long were tied to the main thread and arranged so that they stuck out between the pieces of cardboard, see Figure 5.1. The stimuli were suspended from the roof along a side

Table 5.8. Experiment 13. Agent and recipient activities following pecking incidents. The figures represent the totals of all groups over 8 x 15 minute observations.

	Floor	Cage	Drinker	Food	Preen	Stimulus	Avoid	No Response	Other Bird	Total
Agent	78	13	18	52	114	55	0	43	347	720
Recipients	36	10	19	82	176	60	65	171	101	720
χ^2	15.5	6.7	0.4	6.7	13.3	0.22	65	76.6	135.1	
P	***	NS	NS	**	***	NS	***	***	***	

** Significant at the 0.01 level.

*** " " " 0.001 "

Table 5.7. Experiment 13. The frequency of giving (A) and receiving (R) pecks for individual chicks housed in groups. Data based on 8 x 15minute observation periods per group.

Group	n	No. of birds for which A > R		No. of birds for which R > A		No. of birds for which A = R
		Total	No. sig results	Total	No. sig. results	Total
1	14	5	2	9	4	0
2	12	6	1	5	1	1
3	11	7	0	4	1	0
4	13	6	2	6	2	1
5	9	6	2	3	2	0
6	10	3	2	6	2	1
7	13	3	3	10	2	0
8	9	3	1	6	3	0
9	11	4	1	7	2	0
Total	99	43	14	56	19	3

Effects Tested	χ^2	P
No. of significant results	23.84	***
Frequency of types	1.707	NS
Frequency of significant results for different types.	0.76	NS

See Table 5.1. for a fuller description of the effects tested.

*** Significant at the 0.001 level.

or back of the cage and hung to within 5cms of the floor. Figure 5.1.

Observations.

As in the previous two experiments records were made of pecking encounters and the immediately following responses of the birds involved. In this experiment ten encounters were recorded regardless of the length of time taken for them to occur and in addition to the usual repertoire of pecking activities pecks made at the stimulus were also recorded. Eight observations were made on each group which gave a total of seven hundred and twenty encounters over the whole experiment.

Feather pecking.

Feather pecking began in group 7 on day four and by day seventeen there was some pecking in all groups. Feather damage was scored twice weekly for the first four weeks and then once a week for the remaining four weeks of the experiment. The eight point scale described in Chapter 2 was used.

Results.

Behaviour of individual birds.

The results are shown in Table 5.7. Again birds differed significantly in their behaviour as agents or recipients in pecking incidents. There was no significant excess of one type of bird over another although there was a tendency for there to be more birds that were predominantly recipients than agents.

Behaviour following a pecking incident.

The responses made following a pecking encounter showed the usual differences, agents pecking more at the floor and cagemates. Recipients pecked more at food, they preened more, avoided more and made no response more frequently. See Table 5.8. The number of pecks directed at the cage, the drinker and the stimuli did not differ between the types of birds.

A comparison of recipient activity of birds infrequently or frequently pecked.

It had been planned at the beginning of these experiments to

Table 5.10. Experiments 12 and 13. Agent activity for birds frequently (agents) or infrequently (recipients) recorded as giving pecks. Scaled data.

Activities / Birds	Floor	Cage	Drinker	Food	Preen	Avoid	No Response	Other Bird	Stimulus	Total.
Agents	54	10	10	18	80	11	93	289	26	591
Recipients	46	10	23	46	92	0	138	170	66	591
χ^2	0.64	0.0	5.12	12.18	0.82	11.0	8.84	30.33	17.05	
P	NS	NS	*	***	NS	***	***	***	***	

* Significant at the 0.05 level.

*** " " " 0.001 "

Table 5. 9. Experiments 12 and 13. Recipient activity of birds frequently (recipients) and infrequently (agents) pecked. Scaled data.

Activities / Birds	Floor	Cage	Drinker	Food	Preen	Avoid	No Response	Other Bird	Stimulus	Total.
Agent	23	6	17	51	76	41	205	95	33	547
Recipient	15	14	19	48	111	49	216	55	20	547
χ^2	1.76	3.71	0.18	0.11	6.47	0.64	0.31	10.62	3.28	
P	NS	+	NS	NS	*	NS	NS	**	+	

\+ Significant at the 0.1 level.

* " " " 0.05 "

** " " " 0.01 "

compare the subsequent activities of birds that were predominantely agents after they had received a peck with those of birds which were predominantly recipients after they had been pecked. It was thought that birds which were pecked frequently might behave in some specific way which elicited pecking from cagemates whereas the other birds did not.

Since only a few birds could be classified as purely agents or recipients in each experiment; i.e. those that had significantly higher scores for one or other behaviour; it was decided to pool the results for all these extreme cases from Experiments 12 and 13 to see if there were any tangible differences. These results are presented in Table 5.9.

It can be seen that the pattern is much the same as in the other data. Agents pecked more frequently at cagemates whereas recipients made no response more frequently. Agents were also found to peck more at the floor and at the stimulus which this was present but neither of these activities quite reached significance. The recipients showed slightly more preening than the agents.

Thus there were distinct differences between the predominantly agent or recipient birds after they had been pecked, and these were much the same as the behaviour shown by agents after giving a peck and recipients after receiving a peck.

<u>A comparison of agent activity of birds infrequently or frequently giving pecks.</u>

A similar comparison to the previous one was made in relation to agent activity. The type of behaviour made by birds after they had pecked a cagemate was compared for those that did significantly more pecking and those that were pecked to a significantly greater extent. Again the data came from birds in Experiments 12 and 13.

The results are shown in Table 5.10. Agents were found to exceed recipients in the number of times they pecked cagemates and also the number of times they made avoidance responses. The birds that predominantly recipients on the other hand pecked more at the drinker, food, and the stimulus; they also made no response more frequently than the birds classified as agents.

The results suggest that when an agent gives a peck the behaviour is fairly well defined - and the following response appears mainly to peck another bird or avoid the one that has just been pecked, although no threat or aggressive retaliation by the pecked bird was ever seen. Recipients on the other hand tend to continue their usual behaviour, much as though pecking at a cagemate was no different from pecking at the environment.

EXPERIMENT 14

It is now clear that immediately following a pecking incident the behaviour of the two birds involved differs considerably and it is probable that this behaviour is typical of agents and recipients on a long term basis. The aim of this experiment, was to follow the behaviour of the birds involved in the prime pecking incident for a longer time period to see whether or not the differences in behaviour were maintained.

In this experiment, therefore, the birds were put into separate groups according to their pecking or pecked behaviour; this was based on actual feather and tissue damage and on observations independent of the ones described here.

Method

Subjects

Sixty female light hybrids were obtained at day old and randomly divided into four groups with fifteen chicks in each. Rearing was as described in Cahpter 2.

Feather pecking.

The first signs of feather pecking appeared on day eight and

Table 5.11. Experiment 14. Agent and Recipient Activities Following Pecking Incidents

The figures represent the totals of the groups over 4 x 15 minute observations per group.

Activities	Floor	Cage	Drinker	Food	Preen	Avoid	No Response	Other Bird	Totals
Groups 1 - 4 and residual									
Agents	19	5	14	29	46	0	14	241	367
Recipients	10	5	4	19	48	2	41	42	173
χ^2	2.8	0	5.6	2.1	0.04	2	13.3	139.9	69.7
Significance	NS	NS	*	NS	NS	NS	***	***	***
Pecked Groups									
Agents	15	10	3	6	24	0	6	85	149
Recipients	3	1	6	9	10	6	19	17	71
χ^2	80	7.4	1.0	0.6	5.8	6	6.8	45.3	27.7
Significance	**	**	NS	NS	*	*	**	***	***
Peckers & Pecked/Peckers									
Agents	24	6	15	16	31	0	13	311	416
Recipients	6	7	5	11	27	15	30	47	148
χ^2	10.8	0.08	5.0	0.9	0.3	15	6.7	194.7	127.3
Significance	***	NS	*	NS	NS	***	**	***	***
All Groups									
Agents	58	21	49	51	101	0	33	637	932
Recipients	19	13	15	39	85	23	90	106	392
χ^2	19.8	1.9	18.1	1.6	1.4	23	26.4	397.5	220.2
Significance	***	NS	***	NS	NS	***	***	***	***

fresh outbreaks continued until the end of the third week. As birds became involved in feather pecking either as peckers or as pecked birds they were separated into groups containing other peckers or pecked. By the end of week three only five birds were not involved in feather pecking. These birds were grouped together and designated neutral. The remaining birds were in seven groups, four of peckers, two of pecked and one of pecked birds that had later shown pecking tendencies as well. There were six birds in each of the first six groups and seven birds in the last group. Twelve birds had dropped out of the experiment by week three, due either to death in the first week, accident, or as a result of cannibalism.

Observations.

The observations were carried out in the same manner as in Experiments 11, 12 and 13. Records were made of pecking encounters from each group, the birds involved and their subsequent behaviour. In the experiment all the subsequent behaviour of the two birds over a period of one minute after the pecking incident was recorded. Since this lengthened the observations considerably it was decided to record a minimum of five pecking incidents per group in a set time period, so that although not all the observations were of the same length nor included the same number of pecking incidents these factors were known and so could be allowed for in the analysis.

The observations were done on a weekly basis during weeks two to five inclusive. This meant that the first observations were on the original four groups whereas the second, third and fourth observations were on the re-formed groups. A total of nine hundred and seven pecking incidents were recorded.

Results

Behaviour following a pecking incident.

The findings of this experiment are shown in Table 5.11. A considerable difference was found between the behaviour of agents and recipients just as in the three previous experiments. Thus the extended observations following a pecking incident confirmed the earlier findings based on more restricted information.

Agents were found to peck more at the floor, the drinker, cagemates and in total. This last category, the total amount of activity observed was not relevant in the three previous experiments since only one activity for each bird was recorded and so both agents and recipients were bound to have the same amount of behaviour recorded.

The recipients either avoided or made no response significantly more than the agents, but preening, pecks at the cage and at food did not differ between the two types of bird.

There was little evidence of different patterns of behaviour between agents and recipients in the various groups, except for the number of times the drinker was pecked. This was found to vary from group to group and a test of overall heterogeneity showed that the difference between the groups was significant, $\chi^2 = 6.5$; $p = 0.05$. Since the results were otherwise uniform both between groups and with the three earlier experiments no individual pen analysis was done.

General Discussion

These experiments provide direct evidence that birds do not do equal amount of giving and receiving pecks but that some are mainly peckers (agents) while others are mainly pecked (recipients). This was suggested in Chapter 3 but then there was no evidence based on individual bird behaviour to support the hypothesis.

One interesting point is that almost as many peckers as pecked were found in these experiments and not the small proportion of birds prone to allopecking as expected. There could be two explanations for this, either allopecking had been started by one or two birds and the remainder of the group had followed suit; or maybe many birds are usually involved in allopecking but only one or two cause damage when they peck.

The latter explanation would seem more likely since young chicks peck at most things in their environment and do not need to be encouraged in this behaviour. However, it might be that damaging forms of allopecking are copied by one bird from another.

None of the pecking behaviour recorded here was related to actual feather damage. No attempt was made to consider the data in this form since so many birds had intermediate scores for both damage and pecking activity that they masked the behaviour of the extreme birds.

However, the effect is apparent in all four experiments that birds can be distinguished on the frequency of agent or recipient behaviour.

The activities after a pecking incident differed between agent and recipient and the differences remained constant acorss experiments dispite the different variables introduced.

Considering first the differences in behaviour between agent and recipient. Recipients most frequently were rather passive in their responses, either doing nothing at all, or preening, or pecking at food or drink. The agents on the other hand rarely made no response at all and very frequently their first act was to peck at another bird. Agents also pecked more often at the floor. Thus the main difference between the birds could be one of positive action, the recipients being very infrequent in this type of behaviour while the agents showed mostly active responses.

The amount of pecking directed at the floor, the cage, food and drinker did differ between agents and recipients but the reasons for this are not clear. It is possible that floor pecking by the agent was a form of displacement activity, also noticed by Wennrich (1974), whereas the feeding and drinking observed could have been induced by a real need. It might be expected that floor and cage pecking should occur to an equivalent extent, but this was not so, the agent tended to peck more at the floor whereas recipients pecked more at the cage. Preening was sometimes found more frequently among agents and at others among recipients. This could again be a displacement activity but unfortunately no detailed observations were made on the form of preening and so it is not possible to know whether or not this was the case. Perhaps it was a displacement activity when performed by the agents and a normal comfort movement when performed by the recipients, again corresponding to a division of agents and recipients into active and passive birds. It would also be possible that agents would be more likely to be involved in displacement activity since on many occasions they would be in the conflicting situation of whether or not to peck a cagemate. The recipients would meet this situation much less frequently.

When the behaviour of recipients was compared between birds that were frequently recipients and those that were infrequently recipients distinct differences between the two types emerge even though in this instance all activities are being performed after receipt of a peck. The interesting finding was that the predominant agents still behaved like agents, their most frequent response being to peck another bird, whilst the recipients continued to behave like recipients and make no response.

The corresponding comparison of responses after giving a peck by birds that were frequently or infrequently agents shows similar findings; agents peck at cagemates while recipients either do nothing or make a rather neutral response such as pecking at the food or the drinker. Thus in the extreme cases at least it would appear that agents behave as they do, not because they have just made a peck, but because that is how they always behave, even when they have received a peck. Similarly recipients appear to be passive not because they have just received a peck but because they are always more passive, even when they have just given a peck.

This again is evidence for a fundamental difference between the two types rather than one induced by some condition such as state of plumage or environmental conditions.

The different variables introduced in the experiments did not have a great effect. The overall pattern of pecking in the two age groups used in Experiment 11 were different but only for one category of behaviour, no response, was there significant evidence that agents and recipients behaved differently in the two age groups. However, in addition to this avoidance behaviour was almost entirely restricted to recipients amongst the older birds. The finding that the older birds appeared to respond to feather pecking as to an aggressive peck by showing avoidance is very interesting. One of the puzzling things about feather pecking is that the recipient often does not move or take any avoiding action. The most likely explanation of why avoidance occurred in this experiment is connected with the age and state of the social order attained in the groups. These birds, at ten weeks old, were in the middle of establishing their dominance order when observations were begun and so it is possible that since aggressive pecking was very much in evidence at that time any peck was responded to as though it were aggressive in origin. It is probable that birds in a well established hierarchy would not have responded in this way.

The finding that the type of peck, feather or barb, affected behaviour, might have been expected since barb pecking appears to be different from feather pecking in that it is virtually undamaging and more or less ignored by the recipient (Hughes and Duncan 1972).

The results of Experiment 12 would support this view since an increased tendency to make no response or to preen was observed after barb pecking. After feather pecking the responses were more vigorous and more evenly distributed among all the possible activities. This suggests that recipients distinguished between the different types of pecks they received and reacted less to barb pecks than to feather pecks. Since the birds do make a distinction between the pecks it is perhaps reasonable to assume that the motivation behind the pecking is also different. Are barb pecks some form of preening and feather pecks some form of curiosity, feeding or aggressive pecking?

All recipients appeared to receive similar amounts of feather and barb pecks. Either a bird was frequently pecked or it was not, the type of peck it received was not restricted to one sort or the other. Thus the differences in response to feather or barb peck cannot be attributed to the difference in behaviour between birds.

The effect of introducing a stimulus object into the home environment was found to be unimportant. It appeared from the results of Experiment 13 that the stimulus was treated much as the rest of the inanimate environment. There was no evidence that birds pecked at this in some sort of redirected activity as was originally postulated. It would seem that added stimuli in the environment might reduce the number of primary allopecking incidents but they they were not greatly involved in behaviour following a pecking incident.

Recording all activity after a pecking incident for a period of one minute produced results identical to those of the previous three experiments and no differences were revealed that had not been obvious from the more restricted observations. A slightly increased proportion of other bird pecks was recorded for recipients in this experiment which suggests that although it is not necessarily an immediate reaction of a recipient to peck another bird this behaviour does occur quite frequently if any response is made at all. The agents still showed further allopecking as their most frequent response as in all other experiments.

In Experiment 14 birds were divided into groups of peckers or pecked on the basis of feather damage and further observations. There was no evidence that the separately grouped birds showed any differences in their agent or recipient behaviour. Thus a recipient from a group of peckers was as likely to make no response as was a recipient from an unseparated group or a group of pecked birds. It had been thought that where groups of peckers or pecked birds were housed together a change in this type of behaviour might have been seen, with recipients in pecker groups being as active in their response as the agents themselves particularly in the amount of allopecking. No such trend was evident from these results.

There were not enough observations on the unseparated groups to try and predict whether each bird would develop into a pecker or be pecked. This would be an extremely interesting problem to consider but would require a great deal of continuous observation. It is also possible that the ability to inflict damage rather than simply pecking at cagemates is an important factor and one which might be difficult to quantify.

Thus these experiments provide further evidence that feather pecking is dependant on the activity of specific individuals and not the work of all the birds in any one group. The findings did not vary greatly either with age, the addition of stimuli to the environment or the length of period of observation. The type of peck that was given, feather or barb peck, did have an influence on the behaviour which followed it.

CHAPTER 6

THE EFFECT OF THE ENVIRONMENT ON FEATHER PECKING

An inadequate physical environment is often quoted as being the cause of feather pecking. Evidence for this hypothesis usually takes the form of a comment that "feather pecking rarely occurred when birds were kept on free range". It was therefore thought that an investigation into the effects of the environment on the feather pecking syndrome would be worth while. Previous workers have suggested that feather pecking arises as a result of an unsatisfied pecking drive (Hoffmeyer 1969; Levy 1938). The argument runs that chicks have a pecking need or requirement and that if they are unable to meet this requirement during normal pecking activities then they will peck at inappropriate objects such as cagemates. It is suggested that under commercial rearing conditions the environment is not adequate to allow the birds to fulfill their quota of pecks without resorting to the feathers of cagemates and thus feather pecking becomes a frequent problem.

An alternative, though related hypothesis, is that of boredom. In an unrestricted existence a large part of a birds time would be spent in maintenance activities, such as looking for food and feeding, dust bathing, preening etcetra. In commercial conditions and particularly in cages most of these activities are either made impossible or unnecessary. Once a bird has eaten its quota of food, conveniently provided so that it expends as little time and energy as possible in obtaining it, and it has preened, there is little else to occupy its time. As a result the bird makes one of the few responses it still has the ability to do, peck. Since cagemates are the only changing parts of an otherwise dull wire-mesh environment the pecking is automatically directed at them, this results in feather damage and possibly cannibalism, and all because the birds were "bored" (Duncan and Hughes, 1972; Whittle, 1957).

Little work has been done to find support for either of these two hypotheses, presumably on the grounds that they are "obviously" correct, and so they have often been adopted as explanations for feather pecking without any experimental backing.

The aim of the present group of experiments was to see whether environmental factors did have an effect on the amount of feather pecking observed and if so whether the same sort of effect could be obtained in different types of enriched environment. There was also the question of whether environmental effects occurred only during the actual period of enrichment or deprivation or whether the effects persisted over a longer time period. Some attempt was made to test the validity of the pecking drive hypothesis.

In designing an enriched environment it seemed important to keep the changes as simple as possible so that any effect could be interpreted, thus only one aspect of the environment was altered in each experiment. Following the results of earlier experiments (see Chapter 4) it seemed that by adding stimuli that only provided an extra surface to peck at might not be very effective, stimuli or parts of stimuli were more pecked if they were manipulable as well as just peckable. Thus 'enrichment' in the following experiments refers to an environment including extra stimuli that can be manipulated as well as pecked at by the chicks.

EXPERIMENT 15a

This experiment was designed to test whether or not a simple change in the environment could affect the amount of allopecking shown by groups of birds and whether this could be said to be related in any way to a pecking drive or need in the birds. One of the criticisms levelled at the battery cage is that it does not provide an environment in which birds can satisfy their pecking requirements and so it was decided to use a battery cage with a floor that was covered with shavings. The shavings would provide some peckable material without substantially altering any other aspect of the cage.

Since it was sometimes difficult to obtain actual feather pecking, a medium hybrid strain, the Hubbard Golden Comet, reputed to be a very vicious feather pecker was used, together with the light hybrid used in the majority of the other experiments. It was hoped that feather pecking would then be observed at least in the medium hybrids and so comparisons could be made between environments, behaviour and feather damage. If the light hybrids also developed feather pecking then it was thought that a comparison of the behaviour of the two strains might prove both useful and interesting.

Method

Subjects

One hundred and twenty female day old chicks were obtained, sixty were light hybrids and sixty Hubbard Golden Comet medium hybrids. The birds were randomly placed in eight single strain groups of fifteen. Four of these groups, two of each strain, were in the cages described in Chapter 2 and the other four groups were in the pens described in Experiments 7 and 8 (Chapter 4). All other treatments were as described in Chapter 2.

Observations

General observations began on day seven. For these observations the pens and cages were divided in half by hardboard divisions and five birds were placed on one side of the division, the remaining ten birds being left on the other side. The five birds were given fifteen minutes to acclimatize and then a ten minute observation period was begun. Immediately after the observations ended the first five birds were returned to the rest of the group and a second sub-group of five were placed in the observation side allowed fifteen minutes to acclimatize and then observed. This was repeated for the third sub-group of five, so that eventually all the birds from each pen or cage were observed. The sub-groups were always composed of the same five individuals after the initial selection, which was done at random. Food and water were always available on both sides of the partition, and the side used for observation was varied systematically.

Observations were made twice weekly, starting at the beginning of the second week and continuing until the birds were seven weeks old. A total of ten observations was made on each group.

Results

Results from the sub-groups were combined so that a single score for each group was used in the analysis. The analysis was made by Analysis of Variance with the results shown in Table 6.1.

Strain effects.

There were no significant strain effects in either the total amount of pecking behaviour or in the amount of self, environment food and allopecking.

Treatment effects.

The amount of pecking in the two different environments, pens and cages, was very different.

The total amount of pecking was significantly different between the groups, the birds in pens indulging in much more pecking than the birds in cages. This difference was due mainly to the fact that the birds in pens pecked considerably more at the environment than those in cages. There was no difference in the amount of self-directed pecking observed but the cage reared birds pecked more at food and at cagemates.

Since it was thought that the birds in pens might have been pecking at the floor in search of spilt food, the combined scores for food and environment pecking were compared. The pen birds were still found to do more pecking than those in cages, suggesting that the increase in environment pecking was more than simply accounting for food pecks directed at the floor.

Feather pecking.

There was no feather pecking at any point in the experiment despite the fact a strain with a reputation for feather pecking was included the medium hybrids, as well as the light hybrids mostly used during this study.

Discussion

These results show that birds in an enriched environment (pens) spend more time pecking than those in a restricted environment (cages), and that the birds in the two environments peck at different objects. This result is interesting in relation to the pecking drive hypothesis which would predict in an experiment such as this that the total amount of pecking in both pens and cages would be the same, although the objects at which the pecks were directed might differ. Since the total amount of pecking shown by pen and cage reared birds was found to be very different it cannot be said that these results support the idea of a pecking drive. This is, of course, assuming that the cage reared birds filled their pecking requirements and since the amount of time actually taken up by pecking behaviour was quite a small proportion of the time available it is permissible to make this assumption.

An alternative explanation for the lesser amount of pecking done by the cage reared birds might be that pecks are of different "values"; a peck at a cagemate being worth three pecks at the litter for example. It seems a little excessive to have to make such distinctions and a little difficult to prove whether in fact they are justified. If this were the case, however, why did not the pen reared birds peck less at litter and more at their cagemates? It is usually accepted that the preferred behaviour in a choice situation is the one that is performed most often; this should apply equally in the present situation.

The finding that birds reared in the two different environments pecked at different objects is acceptable under the pecking drive hypothesis since the only requirement this hypothesis has is that the birds will produce an equal number of pecks, the objects which receive the pecks are irrelevant to the basic hypothesis. However, a more feasible explanation for this finding and for the increased pecking shown by the pen birds is that the environment elicits pecking behaviour and that the richer environment elicits more pecking than the impoverished one.

In the present experiment it was assumed that the addition of a solid floor covered with litter would provide an environment more stimulating to peck at than the conventional cage with a wire floor. Since birds in cages infrequently pecked at their wire floor whereas birds in pens spent a large proportion of their time in this behaviour it would appear that the two environments did differ in the manner expected.

Compared to birds in pens those in cages directed a much larger proportion of their pecks at food, which they played with as well as ate, and at cagemates. This suggests that the attractiveness of an item as a pecking object depends not only on the attributes of the object but also on the characteristics of the rest of the environment. In pens particles of food were competing with such objects as litter droppings and feathers that had gathered on the floor as peckable items whereas in cages there was no such competition from similar stimuli.

Another but related factor to be considered is that a change in a restricted environment would be much more noticeable than in an enriched environment. Droppings stuck to the feathers of a cage reared bird would make a comparatively unusual and obvious stimulus for cagemates to peck at but for those in pens the appearance of a small contrasting particle attached to a larger surface would not be unusual and would not necessarily elicit a response.

In this experiment allopecking did not lead to feather pecking but it is quite conceivable that it could have done and extrapolating from the results obtained it would be expected to be worse in cages than in pens. Thus it would appear that feather pecking could be the result not of the birds needing to fulfill a drive but rather birds in an impoverished environment pecking at objects that attract their attention. If these objects proved rewarding by coming out or by producing blood when pecked then the likelihood of their being pecked at again would increase. In a rich environment many objects compete with each other and so feathers may rarely be pecked at and if they do come out or bleed there are still other elements in the environment that make a small bare or bloody area on a chick much less conspicuous than in a cage situation.

Although the results of this experiment were fairly clear cut they were based on only one hundred minutes of observation time per bird and since the theoretical framework built on these findings could be quite important it was decided to repeat the experiment with another batch of birds.

EXPERIMENT 15b

As explained above the aim of this experiment was to repeat Experiment 15a to see if it was possible to replicate the results, since it was felt that a considerable amount of theorising was made on the basis of rather a small number of observations.

Method

Subjects

One hundred and twenty day old female chicks were obtained from commercial hatcheries. Sixty of these were medium hybrids, and sixty were light hybrids. They were divided into groups and treated exactly as described in Experiment 15a.

Observations

Again the details were exactly the same as for Experiment 15a except that only two of the possible three sub-groups of five were observed. The same two sub-groups from each group were always used for observations so that there were five birds in each group that were never observed.

The number and timing of the observations were as for Experiment 15a.

Table 6.2. Experiment 15b. Pecking behaviour of two strains of birds reared in two different environments.

Strain	Environment	Self	Allo-pecking	Environment	Food	Environment + food	Total
		Pecking Behaviour: Total number of pecks per pen.					
Light hybrid	Pens	117	17	257	197	454	588
	Cages	80	24	84	290	374	478
Medium hybrid	Pens	120	16	349	180	528	664
	Cages	98	31	89	298	387	516
Main effect of environment[a]							
	Pens	118	17	303	188	491	626
	Cages	89	27	86	294	380	497
	F	6.23	5.55	64.5	9.1	5.16	10.82
	P	*	**	***	**	*	**

[a] The effects of strain and the strain x environment interaction were not significant.

* Significant $p < 0.05$.
** " $p < 0.01$.
*** " $p < 0.001$.

Results

The results were computed by Analysis of Variance again using the score from each group rather than each sub-group (see Table 6. 2).

Strain effect.

There were no significant strain effects in any of the categories of pecking behaviour.

Treatment effects.

The treatments had very marked effects and were significantly different for all categories of pecking behaviour.

Pen reared birds preened more than those in cages, whereas cage birds allopecked more, and spent more time pecking at food. Environment pecking, environment plus food pecking and total amount of pecking were all greater for the pen reared birds.

Feather pecking.

As in Experiment 15a no feather pecking was observed among any of the groups in either pens or cages or in either strain.

Discussion

In essence these results were exactly the same as those found in Experiment 15a. There was significantly more self pecking among pen birds in this experiment, a result which was not evident in the previous experiment. This was presumably due to the effect of the litter which made it possible for the birds to dust-bathe, an activity which is often followed by preening, (Borchelt, 1977). Why this effect was not found in Experiment 15a is not clear.

Other than this the main treatment effects were similar to the previous experiment and so substantiate the claim that pen reared birds do more pecking than cage reared ones and that the items at which they peck differ depending upon the environment.

Since the interpretation of the findings of this experiment would be the same as for Experiment 15a there is no need to repeat the arguments relating to the drive, satiation and boredom hypotheses and these results. Although this experiment has not provided any additional evidence for or against either of these hypotheses it has achieved its aim by showing that the previous findings were correct and that the interpretations were based on accurate information.

EXPERIMENT 16

If a change in the environment such as the presence of litter on the floor of the cage could cause such a large difference in behaviour, to the extent that birds indulged in different amounts and different types of pecking, it seemed worth investigating whether similar differences could be produced by other less complex changes in the environment.

To test this possibility experimental groups were provided with less diverse stimuli than wood shavings while controls were reared without any stimuli at all. An additional variable of age at introduction of the stimuli was also included to see whether this made any difference to the number of pecks directed at the stimuli or at cagemates.

Method

Subjects

One hundred and seventeen light hybrid chicks were obtained at day old and placed in nine groups of thirteen. Rearing conditions were as previously described (Chapter 2). The groups were randomly assigned to one of three treatments. Groups 3, 6 and 9 were the controls and were reared in cages without any additional objects, C. Groups 1, 4 and 7 received early stimulus treatment, S1, two stimuli were hung in the home cage from day four until the end of week seven. Groups 2, 5 and 8 received later stimulus treatment, S2, for these the two stimuli were not placed in the home cage until the onset of feather pecking in each of the cages at twenty-one days.

Stimuli

To avoid the additional variable of the stimuli being periodically destroyed by the birds a durable stimulus had to be provided. To make the stimulus totally indestructible, however, would probably reduce its attractiveness as a pecking object (see Chapter 4) and so it was made of a material that could be removed in small quantities when pecked. In this way it was hoped that the stimulus would prove to be an attractive pecking object and yet not be destroyed before a replacement could be provided.

The stimuli used were made of white nylon string and sections of cardboard egg trays. The cardboard could be fairly easily removed when pecked, whereas the nylon string remained in place although it often became frayed, but this did not appear to reduce its attractiveness as a peckable object. The stimulus is described in greater detail in Experiment 12, Figure 5.1. Once they were badly damaged the stimuli were replaced up to the end of the seventh week when they were finally removed from all the cages.

Observations

General observations were begun on day eleven, before the advent of feather pecking. They were made three times a week until the seventh week of the experiment by which time fifteen 10 minute observations had been made on each of the nine groups. As well as the usual categories of pecking recorded during general observations, the number of pecks made at the stimuli was also recorded. Another change in the method of recording was that allopecking was sub-divided into barb pecks and feather pecks and these recorded separately. This was done since superficial observations suggested that groups that indulged in large amounts of barb pecking were not involved to any great extent in the more damaging forms of allopecking. The distinction between barb pecking and feather pecking is made in Chapter 1.

Mortality.

There were a large number of deaths throughout the experiment from toe pecking and so the group sizes were considerably reduced and the numbers made uneven by the end of the experiment.

This was the only major out-break of toe pecking and almost the only toe pecking seen throughout this study. In many ways it would appear to be a social vice much as feather pecking is. It involves chicks pecking at the toes of cagemates which results in flesh wounds and often the removal of several joints of the toes and sometimes whole toes. Death frequently occurs either from loss of blood or as a result of infection. As with feather pecking the birds being pecked often do not respond and stand quite still even though their toes may be bleeding. No attempt was made to study this syndrome or incorporate it into the experimental situation.

Feather damage.

Damage was scored weekly on the eight point scale, described in Chapter 2.

Figure 6.1. Experiment 16. The effect of stimuli placed in the cage at an early or later stage on the incidence of feather damage. Treatment means.

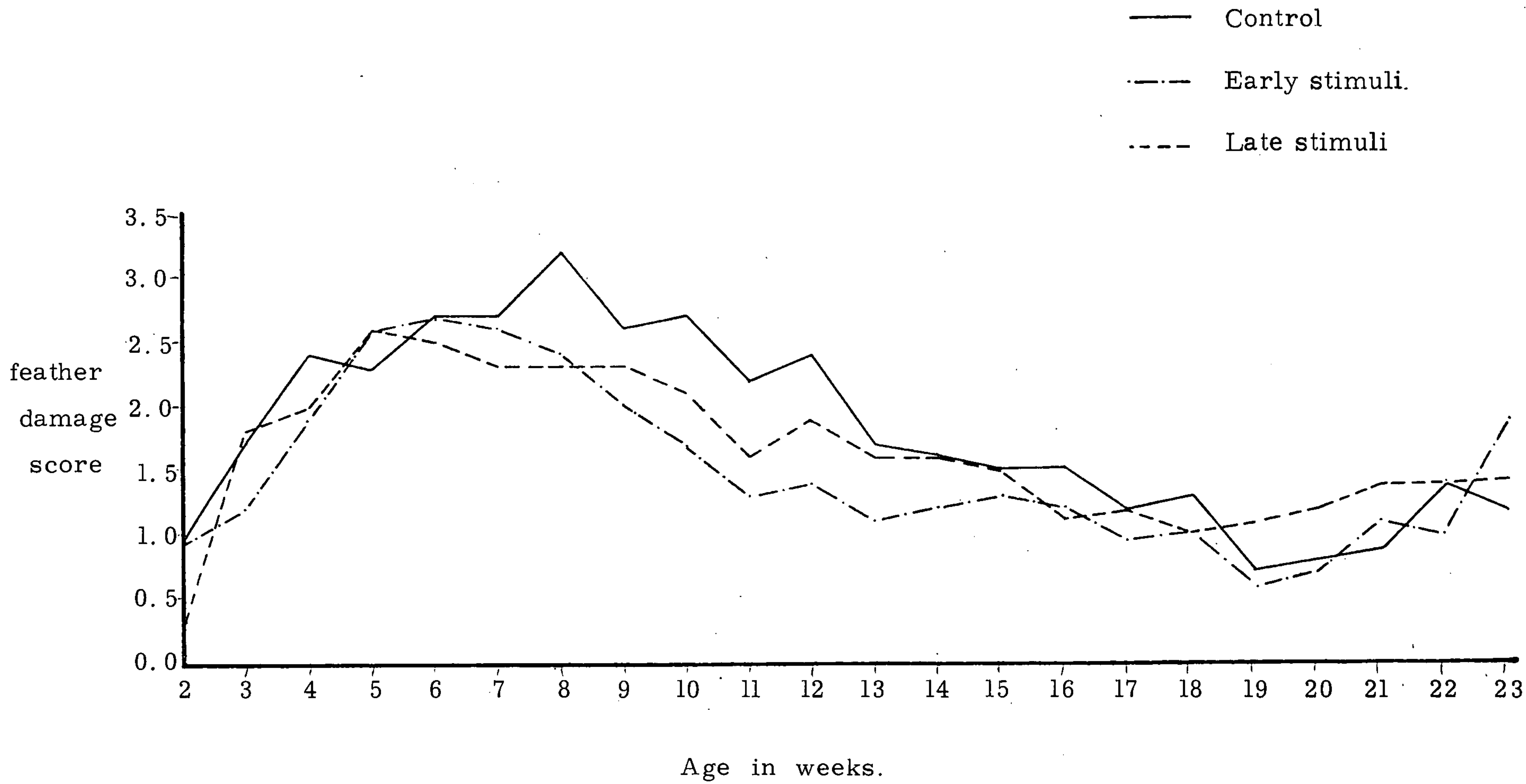


Table 6. 3. Experiment 16. The effect of stimuli on the incidence of different types of pecking and on feather damage scores. The data are group means for fifteen observations for pecking and group means for twenty-two observations for feather damage.

Observations \ Treatment	Control (No stimuli C	Early stimuli St_1	Late stimuli St_2	Significance of comparisons C v St_1	C v St_2	St_1 v St_2
Self pecking	48. 5	37. 5	40. 4	NS	NS	NS
Allopecking total	51. 3	20. 7	34. 4	*	NS	NS
Barb pecking total	16. 0	2. 2	8. 1	*	NS	NS
Allopecking minus barb pecking.	35. 3	18. 5	26. 3	*	NS	NS
Environment pecking	15. 9	8. 3	15. 5	*	NS	+
Food pecking	49. 8	43. 7	51. 5	NS	NS	NS
Stimulus pecking	-	45. 2	39. 1	–	–	NS
TOTAL PECKING	163. 9	154. 7	180. 8	NS	NS	NS
FEATHER DAMAGE	48. 6	38. 2	40. 6	NS	NS	NS

* Significant at the $p < 0.05$ level.
\+ " " " < 0.10 "

Results

The results are summarised in Table 6. 3. and Figure 6. 1. Statistical tests were carried out using Analysis of Variance, the total scores for each group were used in the analysis.

There was no significant difference in the total amount of pecking under the three rearing conditions. There was, however, significantly more allopecking by the birds in the control treatment than in the groups provided with a stimulus at four days of age, and more than the groups provided with a stimulus later in the experiment although this was not statistically significant. When the allopecking score was broken down into barb pecking and other types the difference between the control treatments were still quite evident.

The amount of pecking directed at the environment differed between the early stimulus treatment and both the late stimulus treatment and the control groups; the groups with the stimulus provided early in life showed much less environment pecking than the groups in the other two treatments.

There were no differences in the amount of food pecking, self pecking or stimulus pecking between the treatments.

Surprizingly there was no overall difference in the amount of feather damage sustained by the birds (see Figure 6. 1.). This was generally true both when the stimuli were present in the treatment groups and after their removal although the early stimulus treatment had slightly lower scores than the other groups on most weeks and during weeks eight to twelve the controls had higher scores than any of the others.

Discussion

The results from this experiment suggest that the addition of stimuli makes no differences to the amount of pecking behaviour. This is contrary to the results of Experiments 15a and 15b where it was shown that birds reared in complex environments indulged in more pecking than those reared in impoverished environments. The only difference between these experiments was that in the present situation the difference between treatments was not as large as it was in Experiments 15a and 15b. The addition of a solid floor in the earlier experiments constituted a change not simply by the addition of a stimulus to be pecked at but something much more complex. The shavings on the floor could be scratched through and different objects unearthed, presenting the birds with more things to peck at. Further, more dust bathing could lead to increased self pecking. This environment could generate pecking behaviour in a way that the addition of a simple stimulus could not.

This raises interesting problems in relation to experiments purporting to test for the existence of a pecking drive. In an experiment like the present one where a permanent but not particularly exciting stimulus was present in the cage, the birds peck a constant amount and this pecking is shared amongst the objects available - supporting the pecking drive hypothesis. When, however, the stimuli in the environment are complex and result in other behaviours such as dust bathing and scratching in the litter, which in turn leads to more pecking, then the observations provide no evidence for a pecking drive. Birds in this type of environment peck in total considerably more than birds in a restricted environment.

It would be tempting to postulate from these results that in all environments, however complex or impoverished, essential pecking such as feeding and possibly preening is carried out at equivalent levels by all birds, but that non-essential pecking such as environment pecking, allopecking and stimulus pecking are affected by the type of environment. A fuller discussion of "non-essential" pecking is given in the next experiment. In impoverished environments more pecking is directed at the cage and food and water containers because no alternatives are available. In an enriched environment where some alternative is offered then more pecks are directed at this alternative, sometimes at the cost of other non-essential pecking.

The effect of the treatments on the amount of feather damage inflicted was surprisingly slight. Although there were more allo-pecking among the control groups there was no more feather damage except for a short period between weeks eleven and fifteen. There were many deaths due to toe pecking in this experiment and this may have confused the results.

When the stimuli were removed at the end of the seventh week it was thought that feather pecking in these groups might rise, in fact there was no sign of any change in the feather pecking behaviour of these birds as mirrored by the damage scores. There are two possible explanations for this. Either the stimuli were not being responded to by any birds sometime before they were actually removed from the cages, or individual birds which feather pecked to any damaging extent did not at any time respond strongly to the stimulus. The former is improbable since the level of response to the stimuli, as observed in the general observations, showed no sign of a decrease over time and in fact the converse was observed in several groups. The latter explanation is supported to some extent by the results from Experiment 1 in which it was found that birds with a higher score for feather pecking did not respond to unbird-like stimuli, whereas birds who indulged in a lot of environment pecking did respond to these stimuli. If indeed it were the case that damaging feather peckers did not peck at these particular cardboard and string stimuli then this would also explain why pecking damage was approximately the same for all treatments. It would then follow that the high score for allopecking on the control treatment was caused by birds doing non-damaging pecking that might in the other treatment be directed towards the stimuli. It is unfortunate that general observations were not continued after the removal of the stimuli because it would then have been possible to see whether allo-pecking of a non-damaging kind increased once the stimuli were no longer available.

An important point to establish is whether or not some pecking activities are more essential or more important than others. If it were possible to make such a distinction experimentally then it would give a much greater understanding of experiments such as the present one. The responses made in particular situations or to particular stimuli could be viewed in relation to many other factors and not taken as discrete incidences out of the context of the rest of the animals environment and activities.

EXPERIMENT 17

A change in environment appears to affect pecking behaviour, not simply in terms of which objects the chicks peck, but also in the total amount of pecking that is shown. From previous results some types of pecking, for example food pecking, are only slightly affected whereas others, for example allopecking and environment pecking are greatly modified. It could be argued that pecking behaviour which is unaffected by the environment is "essential" to the health and survival of the bird and therefore it takes place more or less regardless of external conditions. Other behaviour would then only occur once this fundamental activity had taken place; this later behaviour could be much more flexible and much more affected by environmental factors.

During an experiment (not described here) in which two types of environment were being compared a number of power cuts disrupted the amount of 'daylight' that the birds received. When the results were analysed it was found that food and self pecking scores remained at a stable level throughout, whereas allopecking and environment pecking were considerably reduced on days short of light.

These results, although from a very uncontrolled situation, appeared to support the view that some types of behaviour were more flexible than others and that the environmental changes were specific in their effects.

It was therefore decided to alter the light period in a controlled fashion to see if this did in fact affect the birds' behaviour in the way suggested. It was predicted that during short light periods non-essential pecking behaviour would be less than on long or normal light periods. Since the classification of non-essential pecking was very arbitrary it was decided to rear some of the birds with stimuli in their home cages. Pecking at a stimulus could hardly be described as biologically "essential" and so it would provide an independent measure of non-essential pecking.

Method

Subjects

Fifty day old female light hybrids were placed in four groups, A and C (n = 13) B and D (n = 12). Rearing methods and conditions were as described previously (Chapter 2).

Light periods.

The usual lighting regime used in the previous experiments was fourteen hours light and ten hours darkness, and since lengthening or shortening this day would have posed procedural problems it was decided to use an arbitrary dark period of forty minutes and to combine this with light periods of sixty minutes (normal day) and one hundred and twenty minutes (long day) and thirty minutes (short day). Under these conditions observations could be made over the whole "day". The "night" was kept constant at forty minutes, this amount of time being chosen since it bore approximately the same relationship to the sixty minute day (normal) as the ten hour night to the fourteen hour day. In practice an extra five minutes was added to each day to allow time for the experimenter to enter the room and switch on the recording equipment before the observation period began. Thus the actual "days" were all five minutes longer than the recorded "days."

The "normal" light/dark regime was begun on day seventeen and unless other treatments were being imposed it was maintained throughout the experiment until day forty-two. During each week all groups were exposed to one twenty-four hour day of short periods, one of long and five of normal and one of each type was observed during each week. At the end of the experiment the long, short and normal periods had each been observed on three separate occasions.

The birds were cleaned, fed and watered during one of the light periods when they were not being observed. This was usually done first thing in the morning and the birds given the rest of that light period in which to quieten down before observations began.

Observations

General observations were made on the groups three times each week for three weeks. The amount of pecking directed at self, other birds, the environment, food, floor and the stimuli were recorded. The observations lasted for the whole of the light period but five minutes was discounted to allow for entering and leaving the experimental room. Four observations were made on each occasion on the "normal day" and so that observations were made over the same total length of time two observations were made on the "long day" and eight on the "short day". Time sampling was used, each group being sampled for fifteen seconds in every minute, it was thus possible to record the activity of each group once a minute over the full light period. Individual bird behaviour was not recorded, the groups totals for each activity being noted. The number of pecks made at the floor was recorded separately from other environment pecking since it seemed from subjective impressions that floor pecking was often used as a displacement activity by birds who had been feather peckers. It was planned to see if there were correlations between extent of feather damage and number of floor pecks.

Table 6.4. Experiment 17. Effect of day length and environment on pecking behaviour. The values are totals for 12 hours of observation on all treatments except for +, these totals are for two thirty minute periods immediately following light onset.

Environment	Day length	Self pecking	Allo-pecking	Envir. pecking	Floor pecking	Food pecking	Food+ pecking	Stimulus pecking	Total
With stimulus		377	63	48	149	474	127	214	1325
Without stimulus		423	108	58	153	519	142	-	1264
Significance		**	***	NS	NS	*	NS	-	NS
-	Normal 60 minutes	402	97	57	154	457	126	210	1264
	Long 120 minutes.	423	83	58	139	431	122	204	1229
	Short 30 minutes.	376	76	45	166	601	157	227	1377
	Significance	NS	NS	NS	NS	***	**	NS	***

The day length x stimulus interaction was not significant.
* Significant at the $p < 0.05$ level.
** " " " $p < 0.01$ "
*** " " " $p < 0.001$ "

At seventeen days groups A and B had two stimuli placed in their home cages. These were constructed of egg trays and nylon string, as described in the last experiment, and hung in the cages in a similar manner. They were replaced as soon as they became badly damaged. Figure 5.1.

Feather pecking

The birds were checked regularly for signs of feather pecking but no feather damage was recorded at all during the experiment.

Results

The results of the experiment are shown in Table 6.4. There were no significant interactions between the effects of day length and the stimulus and therefore the main effects can be considered separately.

Day length

The different daylengths had significant effects only on food and total pecking. Food pecking, the most obvious form to be categorised as "essential" was significantly greater on short days than on the other treatments. Self pecking, the other possible "essential" activity was not significantly affected by daylength, and indeed did not follow the same pattern being greater on long days. More environmental pecking was also found on longer days but again the effect was not significant.

Allopecking was more frequent on the normal days than on either short or long days but this effect was not significant. Similarly stimulus pecking was unaffected by day length. The total amount of pecking followed the same pattern as food and floor pecking; more being done on short days than on normal or long.

Stimulus effects.

The presence of the stimuli caused significant changes in three sorts of pecking, self, food and allopecking. In all of these the groups without stimuli were found to do more pecking than those with stimuli. The non-stimulus groups also did more environment and floor pecking but neither of these were significant. The total amount of pecking shown was greater in the groups with stimuli but this effect was not significant either.

Feather pecking

Since there was no feather pecking during the experiment the proposed tests for correlations between floor pecking and feather damage could not be carried out.

Discussion

The first problem is the definition of "essential" pecking. It was originally suggested that essential types of pecking would occur to the same extent under different rearing conditions, however, there must be some other definition otherwise the argument becomes circular. One possibility would be to take a biological approach and consider maintenance activities such as feeding and preening as essential and all other behaviour as non-essential. If this was the system adopted, then in this experiment, feeding and preening would be the only two types of pecking that could be classified as essential, and allopecking, environment pecking and stimulus pecking would all be non-essential.

It would then be expected that the levels of feeding and preening should remain the same under all conditions of day length and stimuli, but this was not found to be the case. The shorter the periods of light the greater the amount of feeding and the smaller, though not significantly, the amount of preening which suggests that these two responses were not controlled by the same mechanism.

An explanation for the increased amount of feeding observed during the shorter periods of light could be that behaviour was stimulated by the frequent furning on and off of the lights. This happened eight times during the four hours of short light periods and only twice during the long periods. However, if light onset caused a generalised increase in activity it would be expected that all the behaviours should be greater in this condition, but this was not found to be so. Thus the actual length of light time available to the birds must affect their behaviour to some extent and the findings are not simply the result of a non-specific effect. This conclusion is reinforced by the finding that feeding behaviour analysed over the first half hour after lights on, in all three conditions, showed exactly the same pattern as the total feeding behaviour discussed above. See Table 6.4.

The effect of the different light periods on self pecking initially suggests that this behaviour is not essential as previously classified since the longer the light period the more self pecking occurred, although this effect was non-significant. This could be explained on the basis that although preening may be a maintenance activity perhaps the ceiling of functional self pecking is soon reached and beyond this point preening becomes a non-essential form of behaviour classifiable with environment and allopecking, when the less time there is available the less pecking behaviour there is. It is obviously too simple an approach to try and attribute a single function to any behaviour pattern, even food pecking may take place for a number of reasons. (Masic, Wood-Gush, Duncan, McCorquodale and Savory, 1974).

The provision of stimuli to some of the groups was intended to provide an independent measure of non-essential pecking and thus it was expected that there would be more stimulus pecking on long days than on normal or short. In fact the reverse was found, although the effect was not significant.

The overall effect of the presence of the stimuli was clear cut. As was found in previous experiments the groups reared with the stimuli pecked more, though the total amount of pecking was not significantly different between the treatments. In Experiments 15a and 15b the difference between treatments was highly significant, this discrepancy can probably by explained by the different nature of the environments. In the earlier experiments the enriched environments, the pens, provided a great deal of scope for pecking behaviour whereas in Experiments 16 and 17 only a single type of stimulus of a moderately interesting nature was provided. However, in all cases the results suggest that a large proportion of pecking is elicited by an enriched environment rather than there being a set quota of pecks that need to be fulfilled.

If there are essential and non-essential types of pecking it is clear that this experiment has not been particularly effective in identifying them. Since the amount of so called non-essential pecking was not consistent between activities it is difficult to know whether they are all governed by the same variable, excess time. It could be argued that there are not merely two categories of pecking but rather the activities are on a continuum and that some activities are preferred to others all things being equal. Perhaps food pecking and a certain amount of self pecking occur initially but once hunger and comfort have been satisfied then the pecking turns to other stimuli. There may be complicating factors, however, such as too many birds at the feeder or the feathers of a cagemate in a particularly interesting condition, then feeding may be abandoned in preference for other forms of pecking behaviour until the competing variables have been reduced or the need to feed or preen becomes much greater.

The addition of all these extra and largely unidentified variables make this explanation in terms of essential and non-essential pecking very unwieldy and more or less irrefutable, so that its usefulness is severely limited.

General Discussion

The aim of the experiments reported in this chapter was to investigate the effect of the environment on the occurrence of feather pecking behaviour. In one respect this aim was frustrated by the low incidence of actual feather pecking in several of the experiments, and so it is only possible to surmise what the effects of the treatments might have on feather pecking by extrapolating from the results obtained on other pecking activities.

The environment was found to have a considerable influence on many forms of pecking behaviour and so although it was not seen to directly affect feather pecking in this set of experiments it is quite conceivable that environmental factors, either alone or in conjunction with other variables, could exert a considerable influence on damaging pecking.

The design used in Experiment 16 showed that the point at which the environments were made complex had some effect on behaviour. If, instead of increasing the complexity of the environments at a particular point, stimulation had been removed from the environments, a greater change in behaviour might have been observed. On the other hand this situation would include an extra factor, that of deprivation and so would be asking a different question than was posed here. It would seem that both situations should have been tried.

It would appear from the results from Experiment 17 that the attempt to explain the effect of the environment on feather pecking by distinguishing between essential and non-essential types of pecking was not very useful. Although this type of explanation is very tempting it is most likely that a much more complex system is involved in governing pecking behaviour, even though it would seem fairly obvious that within certain limits the amount of time an animal has available will determine the type and amount of behaviour that it shows. Again rearranging the experimental design and working with more clearly defined concepts might have yielded more conclusive results. If for example, observations followed an unexpected period of dark then comparisons could have been made between different sections of these observations rather than between different "day" lengths as was done in this experiment.

In all these experiments the groups reared with stimuli had larger total pecking scores than the non-stimulus groups but the latter groups had larger scores for many of the sub-categories such as feeding and allopecking. It would seem therefore, that although there is plentiful evidence to suggest that objects in the environment elicit pecks rather than there being a set quota that have to be made to satisfy a drive state, it is also obvious that some of the pecks that are directed at the stimuli are at the expense of pecks made to other objects. This might be because of some other controlling factor such as boredom but at what point does the chick stop pecking out of boredom and begin pecking out of extra stimulation - is it pecking at the stimulus, which in some cases was not very exciting, out of "boredom" or out of excitation? On the other hand it is quite possible that if objects are rewarding to peck at they will be pecked for their own sake, regardless of any quota. This view is supported by the lessened pecking of the groups reared with a single type of stimulus rather than a larger change in the environment. Pecking at an attractive stimulus may mean that some of the actual time available to the chicks is used on this rather than on other activities. Although a pecking quota may not be postulated it is still reasonable to suppose that there is a limited amount of pecking that can be done particularly when a continuous time period is being considered, the effect of stimulation for a short period would probably be very different.

Thus the evidence for the pecking drive or boredom hypotheses as explanations for feather pecking is not convincing. These experiments suggest a much more functional explanation relating pecking behaviour to the type of environment and stimuli available. Although it is probable that environmental factors do exhert an influence on feather pecking the lack of it in these experiments shows that other mechanisms must also be involved.

CHAPTER 7.

THE EFFECT OF EXOGENOUS HORMONES ON FEATHER PECKING.

INTRODUCTION

Throughout the work described so far it was noticed that many of the birds indulging in feather pecking had certain characteristics in common. They were very persistent in their behaviour patterns, pausing infrequently to preen or eat, and often pecking at the same body region on all their cage mates whether or not any damage was apparent. Thus one particularly bad pecker in a group would denude all other members of the group in the same place, the site of damage varying from group to group. Males were found to be more prone to feather pecking than females, and in Experiment 6 sexual maturity of adult females was later in pecker as opposed to pecked groups. All of these characteristics suggest a hormonal influence on feather pecking behaviour.

Andrew (1963) observed that testosterone injections increased persistence in behaviour patterns and thus it seemed possible that there might be a link between feather pecking and testosterone levels. This was examined by the series of experiments described in this chapter. The first experiment was designed simply to see if a response could be elicited whilst in the later ones different dose levels were tested and more detailed observations of behaviour were made. The effect of oestrogen was also studied in two experiments.

Hormone Preparations

The initial experiment in this series used daily injections of testosterone proprionate and oestradiol benzoate as the means of administering exogenous hormone. This followed the method used by Andrew (1963) since it was his results of increased persistence of pecking behaviour that these experiments were aiming to repeat. This method of administering the treatments was very time consuming but since the main objective of the experiment was simply to see whether the hormone treatment affected feather pecking no intensive observations were attempted at the same time.

During the later experiments observations on general pecking behaviour, activity and feather pecking were included in the design and so the time available for treatment was much more limited. It was for this reason that long acting hormones were used for all but Experiments 18 and 23; these were the first two experiments to be done but they have been reported separately since it made the description of the study more coherent.

The long acting hormone used in Experiment 19 was testosterone oenanthate, a slowly absorbed preparation that is active for approximately four weeks. In the remaining Experiments, 20, 21 and 22, in which testosterone was administered, a combination of testosterone esters was used to give a slightly longer treatment effect, it may also have released the hormone at a more regular rate. The preparation (Duratestone, Intervet Laboratories Ltd.) combined testosterone proprionate, phenylproprionate, isocaproate and decanoate.

The long acting oestrogen used in Experiment 24 was oestradiol undecylenate, it was thought to be active for three to four weeks and to be similar in effect to oestradiol benzoate.

It was realised that the use of different hormone preparations might affect the results but since the experiments could not have been done in such detail without a reduction in the time spent in treatment this change to long acting preparations was felt to be justifiable. Measures of body weight and comb size were made so that a check could be kept on the gross physical effects of the treatment.

Administration

All the hormones were given by injection. The substance used plus the route and frequency of administration are summarised in Table 7.1. Treatments were given subcutaneously or intramuscularly according to the manufacturers advice.

Table 7.1. Hormone Preparations.

Experiment Number	Hormone administered	Frequency of treatment	Method of treatment
18	Testosterone proprionate Oestradiol benzoate	daily	subcutaneous
19	Testosterone oenanthate	once	intramuscular
20 (1)	Testosterone oenanthate	once	intramuscular
20 (2)	Testosterone oenanthate	once	intramuscular
21	Duratestone	once	intramuscular
22	Testosterone oenanthate	once	intramuscular
23	Oestradiol benzoate	daily	subcutaneous
24	Oestradiol undecylenate	twice	intramuscular

Dose Levels.

The dose level of testosterone used by Andrew (1963) was tried first and once this had been found to affect feather pecking lower doses were included in the experiments. It seemed that feather pecking could not result specifically from physiologically impossible levels of testosterone and if this behaviour was dependent on hormonal balance then it should be possible to obtain a similar effect with a vastly reduced dose.

The amount of oestrogen administered was again taken initially from the work of Andrew(pers. comm). In later experiments, 23 and 24 the doses were varied to include what was hoped would be a level approximating to a physiological amount, 0.001 mg. per 20 gms body weight, and a higher dose, 0.04 mg per 20 gms. The higher dose was expected to affect physical factors, such as vent development, and so indicate the importance of the physical properties of the pecked birds in attracting feather pecking.

EXPERIMENT 18.

The first experiment was designed simply to discover whether testosterone injection affected the incidence of feather pecking, both no hormone and oestrogen treatments being used as controls. No work on the effect of oestrogen on feather pecking was known and it seemed possible that any behaviour elicited by testosterone might also be produced by other gonadal hormones.

Method

Subjects

Ninety female Shaver 288 chicks were obtained at day old and randomly assigned to one of six groups, each with fifteen members. Rearing and husbandry conditions were as described in Chapter 2. At six weeks of age all the birds were moved into battery accommodation.

Treatment.

There were two experimental treatments, groups TP 1and 2 were given injections of testosterone proprionate and oestrogen, 1 and 2 received injections of oestradiol benzoate. Both these hormones were administered in arachis oil and so the control groups, C 1 and 2, received equivalent amounts of oil only. The dose levels followed those used by Andrew (1963), for TP 0.25mg per 20gm of body weight and for oestrogen groups 0.02 mg per 20gm body weight. The amount injected increased with age and varied between 0.1 and 0.4ml. Subcutaneous injections were given daily except at week-ends and the dose increased each week as the mean body weight of each group increased. The control and TP groups both received twenty injections over the four week experimental period, the oestrogen groups received only eighteen injections since deaths from vent pecking in this treatment became intolerable. The treatment began on day fourteen in all groups.

Feather Damage.

The birds were scored daily during the four week experimental period using the eight point scale described in Chapter 2. At the end of this period, when the birds were six weeks of age, they were moved to battery accommodation and scoring was begun again at ten weeks and continued weekly for the next sixteen weeks.

Observations.

Since the main objective of this experiment was to see the effect of TP on feather pecking behavioural observations were fairly scanty. One ten minute general observation was made each week for four weeks on each group, no other behavioural measures were made.

Physical Effects.

All the birds were weighed and had their combs measured each week. This was simply a check to see that the hormones were having a domonstrable physical effect and so the injections could be presumed to have been successful.

Results.

Gross behavioural effects.

There were no very marked behavioural effects due to the injections of TP. The chicks did not crow and fighting was not at all evident. The birds given oestrogen did crouch at the approach of the experimenter's hand but no other changes were observed.

Table 7.2. Experiment 18. Effect of testosterone and oestrogen treatments on body weight and comb factor (length x height).

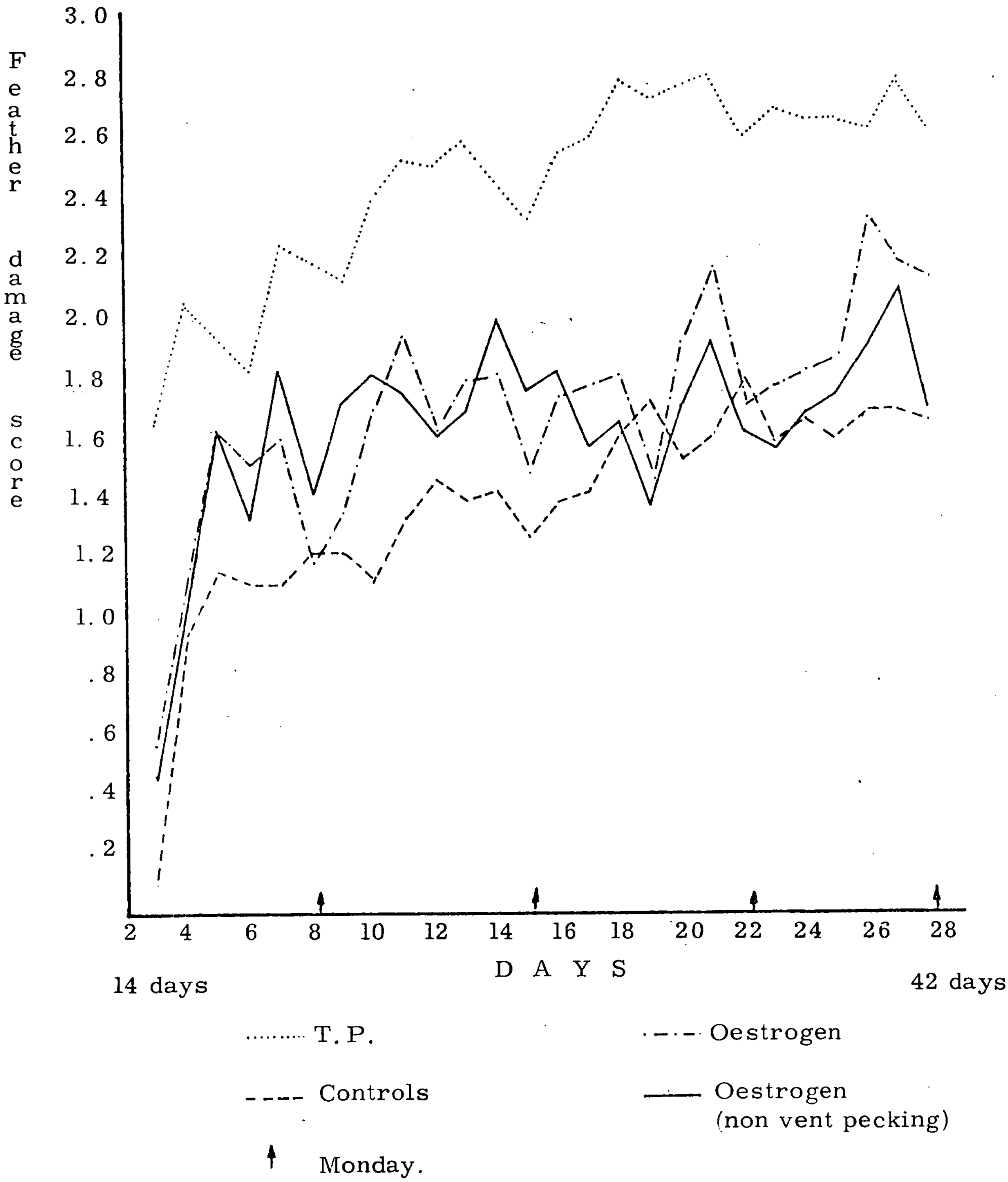
	Control	Oestrogen	Testosterone
Body weight (g/bird)	430	426	391
Comb factor (cm^2)	1.19	0.58	9.03

significance of comparisons

	Body weight		Comb factor	
	T	P	T	P
C v O	0.31	NS	7.71	***
C v T	3.22	**	29.43	***
O v T	2.73	**	32.13	***

NS = not significant; ** $p < 0.01$; *** $p < 0.001$.

Figure 7.1. Experiment 18 Amount of feather damage suffered by the treatments, weeks 2 - 6.



Physical Effects.

The birds in groups given TP were lighter than either the controls or the oestrogen treated groups, but there was no difference between the weights of the latter groups. See Table 7.2. The comb measurements were converted into a comb factor, length x height, following the method suggested by Breneman (1938). A comparison was made between the factors for the three treatments, and it was found that oestrogen depressed comb size, whereas testosterone increased it. Table 7.2. Oestrogen also encouraged the development of the vent which became large and protruberant in all birds treated with this hormone. Five deaths from vent pecking occurred in one of the oestrogen groups. These results show that the hormones were being assimilated and were affecting the physical development of the chicks in the expected way.

Feather Damage.

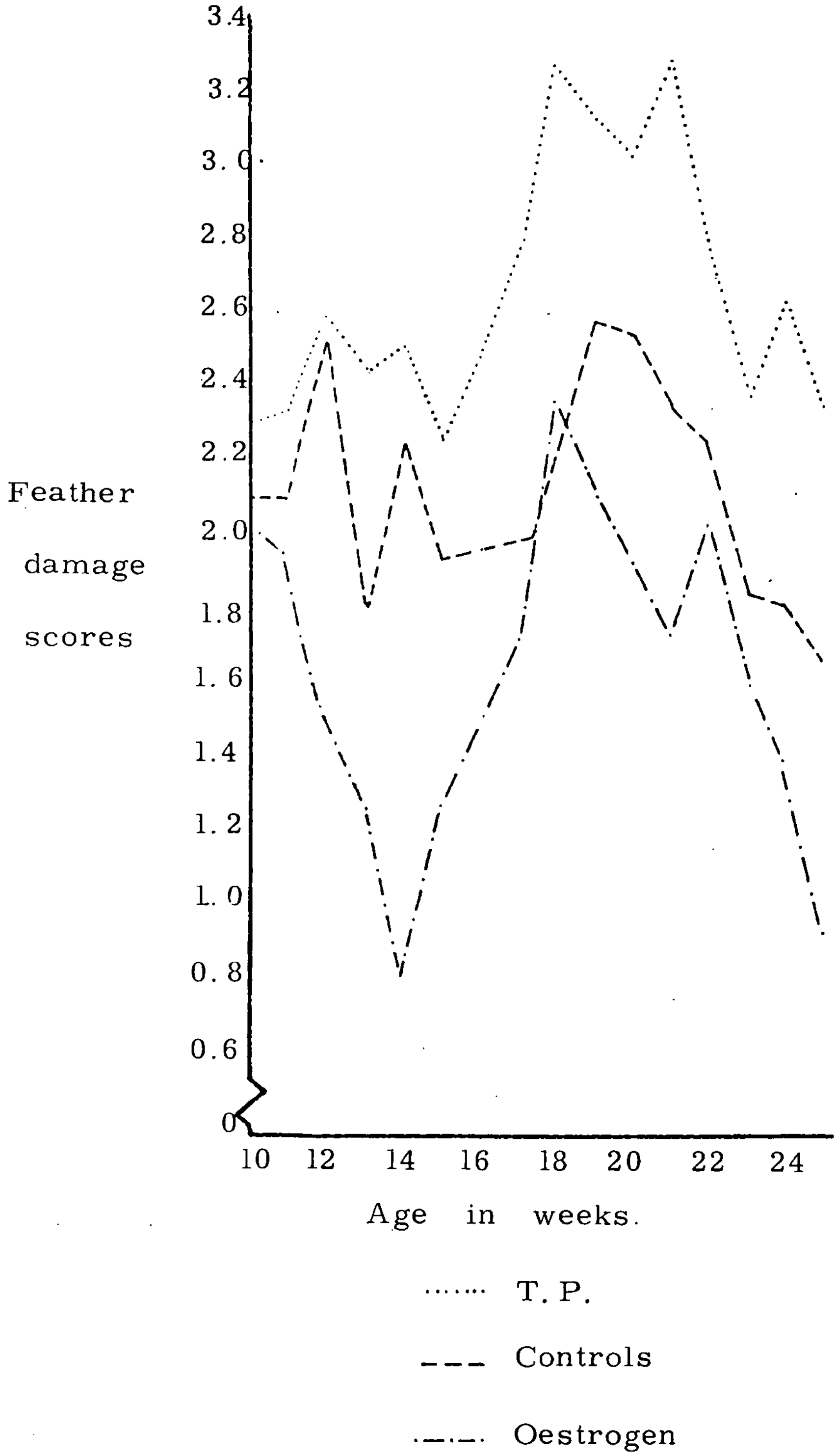
Figure 7.1. shows the amount of feather pecking damage suffered by each of the three treatments in weeks two to six. It can be seen that the groups given TP had more feather damage than the controls, or oestrogen groups, and the oestrogen treatment had higher scores than the controls. Table 7.3. This high score among the oestrogen treated groups was not due to an outbreak of vent pecking in one of the groups since the scores from the group in which there was no damaging vent pecking were often higher than the scores from the vent pecking group.

Table 7.3. Experiment 18. The effect of treatment on feather damage shown as group means.

Age	Control	Oestrogen	Testosterone	F	P
15 - 28 days	0.95	1.25	1.88	7.7	**
29 - 42 days	1.56	1.84	2.62	6.7	**
10 - 25 weeks	4.26	3.29	5.24	11.9	**

** $p < 0.01$.

Figure 7.2. Experiment 18. Amount of feather damage suffered by the three treatments weeks 10 - 25.



The feather damage scores from weeks ten to twenty-five, four to twenty weeks after the end of the treatment, continue to show that TP treated groups suffered more damage than the other treatments. See Figure 7. 2.

The oestrogen birds on the other hand, showed a rapid decline in damage once treatment had ceased and had much lower scores than either of the other treatments.

One interesting point was that all treatments showed an increase in damage between weeks fourteen and twenty-five suggesting some environmental alteration or some developmental change that affected all birds at the same time.

Observations.

The results of the general observations did not show any differences between the behaviour of the three treatments, Table 7. 4. shows the total amount of pecking and the amount of allopecking only, it is possible that the observations were too infrequent to obtain information precise enough to show up any differences.

Table 7. 4. Experiment 18. Total of pecking activity and allopecking during four 10 minute observations periods. Group means.

Group	Total of pecking	Allopecking
Control	7. 43	1. 48
Oestrogen	8. 50	1. 73
T. P.	6. 35	1. 43

Correlations between measures.

Correlations between several behavioural and physical measures were calculated on a within group basis using the Spearman rank correlation (r_s). The results are shown in Table 7. 5.

Table 7. 5. Experiment 18. Rank correlations between various physical and behavioural measures calculated on a within group basis.

Measure Correlated		Control 1	Control 2	Oestrogen 1	Oestrogen 2	T. P. 1	T. P. 2
Body weight and comb factor, week 4	r_s p	+0. 63 **	+0. 10 NS	+0. 59 *	+0. 20 NS	+0. 62 **	+0. 10 NS
Bodyweight at week 1 and week 4.	r_s p	+0. 70 **	0. 53 *	+0. 55 +	+0. 59 *	+0. 21 NS	+0. 51 *
Feather damage at week 1 and week 4.	r_s	-0. 11 NS	+0. 51 *	+0. 50 +	+0. 21 NS	+0. 82 **	+0. 58 *
Bodyweight and allopecking	r_s p	-0. 17 NS	-0. 11 NS	-0. 43 +	-0. 33 +	0. 04 NS	-0. 02 NS
Comb factor and allopecking	r_s p	+0. 2 NS	-0. 1 NS	-0. 26 NS	-0. 64 **	-0. 19 NS	-0. 31 +
Pecking damage and body weight week 1.	r_s p	+0. 25 NS	0. 0 NS	+0. 14 NS	-0. 05 NS	-0. 37 +	+0. 58 *
Pecking damage and body weight week 4.	r_s p	-0. 50 *	-0. 03 NS	+0. 50 +	-0. 01 NS	-0. 29 NS	-0. 27 NS
Pecking damage and comb size	r_s p	-0. 19 NS	+0. 03 NS	+0. 51 +	+0. 05 NS	-0. 61 **	+0. 18 NS

NS = not significant; +, *, **, = $p < 0.1$, < 0.05 and < 0.01 respectively.

Significant positive correlations were found between body-weight and comb factor and body weight and feather damage measured at the beginning and end of the first period. These results show that the physical state of the bird remained consistent.

Correlations involving behavioural measures were variable. Correlations between allopecking and both body weight and comb size were not significant although a negative bias was present in both. When body weight and comb size were correlated with feather damage the results were again variable and probably not very reliable. By week four the weight of the birds and the amount of damage tended to be negatively correlated, although significance occurred only in one control group.

Discussion

The results of this experiment showed firstly that the administration of gonadal hormones does affect the amount of feather damage. This was true for both TP and oestrogen treatments although the effect was much greater in the TP groups. The early development of aggression due to the administration of TP cannot be blamed for this effect since at no time was any form of aggression or even crowing observed in the groups. It could be argued, however, that the increase in feather damage was mediated by different factors, TP acting on the behaviour of the pecking bird by making it more persistent; and the oestrogen acting on the pecked bird, which in this case would have enlarged vents and would crouch and remain still when pecked or touched from the rear. In one group vent pecking developed but this did not affect the damage scores particularly and so cannot be the only reason for the damage of this treatment being greater than the controls.

An interesting finding was that the effects of the treatment fluctuated according to whether or not hormones had been recently administered. Figure 7.1. shows a depression in the damage scores for all the hormonally treated groups on Mondays, treatments were not administered over the week-end. The control groups did not show this variation so it is unlikely to be an artifact due to less handling or other practical measures involved in the experiment. It is possible that in the very early weeks the downy feathers could regrow and the tissue heal in a matter of a couple of days and so give this effect.

Over a much longer time period, weeks ten to twenty-five, the effect of the treatments, no longer being administered, was very marked. The TP birds still had the highest feather damage scores for this whole period while the oestrogen treated birds reduced their level of damage not long after the treatment stopped and remained as the least damaged groups until the end of the experiment. These results appear to be quite contradictory to those of other workers (Hughes, 1973), but since the conditions of the experiments varied to a large extent, this is perhaps not surprising.

There was no obvious environmental change between weeks fourteen and twenty-five to explain the increase in damage that occurred in all treatments at that stage. In view of the main findings of this experiment an explanation based on a rise in endogenous hormones at a particular developmental stage would not seem too impossible. J. Wells (personal communication) found evidence of a rise in testosterone levels in pullets at approximately sixteen weeks of age which would support such an explanation. No attempt was made to measure levels of circulating hormones in the birds in this experiment and so no direct evidence on this point is available.

The physical effects of the hormone, particularly the effect on comb growth showed that the treatments were being effective in the expected way and since the physical characteristics were being altered, it is reasonable to assume that conditions had been created where behavioural changes might also occur.

In fact, when the results of the general observations are compared, it can be seen that there is no difference in the total pecking behaviour of the birds or in the amount of allopecking they do. TP birds do not appear to get "locked on" to a particular type of behaviour and do that more persistently than any other. However, the observations made in this experiment were few and it is possible that insubstantial data obscure any difference. Since the total amount of pecking does not differ between treatments, it is reasonable to assume that any differences in the feather damage suffered by the groups was not due to different levels of general activity.

The results of the correlations showed that body weight of individuals was consistent from week one to week four, and that body weight and comb size were positively related. Neither of these are unexpected findings. Pecking damage was found to remain consistent from the beginning to the end of the treatment period suggesting that birds badly pecked in week one were similarly affected in week four. This supports the earlier findings that only some birds peck or are pecked, if birds were being pecked at random the four week treatment period was quite long enough for denuded areas to regrow on birds pecked during the first week.

The negative correlation between weights and the amount of damage received suggests that it is the smaller birds that are worst affected. Since weights are consistent from weeks one to four, this would imply that small birds are pecked not that pecked birds become small. However, damage is also consistent from weeks one to four, and it is possible that during the first week of the experiment the damage could have affected weight to an appreciable extent. Further observations must be made before a firm conclusion can be reached.

There was also a negative relationship between weight and allo-pecking, thus the lighter birds did most pecking and were most pecked. This finding is contrary to all the previous observations in which one or two birds were found to do a great deal of pecking but not be pecked themselves. Both the significant correlations were in the TP treatment and since the overall effect of this was to increase pecking damage dramatically it is assumed that these correlations are the result of a hyperactive group as far as allopecking is concerned in which all birds were turned into peckers and all became targets.

The one exception to the negative weight/damage relationship

Table 7.6. Experiments 19 - 21 Experimental Details

Experiment number		Group size	No. replicates per treatment	Age at injection	Age during observations	Doses C	D1	D2	D3	Observations Feather damage	Bodyweight comb size	General observ.	Activity observ.	Stim obser.	Egg prod.
						A 0.0 B 0.0	0.02 0.01	0.16 0.08	1.4 0.7						
19	1	15	6	18 days	3 - 9 weeks	A	A	A	A	✓	✓	✓	✓	-	-
	2	7	11	-	14 - 25 weeks	-	-	-	-	✓	✓	-	-	-	✓
20	1	15	6	18 days	3 - 9 weeks	A	A	A	A	✓	✓	✓	✓	✓	-
	2	7	11	98 days	14 - 25 weeks	B	B	B	B	✓	-	✓	✓	-	-
21		15	2	18 days	3 - 7 weeks	A	-	-	A	✓	✓	✓	✓	-	-
22		16	1	18 days	3 - 8 weeks	A	A	-	A	✓	✓	feather pecking observations			

was found in group oestrogen 1. In this treatment group a large bird was probably a particularly large vented, frequently crouching bird, one in which the oestrogen was having a very marked effect, and as such would be less active and so do less pecking, but it would also be a very good target for the pecks of cage mates. Why this effect was not found in oestrogen group 2 is not clear.

The main finding of this experiment was that treatment by gonadal hormone did affect the amount of feather damage received by the subjects. Also that physical aspects such as comb size and body weight were associated with different levels of pecking; whether as a result of the treatment or of the pecking damage was not clearly established. It now remained to make more detailed observations of the treated birds and to use different dose levels to investigate the effects more fully.

EXPERIMENTS 19 - 21.

A series of three experiments was carried out to test further aspects of the effect of testosterone on feather pecking. Since these had many features in common they are described here together. This common description covers all aspects of Experiments 19, 20 and 21.

Method

The general feature of the three experiments are summarized in Table 7. 6. In Experiment 19 the behavioural responses to a range of testosterone levels were studied. In the experiment some observations were continued until twenty-five weeks of age. Experiment 20 was partly a repetition of the earlier experiments but also extended the treatments to older birds in view of the findings of Hughes (1973) that administration of testosterone to fourteen week old birds reduced feather damage. Experiment 21 was carried out specifically to provide more detailed observations on general behaviour on the two most extreme treatments used.

Subjects.

Female light hybrid chicks were used throughout. In Experiments 19 and 20 they were reared in groups of fifty under normal battery conditions before being allocated to treatment groups at eighteen to nineteen days when the hormone treatments were administered. Whenever possible spare birds were used to replace losses which occurred early in the experiments. Prior to phase 2 of Experiment 20 the birds were regrouped at random before having new treatments administered. In most cases groups of fifteen birds were used with the number of replicate groups shown in Table 7. 6. In phase 2 of Experiment 20 the fourteen week old birds were formed into groups of seven. All other rearing conditions were as described in Chapter 2.

Treatments.

The hormone preparations and the choice of dose have already been discussed. As shown in Table 7. 6. the doses were calculated to provide the equivalent of 0. 02, 0. 16 and 1. 4mg testosterone per 20gm body weight per day when averaged over twenty-eight days. Testosterone was administered in arachis oil, the controls receiving oil alone. The above doses were administered at eighteen to nineteen days in all experiments except for phase 2, Experiment 20; in this case lower doses were used since calculation on the same body weight basis would lend to the use of massive doses. The doses were thus reduced to 0. 01, 0. 06 and 0. 18mg testosterone per 20gm body weight per day, but for convenience the same treatment codes are used throughout.

Observations.

In most cases observations were made during a period of six weeks after treatment (four weeks in Experiment 21). The detailed timing of the observations is shown in the tables of results.

In Experiment 19 general observations (Chapter 2) and activity measurements were made. Activity was measured by counting

Table 7.7. Experiments 19 - 21. Effects of testosterone administration on body weight and comb size.

Body weight (g/bird)

Experiment		Control	Dl	D2	D3	F	P
a 19		924	905	894	888	0.08	NS
b 20	1	398	396	382	379	4.92	+
20	2	No observations made.					
c 21		381	-	-	340	4.5	+

a. Average weight weeks 0 - 6 after treatment.
b. Average weight at 6 weeks of age.
c. Average weight at 6 weeks of age.

Comb factor (length x height)

Experiment		Control	Dl	D2	D3	F	P
a 19		1.69	2.42	7.40	11.06	46.76	***
b 20	1	1.4	3.2	5.4	11.8	18.20	**
	2	No observations made.					
c 21		1.8	-	-	9.5	9.0	**

a. Average comb size 0 - 6 weeks after treatment.
b. Average comb size at 6 weeks of age.
c. Average comb size at 6 weeks of age.

+	significant at the			0.1	level.
**	"	"	"	0.01	"
***	"	"	"	0.001	"

the amount of movement around the cage. Four structural bars divided the cage into three sections and an activity score of one was given for each bird that crosssed from one section into another or moved from the back of the cage to the front or vice versa. In this experiment group scores only were obtained.

In Experiment 20 and 21 general observations and activity measurements were made. In addition in phase I of Experiment 21 the reaction of birds to two stimuli was tested. The stimuli, the green wooden block and the model bird with a patch of red feathers, (see Figure 2.2.) were placed in the food trough in front of the cage for five minutes. Reaction in terms of facing, approaching and pecking the stimulus was recorded. The tests were arranged so that no group was tested on the same day as its nearest neighbours since it was possible to see the stimuli from one cage to the next.

Feather Damage.

Feather damage was scored in all experiments, generally on a weekly basis, using the eight point scale described in Chapter 2.

Physical Measures.

Measurements of body weight and comb size were made weekly to establish the effectiveness of the hormone treatments. Longer term measures, including the onset of egg production, were made in Experiment 19 alone.

Results.

Physical Effects of Treatments.

As shown in Table 7.7. in all the experiments testosterone tended to reduce body weight slightly and to increase comb size very considerably and significantly. These results show that the testosterone treatments had the expected physical effects.

Feather Damage.

The average feather damage scores observed in each experiment are shown in Table 7.8. Apart from Experiment 21 it was a consistent finding that the highest dose of testosterone increased feather damage scores. In the earlier stages of Experiment 19 the overall treatment effect was not significant but the score on D3 was significantly greater than Dl. The overall effect was significant in Experiment 19, observation 2, and in Experiment 20, phase 2. The overall damage scores were very low in both Experiments 20 and 21.

Table 7.8. Experiments 19 - 21. Effect of testosterone administration on feather damage scores.

Experiment		Control	Dl	D2	D3	F.	P.
a 19	1	2.7	2.0	3.3.	5.0	1.80	NS
b 19	2	4.6	3.8	5.4	8.2	4.38	**
c 20	1	0.87	0.80	0.87	1.21	0.47	NS
d 20	2	0.82	0.61	0.85	1.32	7.72	***
e 21		0.60			0.0	-	-

a) Mean score for groups of 15 birds averaged over 7 weekly observations.
b) " " " " " " " " 12 weekly observations.
c) " " " " " " " " 7 weekly observations.
d) Mean score for groups of 7 birds averaged over 12 weekly observations.
e) Mean score for groups of 15 birds averaged over 10 weekly observations.

** Significant at the 0.01 level.
*** " " " 0.001 level.

In Experiment 19, observation 2, made at twenty-five weeks of age, i.e. twenty-two to twenty-three weeks after treatment, the treatment effect on feather score persisted. The administration of hormone to older birds in Experiment 20, phase 2, also produced a significant effect on damage scores.

Table 7.9. Experiments 19 - 21. Effects of testosterone administration on general behaviour.

	C	D1	D2	D3	F	P
Self pecking						
Experiment 19[a]	1.8	1.8	1.8	2.1	1.01	NS
" 20 (1)[b]	1.8	1.5	1.5	1.7	1.61	NS
" 20 (2)[c]	1.3	2.2	1.9	2.2	8.99	***
" 21[d]	2.4	-	-	2.6	0.32	NS
Allopecking, total						
Experiment 19	1.0	0.9	1.1	1.6	1.81	NS
" 20 (1)	1.1	1.4	1.0	1.5	1.37	NS
" 20 (2)	1.3	1.1	1.1	1.1	1.93	NS
" 21	1.7	-	-	1.8	0.04	NS
Allopecking, barb						
Experiment 19	0.8	0.8	0.8	1.2	0.64	NS
" 20 (1)	0.5	0.5	0.3	1.0	3.86	*
" 20 (2)	0.1	0.2	0.2	0.3	2.99	*
" 21	0.8	-	-	1.1	0.1	NS
Environment pecking						
Experiment 19	0.7	0.5	0.7	0.3	5.09	**
" 20 (1)	0.7	0.6	0.7	0.4	1.21	NS
" 20 (2)	0.9	0.9	1.2	1.1	1.21	NS
" 21	0.9	-	-	0.6	2.85	NS
Food pecking						
Experiment 19	5.6	5.5	5.4	4.2	2.20	NS
" 20 (1)	3.8	4.3	3.7	3.1	0.74	NS
" 20 (2)	2.2	3.2	2.4	3.1	3.81	*
" 21	1.5	-	-	2.1	2.04	NS
Total pecking						
Experiment 19	9.0	8.7	9.0	8.1	1.42	NS
" 20 (1)	7.4	7.7	6.8	6.7	0.95	NS
" 20 (2)	5.8	7.3	6.9	7.5	6.61	***
" 21	6.6	-	-	7.0	0.27	NS

a) Figures are bird means, averaged for 9 observations, twice weekly for 1st three weeks and once weekly for second three weeks of the experiment.

b) & c) Bird means, averaged for six weekly observation periods.

d) Bird means averaged for the observation periods made over 4 weeks.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Although the effect was in no case significant, it is interesting that in all three experiments the lowest dose of testosterone slightly reduced feather damage in comparison with control birds.

General Observations.

The scores obtained from the general observations are shown in Table 7. 9. The overall results show that behaviour was not markedly affected by the treatments and a majority of the significant results were found when the treatments were applied at fourteen weeks of age in Experiment 20, phase 2. This concentration of significant results is largely explained by the smaller errors which were obtained in this experiment rather than by the size of the treatment effects. In Experiment 21, which was specifically carried out to provide more complete observations on the extreme treatments, the absence of effects was striking.

There are however, some general tendencies that can be noted. Within a constant level of total pecking, environment pecking, and in Experiment 19 food pecking, also tended to be lower on the highest testosterone treatment. Conversely allopecking and especially barb pecking tended to increase on this treatment. In both phases of Experiment 20 the effect on barb pecking was significant. In phase 2 of this experiment self pecking was also significantly increased by testosterone treatment but this effect is very inconsistent across the experiments as a whole.

In general it can be said that there is some evidence that pecking behaviour is directed more towards birds, and less towards the environment when testosterone is administered.

Activity.

Table 7.10 shows the activity scores obtained in each experiment. In Experiment 19 a consistent, marked and significant increase in activity was observed with each dose of testosterone, (and in Experiment 21 this same increase was observed between control and dose 3 birds). In the remaining experiments such an effect was not demonstrated and the treatment differences, although in the same direction, were small.

Table 7.10. Experiments 19 - 21. Effect of testosterone administration on activity.

Experiment		Control	Dl	D2	D3	F.	P.
a 19		76.7	88.7	98.4	117.0	6.02	**
b 20	1	4.0	3.7	3.2	4.1	1.60	NS
c 20	2	2.5	2.5	2.1	2.7	1.64	NS
d 21		6.4	-	-	9.7	5.48	*

a) Mean score for groups of 15 birds averaged over 9 observations.
b) " " " " " " " " 6 "
c) " " " " " 7 " " " 6 "
d) " " " " " 15 " " " 10 "

Mortality due to feather pecking.

In Experiment 19 mortality due to feather pecking was considerable, forty-two birds or 11.7% dying during the experiment. The number of deaths for individual treatments were 12, 12, 9 and 6 for C, Dl, D2 and D3 respectively. The deaths occurred gradually throughout the experiment and not at a specific stage in the birds development. Thus mortality due to feather pecking in this experiment showed an exactly converse pattern to feather pecking damage (See Table 7.8.)

Egg production.

Egg production was recorded in Experiment 19 for a four week period from the onset of lay in the flock. The number of eggs per bird was slightly increased by the testosterone treatment, the numbers being 12.9, 11.7, 13.7 and 15.0 per bird for treatments C, Dl, D2 and D3 respectively.

Response to stimuli- (Experiment 20, phase 1)

Table 7.11 shows the reaction of the treatments to the stimuli, neither of which received a marked response. Of the three categories of response recorded only "facing the stimulus" was scored frequently enough to be analysed statistically. None of the treatments differed significantly in this behaviour although the administration of D2 and D3 did depress the number of individuals making this response. D1 birds behaved exactly like controls.

Table 7.11. Experiment 20. Mean number of birds facing the stimuli during stimulus tests.

Stimulus	Control	Dose 1	Dose 2	Dose 3	Total	F	P
Green block	19.3	19.9	19.9	15.5	74.6		
Bird model	18.2	18.4	11.9	14.2	62.7		
TOTAL	37.5	38.3	31.8	29.7	137.3	0.0017	NS

Discussion

The one effect that remained constant throughout these experiments was that high doses of testosterone increased the amount of feather damage observed and low doses reduced the amount of damage. This finding is difficult to interpret but it does support the apparently differing results found in Experiment 18 and the work of Hughes (1973).

It is still uncertain how the hormone has its effect, none of the other measures made during these experiments remained constant across experiments, even though the effect on pecking damage did.

Thus an increase in general activity which could have been used to explain the findings in Experiments 19 and 21 is an inadequate explanation for Experiment 20, phase 1 and 2.

Similarly, increased allopecking in treated groups found in Experiments 19 and 20, phase 1, seemed an "appropriate" cause of the increase in feather damage and yet in Experiments 20 phase 2 the difference between treatments in the amount of allopecking shown was small, even though the difference in feather damage was considerable. It is possible that the method of recording behaviour is responsible for some of this discrepancy. The time sampling method, although adequate when recording most behaviour patterns, may not produce results that make it possible to distinguish between frequently and very frequently occurring behaviour.

Another possibility is that the hormone is acting indirectly rather than on the actual feather pecking behaviour. Since feathering is under hormonal control to a large extent, it is perhaps possible that there was an alteration in the pattern or growth rate of the feathers, or that the birds began an early moult. However, this was not at all apparent and certainly did not happen in the conventional way, with the large tail and wing feathers being lost first, followed by feathers on the neck and a generally ragged appearance. The treated birds in fact had much sleeker plumages than the controls and when damage occurred it was in discreet areas, such as the centre of the back, the wing and the tail. The treated birds certainly preened more than the controls but this might have been due to increased action of the uropygial gland in response to stimulation. Van Oordt (1963) reported that in mice increased levels of testosterone resulted in larger sebaceous glands, a similar relationship in fowls is not impossible (Kar, 1947)

Even if moulting cannot account for the difference in the plumage condition, it is possible that the hormone made the feathers more easily removable and that even a light peck such as a barb peck could result in damage. If this had been the case then it would have been noticed during observations and there was certainly no evidence of this.

Just as the observations on behaviour did not always fit the findings neither did the level of mortality due to feather pecking, since it was found that the number of deaths due to feather pecking were reduced by the treatment. This is a difficult result to understand, since feather damage was increased by treatment it would be expected that deaths due to feather pecking and cannibalism would be too. The deaths occurred at all times during the experimental period and so phenomena such as prolapsed vents followed by vent pecking cannot be a major causal effect.

The lack of response to the stimuli was disappointing. The rationale for introducing the stimulus tests was that an injection of testosterone might increase "aggressive" behaviour. If this were the case the birds response to these fairly arbitrary stimuli might show some difference between treatments. If the bird model was approached, or challenged, or attacked differently by the treatments, then some comment on treatment and levels of aggression could be made. Alternatively, the green block might be investigated by the more curious of the groups, this again might be affected by treatment, a possibility worth investigating.

The treated birds do show a reduction in the 'facing the stimulus' measure as the dose increases and so it is possible that with increased observation or with more sensitive measures involving records of vocalizations, freezing etcetera, a clearer result might have been obtained. The reduction in response by dose 2 and 3 birds would suggest that no conventional explanation in terms of increased curiosity or lack of fear on the part of the treated birds led to a greater amount of feather pecking.

Perhaps the reduced response to the stimuli shows the other side of Andrew's persistency hypothesis. A new situation might be accepted more slowly by birds that had become persistent in established behaviour patterns as a result of treatment with testosterone. Quadagno, Shryne ; Anderson and Gorski (1972) found a reduction in exploration in female rats after treatment with exogenous testosterone, it would seem that a similar effect exists in chickens. Since a numerical record of freezing was not made it might be possible to argue that birds in the control and low dose treatments were in fact alarmed and froze facing the stimuli, whereas birds in treatments 2 and 3 began to behave "normally" and in continuing with other activities faced away from the stimulus on more occasions than the "frozen birds". However, "normal" behaviour would usually involve the investigation of an unfamiliar stimulus rather than total avoidance of it. Thus it is unlikely that these birds were too preoccupied to give even a glance at the stimulus and the initial conclusion that they were actively less responsive to it is probably accurate. Archer (1976) reports similar findings.

The physical effects of the treatment, in terms of body weight and comb growth, need little in the way of discussion. Increase in comb growth but an overall decrease in body weight were found in association with the treatment as in the previous experiment. These results simply confirm that the hormones were being absorbed and were working in the normal manner. The differential effects of the different dose levels is important since from these it can be seen that a ceiling, in physiological terms at least, was not reached before the high dose level.

Egg production showed no ill effects from the treatment, in fact the reverse was true, the higher the dose the higher the production. The explanation for this presumably lies in the effect of the experimental treatment affecting the endogenous levels of hormone being produced weeks after the end of the treatment.

The findings of these experiments support the earlier work suggesting that testosterone increases feather damage but there is still no clear indication as to how or why this increased damage occurs. It does not seem likely that the slight increase in allopecking; which was found to be mostly an increase in barb pecking; could account for the differences in plumage conditions and yet the appearance of unpecked birds from treated groups rules out the suggestion of changes in the pattern of feather growth or loss. Perhaps rather than increasing feather pecking behaviour it is the pecked birds that are affected. Treatment might make them more attractive or easily damaged targets. The observations reported so far suggest that either the pecker, the pecked birds or both could be involved.

EXPERIMENT 22.

In an attempt to discover whether testosterone had its effect on feather damage, by acting on the pecker or on the pecked bird, an experiment was designed in which birds receiving different hormonal treatments were housed together. The resulting behaviour of the birds within these mixed groups could then be compared.

Method

The three groups used in this experiment were C + Dl; C + D3; and Dl + D3. There were sixteen birds in each group, eight of each treatment. The two extreme doses of testosterone were used since it was possible to make only a limited number of intensive observations. This is also why no replications of the treatments were used. In all but group composition the treatment of these birds was as described for the single treatment groups. Table 7. 6.

Feather damage was scored weekly as were body weight and comb size. General observations and activity observations were not made in this experiment but more detailed observations of feather pecking behaviour were made. This was done by counting the number of times that individual birds in the groups pecked each other. During these observations every feather peck made by a bird during a ten minute period was recorded. The recipient and area pecked were not recorded and also feather pecking alone was counted; barb pecking and aggressive pecking, should any be shown, being excluded.

Since one possible effect of treatment with testosterone was an increase in persistance in behaviour it was thought that pecking might occur more frequently in bouts in treated birds. Certainly feather peckers appeared to show bouts of pecking. For this reason records were also made of the number of times bouts of pecking occurred; a bout being defined as a number of pecks given in rapid succession and usually but not always to the same area on the same recipient. Since

Table 6.1. Experiment 15a. The pecking behaviour of two strains of birds reared in two different environments.

Strain	Environment	Pecking Behaviour: Self	Allo-pecking	Environment	Food	Environment + Food	Total
		Total number of pecks per pen.					
Light hybrid	Pens	175	16	283	138	421	611
	Cages	205	46	63	175	238	489
Medium hybrid	Pens	217	17	268	118	386	620
	Cages	210	32	67	215	282	523
Main effect of environment[a]							
	Pens	196	17	276	128	404	616
	Cages	207	39	65	195	260	506
	F	0.43	18.75	256.0	8.0	38.9	39.33
	P	NS	***	***	*	***	***

[a] The effects of strain and the strain x environment interaction were not significant.

* Significant $p < 0.05$.
*** " $p < 0.001$.

it was extremely difficult to count the number of pecks made during such a bout this was not recorded but simply the fact that a bout had occurred.

The nature of the observations made it impossible to be more precise in determining bouts and so no time limits with respect to bout-length or inter-bout intervals were set. Also feather pecking behaviour was not readily grouped into such periods since it happened very rapidly but for a comparatively short period of time, just a few seconds; unlike feeding in which bouts of several minutes can be recorded, (Duncan, Horne, Hughes and Wood-Gush, 1970; Slater, 1974).

Results.

The question posed in this experiment was whether the behaviour of all the birds within each of the mixed groups was the same or whether it differed depending on treatment. Thus comparisons are made of the behaviour of sub-groups within groups using X^2 tests.

Feather Damage.

The results shown in Table 7.12. demonstrate clearly that although amounts of damage were small the treatment acts independently of the environment. A distinction in the amount of damage suffered was clear in all but the group containing C and Dl birds in which there was no feather damage at all. In both the other groups the D3 birds suffered less damage than the controls.

Feather pecking behaviour.

Table 7.12 shows the results of the observations on feather pecking activity. It can be seen that hormonal treatment affected both the total number of pecks and the number of bouts of pecking. In each of the groups the birds given testosterone did more feather pecking and more bouts of pecking than the controls housed with them and D3 birds showed a higher level of these behaviours than the Dl birds housed with them.

This makes it quite clear that testosterone affects pecking

Table 7.12. Experiment 22. Comparison of the behaviour of the different treatments within each group.

Groups / Measure		C + D1		C + D3		D1 + D3	
		C	D1	C	D3	D1	D3
Feather damage score.	observed	0	0	31	7	6	0
	χ^2	0		15.16		6.0	
	P	NS		***		*	
Total number of pecks at feathers.	observed	23	56	63	73	54	111
	χ^2	6.55		53.4		19.7	
	P	**		***		***	
Feather pecking bouts	observed	0	2	11	63	0	14
	χ^2	2.0		36.5		14.0	
	P	NS		***		***	
Comb size cm^2	observed	0.98	1.66	1.73	11.88	1.60	12.13
	t	2.37		10.13		12.04	
	P	*		***		***	
Body weight g/bird	observed	397	388	324	294	347	306
	t	0.17		1.57		3.02	
	P	NS		NS		NS	

* P Significant at the 0.05 level

** " " " " 0.01 "

*** " " " " 0.001 "

behaviour but since the largest number of pecks and bouts were made when treated and control birds were reared together it would seem that the behaviour of the other birds in the group, the potentially pecked birds, may also be important.

Physical effects.

These were as found in previous experiments, comb size increased with dose level and body weight decreased although not significantly. These results were independent of the rearing conditions.

Discussion

The most important finding of this experiment was that the hormone treatment increased the feather pecking behaviour of the treated birds and not that of the controls housed with them. This effect was apparent in both the high and low dose groups, but the greater the dose of hormone the greater the increase in pecking behaviour. Another aspect of this result was that there was more feather pecking when groups contained control birds as well as treated ones, rather than two different treatments. Since there were no group replications the reliability of this finding is unknown but considering the results found in Chapter 5 it would seem quite probable that the behaviour of the birds that are potentially 'the pecked' would be important in influencing the type of behaviour that occurred in a group. If, for example, there were a number of birds that were not very active in general movement around the cage, then these birds might invite more pecks than birds that were constantly moving. This view is supported by the finding that there were far fewer bouts of feather pecking in the Dl and D3 group than in the C + D3 group which suggests that in this instance none of the birds were prepared to 'accept' a bout of pecking unlike the controls in C + D3.

The separate feather damage scores for birds in these mixed groups, show clearly that the control and Dl birds had more damage than the D3 birds housed with them. The C + Dl group did not show any difference between the treatments. These results again support the view that the high dose testosterone birds administer more pecks and receive less, suggesting that the control birds are in some way more attractive to peck at.

If treatment with testosterone has these two effects, that of increasing feather pecking behaviour and reducing the amount of pecking a bird will tolerate then explanations for two previously contradictory findings are possible. Firstly the findings that low doses of testosterone reduced feather damage, Experiments 19 and 20. If these birds were not giving a greatly increased number of pecks (feather pecking was found to increase with dose) and at the same time were more active in avoiding repeated pecks, then the ensuing damage might well be less than control birds that would not take avoiding action. The finding that mortality due to feather pecking was inversely related to dose level and to pecking damage, Experiment 19, can be similarly explained.

High dose testosterone birds would give a large number of pecks and so pecking damage would be high, however, since recipients would not stand and receive a large number of pecks in one area at one time there would be few birds with deep wounds and acute injury. The lower dose birds and controls might suffer less overall damage because of less pecking but would not protect themselves from acute injury by taking avoiding action.

Thus the effect of testosterone is to increase the amount of feather pecking behaviour shown by treated birds and this in turn results in increased feather damage. However, as the results of this experiment show the behavioural effect of this treatment was only discernable with detailed observations on the pecking behaviour and was not reliably recorded when a less sensitive form of observation was used.

EXPERIMENT 23.

One of the findings of Experiment 18 was that testosterone was not the only hormone to increase feather pecking, the birds given oestrogen also showed more damage than the controls. The birds treated with oestrogen developed very enlarged vents and several of them died from vent pecking. It seemed that the increased feather damage might have been due to increased pecking around the tail and vent area and rather than the oestrogen increasing the birds pecking behaviour, it might simply have resulted in the development of a particularly good stimulus for the birds to peck at.

To investigate this, some of the groups in this experiment were composed of both treated and non-treated individuals and the difference in their behaviour and the amount of pecking damage received would, it was hoped, show how oestrogen influenced feather pecking.

Method.

Subjects.

One hundred and eight female white leghorn chicks were obtained at day old from a commercial hatchery. They were placed in six groups of sixteen and reared as described in Chapter 2.

Treatment.

Injections were given daily, excluding week-ends, from day fourteen to forty-two. The dose levels used were 0.001mg. per 20gms. body weight for dose 1 and 0.04 mg. per 20gms. body weight for dose 2. Both doses were given in arachis oil, the control birds received injections of oil only. Only half (eight) of the birds in each of the experimental groups were given oestrogen, the remaining eight birds were given the control treatment, there were two replicates of each dose level. In addition to the mixed groups there were also two groups of sixteen birds that had been given oil only.

Observations

General observations (Chapter 2) and feather pecking observations were made weekly. During the feather pecking observations a continuous record of all feather pecking incidents were made over a period of five minutes, (as in Experiment 22).

Feather damage.

Feather damage was scored every two days and the weight of the birds taken weekly. The amount of oestrogen given was based on the mean body weight of each group.

Results

Gross behavioural effects.

The birds receiving oestrogen treatment crouched at the approach of the experimenter's hand but there were no other very obvious behavioural differences between the treated and control birds. As in Experiment 18 the treated birds did have enlarged vents and this effect was related to dose, the birds with high doses having larger vents than those with low doses.

Feather damage.

See Table 7.13. Comparison of the pen means for feather damage shows very similar values for the control and C + D2 pens, both being significantly greater than the C + Dl pens. However, one of the control pens had a very high score for damage which biased these findings to a considerable extent. Within groups the hormone treated birds had higher damage scores although the effect was only significant for the C + Dl treatment.

Feather pecking behaviour.

There was no difference in the amount of feather pecking behaviour shown by the treatments when the groups were considered as a whole. When the results for treated and control birds were separated however, Table 7.14, it can be seen that the controls did significantly more pecking than the treated birds. In addition controls in mixed groups did more pecking than controls reared on their own. There appeared to be a dose effect of some sort, both controls and oestrogen birds in dose 2 doing more pecking than those in dose 1 and controls alone doing least of all.

Table 7.13. Experiment 23. The effect of oestrogen treatment on feather damage. (Mean scores over whole experiment).

Treatment	C	C + D1		C + D3		T	P
		control birds	treated birds	control birds	treated birds		
Comparisons within pens	-	0.84	1.06	-	-	3.04	**
	-	-	-	1.58	1.64	0.83	NS
Comparison between pens	1.67	0.95		-		11.51	***
	1.67	-		1.61		0.96	NS
	-	0.95		1.61		12.92	***

** Significant at the 0.01 level.

*** " " " 0.001 level.

Table 7.14. Experiment 23. Total number of pecks recorded during four 15 minute feather pecking observations.

Treatment	Control	Oestrogen	χ^2	P
Control	47	-	-	-
Dose 1	91	40	19.85	***
Dose 2	112	78	6.08	*

* Significant at the 0.05 level *** Significant at the 0.001 level.

Distribution of pecks.

During the general observations the area of the peckedbirds body involved was recorded for each allopecking incident. Table 7.15 shows the number of pecks directed at each area of the body by birds under different treatments. The distribution of pecks differed in a general way amongst the treatments but most particularly with respect to back and tail pecking, which together accounted for most of the pecks received. Chi-square tests on the incidence of pecking on these two sites showed a significant excess of back pecking in control groups ($X^2 = 27.7$; p 0.001 and 9.27; p 0.01 for doses 1 and 2 respectively). Furthermore, when compared with the average distribution of back and tail pecking the patterns observed within the treatments were also significantly different ($X^2 = 37.0$; p 0.001). Vent pecking was not scored separately from tail pecking and so it can only be assumed that pecking at the tail region was increased in the treated groups by the presence of the enlarged vent.

Table 7.15. Experiment 23. Total number of pecks directed at different body areas recorded during four 10 minute general observation periods.

Area	Control	Oestrogen 1	Oestrogen 2
Back	48	14	53
Tail	21	59	87
Front	12	10	7
Wing	25	10	40
Side	2	3	10
Head	1	6	7
Neck	7	18	2
Leg	0	2	4
Total	116	122	210

General observations.

The behaviour recorded during these observations showed that the total amount of pecking behaviour did not differ significantly between the groups; but as Table 7.16 shows, the scores gradually decreased from control to dose 1 and dose 2 showing the least pecking behaviour, food pecking was also decreased by treatment. Allopecking was the only behaviour to increase with treatment but this was again not significant. There was no significant difference in the amount of environment or self pecking, although dose 1 birds did do more self pecking than either controls or dose 2.

Table 7.16. Experiment 23. Effect of oestrogen treatment on behaviour observed in the general observations.

Pecking Behaviour	Control	Control + Dose 1	Control + Dose 2	F	P
Self	32.7	41.5	33.5	-	NS
Environment	13.3	13.7	12.5	-	NS
Allopecking	15.5	12.7	20.7	-	NS
Food	38.3	24.8	17.8	15.90	*
Total	99.8	95.2	84.5	1.26	NS

* $p < 0.05$

Body weight

As in Experiment 19, body weight was found to increase with treatment. The mean weight of the controls was 400g and of the treated birds 410g and 416g for dose 1 and 2 respectively.

This is interesting in view of the finding of the general observations that groups including hormonally treated birds peck less at food than the all control groups.

Discussion

The main effect of injecting fourteen day old female chicks with oestradiol benzoate was to increase the amount of feather damage suffered by the treated birds. Since controls reared in the same cages as treated birds had lower scores for feather damage, it is probable that the effect of oestrogen was to increase the number of pecks the birds received rather than the number they gave. Whether it was behavioural or physical attributes that were affected by the hormone is not clear. However, it was found that groups containing oestrogen treated birds were less active in total pecking behaviour than groups of controls alone and that this effect was dose related, dose 2 groups being less active than dose 1. Thus it could be that oestrogen makes the birds generally less responsive, both to the environment and to pecks from other birds and so they become more damaged. Allopecking was found to be the one type of pecking that the cages with treated birds did more of than the controls caged alone. There could be two explanations for this, either contrary to the previous argument - oestrogen does increase the feather pecking behaviour of the treated birds or the treated birds have some physical or behavioural attribute which encourages the control birds housed with them to show more allopecking and to direct most of it at the treated birds. In support of the latter argument is the finding that oestrogen birds are more damaged than controls, this would not be expected unless there was something specific about oestrogen treated birds that elicited more pecks. The finding that more pecks at the tail region, including the vent, are directed at the oestrogen birds suggests that there is, in fact, something different about these birds that elicits pecking behaviour. Also the results of the feather pecking observations show that controls do indeed do a great deal more of the pecking than oestrogen birds.

No distinction was made between the tail and vent areas and so it is not possible to tell whether the stimulus that encouraged extra allopecking was the enlarged vent itself or whether this was only one aspect of the treated birds that elicited more pecking. The feather pecking behaviour of the treated birds as well as the controls reared with them appeared to be dose dependent since both types of birds in dose 2 did more feather pecking then in dose 1. This would suggest that the same stimuli that result in more pecks from the controls also increases the number of pecks from the treated birds to a greater or lesser extent.

The general observations did not distinguish between the treatments on behavioural grounds except for feeding and perhaps the total amount of pecking shown. This is not particularly surprising since each group was comprised of eight treated and eight control birds and so any effect there might have been due to treatment was very much diluted by the eight controls in the same group. In the following experiment (Experiment 24) this confusion was avoided by identifying the birds as treated or controls in the general observations and so getting separate results within each group.

Feather damage in groups composed only of control birds was in one case greater than controls housed with treated birds and in the other case less. This emphasises the problem of interpreting data which have been found to depend so largely on the behaviour of a few individuals. However, such a control is useful (when comparisons of a more detailed nature, such as the general observations are being made) and when physical effects of the treatment are being monitored.

In fact the effect of the hormone on weight was as found in Experiment 18, treated birds being slightly heavier than controls. This is an interesting finding in relation to behaviour, since the general observations showed that the treated birds pecked less at food than the controls. No records were made of the actual amount of food ingested so it is possible that the birds were only pecking at rather than eating the food. Also, the effect of oestrogen on weight increase is physiological so that the same intake could result in different weight gains due to changes in metabolic rate, fat deposition etcetera (Sturkie,1965).

This experiment has repeated the finding that oestradiol benzoate increases feather damage and suggests that the effect of the hormone is to make the birds more pecked rather than more pecking. However, an increase in pecking by all birds must be involved to explain the findings of Experiment 18 in which only treated birds were housed together and yet increased damage was observed.

Since information on the identity of the recipients of the pecks, whether control or treated, as well as the identity of the peckers, would make it possible to be more precise about the action of the hormone, these were the factors investigated in the next experiment.

EXPERIMENT 24

The results of the last experiment confirmed the finding that treatment with oestrogen increased feather damage. It is still not clear, however, whether this is due to behavioural or physical factors and whether the action of the controls housed with treated birds is more important in inflicting damage than the behaviour of the treated birds themselves.

The present experiment was designed to investigate whether birds treated with oestrogen pecked more or less at cage mates than controls and whether they received more pecks than their controls. The body areas pecked at were also compared between control and experimental birds.

Method

Subjects

Fifty-six female light hybrid chicks were obtained at day old and divided into four groups of fourteen. The rearing conditions and husbandry were as described in the pilot experiment.

Treatment

At three days, the chicks in each group were arbitrarily assigned to one of two treatments, control and experimental. There were seven birds of each treatment in each group.

Injections were given on day fourteen. The control birds received an injection of oil and the experimental birds a dose of a long acting (3-4 weeks) preparation of oestrogen, oestradiol valerate. The dose given was calculated as 0.02mg per 20g body weight x 28 to cover the four weeks of the experiment. At the beginning of the third week of the experiment a booster injection was given to compensate for the increase in body weight since the first injection. This dose was based on the same initial figure of 0.02mg per 20g but the action of the earlier treatment was also taken into account.

Observations

General observations were made three times per week during the four weeks of the experiment, a total of twelve observations. As well as the usual behaviour recorded, the identity of a pecking bird, its recipient and the area pecked were also noted.

Feather damage

A weekly scoring of feather damage was made using the eight point scale described in Chapter 2, and the birds were also weighed at this time.

Results

As it can be seen from Table 7.17 feather damage was not consistently affected by the experimental treatment. There was no damage in groups C and D and in groups A and B the results were conflicting. In group A the oestrogen treated birds were pecked more than the controls and in group B the reverse was true.

When the results of the general observations were analysed, using a X^2 test of independence, control birds were seen to do a great deal more feather pecking than the experimental birds, Table 7.18 and the oestrogen birds were pecked at slightly more than the controls, Table 7.19. There was no significant interaction, oestrogen and control birds appeared to distribute their pecks equally.

Table 7.17. Experiment 24. Effect of oestrogen on feather damage. Group means (totalled over four observations).

Group	Oestrogen	Control
A	9.6	7 9
B	3.1	3.9
C	0	0
D	0	0
Total	3.18	2.95

Table 7.18. Experiment 24. Amounts of feather pecking done by the two treatments and to whom.

Pecker	Oestrogen		Control		χ^2	P
Pecked	Control	Oestrogen	Control	Oestrogen		
A	50	17	80	75		
B	39	44	73	50		
C	29	18	25	37		
D	27	33	57	40		
TOTAL	145	112	235	202		
Total number of peckers	257		437		46.69	***
Total number of pecked	380		314		6.28	*

* Significant at the 0.01 level.
*** " " " 0.001 level.

The overall tendency for oestrogen treated birds to be pecked more than controls was due entirely to a highly significant excess of tail pecking, $X^2 = 12.91$; $p < 0.0003$. Vent pecking was very low in both treatments but surprisingly the controls received more pecks in this area than the oestrogen treated birds. The effect was not significant. The distribution of the pecks to the remaining areas of the bird's body did not differ between treatments. See Table 7.19.

Table 7.19. Experiment 24. Number of pecks received by different body areas of birds in the two treatments.

	Area	Oestrogen	Rank	Control	Rank	χ^2	P
	Head	26	6	22	6	0.333	NS
	Neck	21	7	15	7	1.00	NS (p=0.32)
	Front	34	4	35	4	0.014	NS
	Back	101	1	88	1	0.894	NS
+	Wing	68	3	63	2	0.191	NS
	Leg	28	5	32	5	0.267	NS
+	Tail	97	2	53	3	12.91	0.0003
	Vent	2	8	7	8	2.78	NS (p=0.096)

\+ The only ranks to differ between the two treatments.

The other results of the general observations, Table 7.20, were similar to those of Experiment 23. The hormonally treated birds were less active in the total amount of pecking behaviour shown, although this effect was not significant, and they also pecked less at food. There was a slight increase in the amount of preening and environment pecking, the difference in preening almost reaching significance.

Table 7.20. Experiment 24. Amount of pecking recorded during twelve general observations. Totals for four pens.

Pecking behaviour	Oestrogen	Control	χ^2	P
Self	1005	920	3.75	+ (0.06)
Environment	767	718	1.62	NS
Food	1401	1433	0.36	NS
Allopecking	260	444	48.1	NS
Total	3406	3515	1.72	NS (0.2)

The effect of the experimental treatment on weight was found to be the same as in Experiments 18 and 23, the oestrogen treated birds were heavier than the controls. Table 7.21. The development of the vent was also increased by treatment as in the earlier experiments.

Table 7.21. Experiment 24. Effect of oestrogen treatment on body weight. Group mean (in g) at six weeks.

Group	Oestrogen	Control	F	P
A	417	400		
B	460	400		
C	480	400		
D	437	431		
Total	1794	1631	6.71	*

* Significant at the 0.05 level.

Discussion

Although behaviourally the results obtained supported the two earlier experiments the main effect of increased feather damage was not present. There could be two explanations for this, firstly a different preparation of oestrogen was used and as Sturkie (1965) points out the effects of different preparations are not always the same. Perhaps the behaviour of the treated birds was not quite so passive when pecked and so they did not provide such a rewarding target. Equally the feathering might have been differently affected so that it was not as attractive to peck at or was not quite so easy to remove.

As a long acting hormone was used there was no way of monitoring if there were fluctuations in the dose being released. The behaviour of the birds did not give any indication of fluctuations and neither did the body weights and vent size, both remaining consistently different for the four weeks of treatment.

The other explanation for variability in the results is simply individual differences between birds. In groups C and D perhaps there were no birds which were initially prone to feather pecking and so none developed. This, and some effect on feathering or behaviour could have interacted resulting in absolutely no pecking damage. These results are typical of many obtained throughout this study of feather pecking - the variability in the behaviour of seemingly similar groups of birds is quite inexplicable unless some concept based on individual bird differences is evoked.

Although the feather damage scores did not show any differences between treatments the results of the general observations did. Here it was found that the controls did do a great deal more feather pecking than the treated birds. The pecks were fairly evenly distributed between the treatments although the oestrogen birds received more pecks than the controls. These results suggest that some factor depressed the action of the experimental birds or increased it in the controls, possibly both. If the oestrogen treated birds were in some way increasing pecking behaviour of the controls then the effect must have been very subtle since the recipients of the pecks were not always oestrogen treated birds, the controls also received pecks from members of their own treatment.

It could be that there was some factor about the treated birds that led to increased pecking but which was not so specific that it restricted the pecking to the affected birds only. Ease of removal of feathers or lack of responsiveness when pecked could be two such factors, it not being obvious to the pecker what the reaction would be until the peck had been made. Obviously the slightly enlarged vent was not particularly important, it may have been a general factor focusing attention on the treated bird but specific pecking at the vent area did not account for very many of the pecks. The fact that the control birds were pecked more frequently in the vent area than the treated birds suggests that as a stimulus at which to peck an enlarged vent did not rate highly.

The tail on the other hand was pecked a great deal more in the oestrogen treated groups than in the controls, there were no other differences between areas pecked on the two treatments. It would seem probable that the size of a birds' vent focused attention on that bird when viewed from the rear and resulted in the pecking of the feathers near the vent if not of the vent itself. In Experiments 7 and 8, Chapter 4, in which a model bird with one coloured feather in the middle of its back was presented to a group of birds it was found that it was pecked at more than a model without the coloured feather and yet few of the pecks were aimed specifically at the coloured feather. In both instances an extra stimulus drew attention to the birds but did not control precisely where the pecks were aimed.

The results from the general observations also show that lack of responsiveness or activity could be a major influence on the results of the oestrogen treated birds. The experimental birds were less active in total pecking behaviour and they were found to preen more, behaviour which is frequently associated with fairly long periods of sitting or standing in the same place. Horne and Wood-Gush (1970) found the reverse effect after treatment with stilboestrol, however, many variables differed between the two studies including the age of the birds, hormone preparation used and the conditions during the observations.

Whether the results from the three present experiments means that controls did an increased amount of pecking or just that the oestrogen groups did a decreased amount is not clear, although the results of Experiment 23 would support the former suggestion. But for whatever the reason it would appear that increased feather pecking was due more to the action of controls housed with oestrogen treated birds than to the treated birds themselves.

GENERAL DISCUSSION

Treatment with both testosterone and oestrogen lead to an increase in feather damage but it seems that the mechanisms involved differ with the two treatments. Administration of testosterone increases pecking behaviour and decreases the likelihood of being pecked whereas treatment with oestrogen decreases pecking and increases the chance of being pecked. However, it seems probable that these effects are not as separate as they appear and that the behaviour of the variously treated birds simply derives from different points along the same continuum.

Experiment 22 showed that when testosterone treated birds were housed with untreated controls the former were more active in pecking behaviour and less badly pecked than the controls. Conversley Experiments 23 and 24 showed that oestrogen birds did less pecking and were themselves more badly pecked than controls it is suggested that the administration of testosterone not only increases a birds inclination to peck at cagemates but also decreases its attractiveness as a stimulus to be pecked; probably due to its increased activity, Experiment 19, and a less passive acceptance of pecks. Thus in this situation the control birds receive more pecks than the treated birds. The oestrogen treated birds on the other hand, were remarkably passive and often crouched when approached or pecked by another bird. Thus these animals would encourage pecking behaviour although, because of their general inactivity, do little of it themselves, so in relation to the controls these birds would be the more badly pecked. Thus the total amount of damage per cage would increase with the administration of either testosterone or oestrogen but the behavioural effects of the treatments would not be the same.

Although these effects were often obtained by large doses of hormone, effects were also found by the low, approximately physiological, levels and so there is no reason to suppose that such a variation in behaviour would not be observed in normal, non-treated birds.

The effect of testosterone

The persistance in feather pecking behaviour seen in some birds appeared to be similar to the results of testosterone administration on chick vocalizations found by Andrew (1963, 1972 b+c). The physical results of treatment with testosterone were similar in both sets of work; depressed growth rate, increased comb size and some crowing. Further, bouts of feather pecking were found to be increased by treatment with the hormones as were bouts of vocalization in Andrews work. It is interesting therefore that Andrew had not been able to reproduce his effects with female chicks injected with testosterone (Andrew 1972a).

Hamilton and Golden (1939) found that fighting and pecking increased among adult hens that had been treated with testosterone. No clear definition is given of 'fighting and pecking' but since the two activities are specified separately it is possible that aggressive pecking was not the only type of pecking observed.

In this study the general observations showed that an overall increase in pecking behaviour was not the reason why testosterone treated groups suffered more feather damage. There was an increase in pecking but this was almost exclusively allopecking and did not involve more pecking at the environment, food etcetera. In only one experiment, 22, was an attempt made to measure the number of bouts (persistance in behaviour) of allopecking and it was quite clear from the results that treatment increased the number of bouts observed. This is again contrary to Andrew's finding that persistance levels in females were not affected by testosterone. On the other hand, Quadagno et al (1972) found that female rats were considerably affected by treatment with testosterone, becoming far less exploratory. He suggested that the hormone might alter the general reactivity of an animal to its environment. Extrapolating from rat to hen perhaps testosterone reduces the amount of exploratory pecking and so pecking is directed at a familiar form of another chick, or at a simpler level, more feathers.

Increased aggression would seem to be a obvious explanation of increased allopecking following testosterone treatment. The relationship between feather pecking and aggression will be discussed more fully in the next chapter but evidence from these experiments suggests that aggressive behaviour is not an important factor in feather pecking. Very little fighting or sparring was seen and the number of pecks recorded during general observations included very few that could have been described as aggressive. It is unlikely that aggressive pecks would have been overlooked since the observer was aware of the connection between testosterone and increased aggression and of the hypothesis relating feather pecking to the dominance hierarchy.

In Experiments 19 and 20 self pecking was increased by treatment with testosterone. This could indicate a difference in feathering between groups, particularly since moulting and feather type are considered to be under hormonal control (Sturkie,1965). It is possible to argue that testosterone treated birds feathered differently or more quickly than controls or that the uropygeal gland increased its activity. No quantitive data was collected on the general condition of the plumage but it appeared that testosterone treated birds were sleeker and to have a better covering of feathers in the places where the plumage was intact. So although testosterone may have affected the growth of feathers it did not induce feather loss which might have been mistaken for pecking damage. But a change in feathering or gland activity could have influenced self pecking.

The results from each of the experiments in which testosterone was administered were not always consistent, for example, in Experiment 21 no effect or feather damage was found, in Experiments 19 and 21 activity was increased by treatment, but in Experiment 20 no increase was observed. The results of the general observations were also found to differ slightly between experiments.

It could be that individual differences in behaviour between birds lead to the facilitation of different responses in various experiments. In support of this suggestion Turner (1965) found that a pecking model of a hen not only facilitated pecking but also directed attention to the type of food the model was pecking at. Tolman (1965) also showed social facilitation for food pecking but in this instance the stimulus bird had to peck very frequently to influence cagemates. This effect could easily occur in feather pecking where peckers are known to peck repeatedly at cagemates. It seems possible that even the area being pecked by one bird could direct the pecks of other birds in the group to that same area. But in any case the effect of the presence of a very persistant pecker in a group would be to increase feather pecking rather than just general pecking activity.

There is also some evidence to support the view that differences between experiments might be attributed to the different hormone preparations used. Beach, (1965) reported that when a fixed quantity of testosterone was injected all at once or little by little over ten days there were distinct differences in the behaviour of the rats in the two treatments, similar effects are also reported for hens. Similarly (Sturkie, 1965) reports that testosterone produces a different reaction depending on the environment; light, temperature and bird density. Thus it is clear that any small difference in the type and administration of the hormone or the rearing environment of the birds could have produced slightly different behavioural effects.

It is assumed that the effect of the hormone treatment is to alter the balance between hormones rather than to produce specific levels. As it is probable that this balance will vary in different individuals it is feasible to assume that birds will show different behaviour as a result of similar treatment and that they could 'pass on' this behaviour by social facilitation to other members of the group. Thus resulting in similarly treated groups behaving slightly differently in different experiments.

In summary, the main effect of injecting large doses of testosterone into both young and adult birds was to increase feather pecking behaviour and feather damage. When low doses were administered this effect was not always found but this can be explained since testosterone makes birds both less receptive to pecks and more likely to administer pecks.

It was thought unlikely that increased aggression played any part in the increase in pecking and damage similarly alteration in feather development or growth was not thought to be responsible for the changes found among treated groups.

The only consistent explanation for the effects of testosterone treatment come from Experiment 22 where it was found that treated birds behaved differently from the controls housed with them and that the effect of the testosterone was to increase the amount of allo-pecking shown and the number of bouts of allopecking but to reduce the number of pecks received. These behavioural observations would appear to provide the explanation for the physical difference observed in all other experiments involving testosterone treatments.

The effects of oestrogen.

The results of Experiments 23 and 24 showed clearly that the effect of oestrogen treatment was to increase the propensity for being pecked rather than to increase the amount of pecking behaviour.

Birds treated with the hormone were less responsive than the controls, they spent a considerable amount of time sitting, often crouched when approached by another bird and did not react when touched or pecked. In other words displaying behaviour that was typical of a receptive hen to a cock. The treated birds also had much larger vents than the controls and possibly more ruffled plumage. This type of bird would offer a perfect stimulus (Chapters 4 and 5) for eliciting pecks and so would encourage the development of feather pecking. At the same time the difference between control and treated birds need not be so great as to make their identification automatic. In many instances a control bird would be pecked rather than a treated one, or the peckers might generalize their behaviour to the non-treated members of the group even though they could distinguish between them. But on the whole the non-treated birds would give more pecks and receive less than the treated ones.

Since oestrogen-treated birds in mixed groups were found to give few pecks it makes an explanation for the results found in Experiment 18 difficult. In this experiment all the birds in a group were treated and yet increased damage was still observed. It is possible that some birds were less affected by treatment than others and that they found their crouching, unresponsive cagemates as attractive to peck as the controls did in later experiments.

Vent pecking was not found to be directly associated with feather pecking although it is possible that the enlarged vent encouraged pecks to be directed at particular birds even if not at specific areas.

There were again variations in the results from one experiment to another but these differences can probably be explained on the basis of stock variation or unconscious variations in treatment.

Thus the increase in feather damage due to treatment with gonadal hormones was found to be a reliable effect and it is suggested that the different behaviour elicited by the two hormones arose from different points along the same continuum of reactivity and non-reactivity with regard to pecking.

CHAPTER 8

THE RELATIONSHIP BETWEEN FEATHER PECKING AND THE SOCIAL DOMINANCE HIERARCHY.

INTRODUCTION

It is frequently assumed that feather pecking is related to the social dominance hierarchy found among groups of hens. The assumption is that birds at the top of the hierarchy give the majority of pecks and receive very few, and vice versa for birds at the bottom. This pattern would fit the classification of birds as peckers or pecked as suggested in this thesis so perhaps we need to look no further for the cause of feather pecking. Is it simply the result of pecking generated by the establishment and maintenance of the dominance order? As described in Chapter 1 some workers are in support of this explanation of feather pecking, for example, Pulliainen (1965) and Whittle (1957). On the other hand Hoffmeyer (1969) suggested that there was absolutely no relationship between the dominance order and feather pecking. Wennrich (1974) was in agreement with this view although in later publications (1975a+c) he suggested that there might be a relationship but that the amount of pecking given and received was not entirely consistent with the daminance hierarchy of a group. Hughes and Duncan (1972) also took an intermediate position and cautiously decided that there was no "absolute" relationship. A fuller discussion of the work of these authors is given in the literature review, Chapter 1.

The conflicting opinions just cited are not due solely to different methods of assessing "dominance" although this must be considered. Both Whittle and Pulliainen compared the amount of feather pecking damage with a hierarchy defined by observing the number of pecks given and received by members of a group. Hoffmeyer and Wennrich also used this method but combined it with observations on the pecking behaviour itself, the direction of approach, the areas pecked and the response of the pecked bird. Hughes and Duncan used competitive feeding trials to assess dominance and these have been reported (Guhl and Fischer, 1969) to give similar results to the more time consuming methods used by Pulliainen and reported by Whittle. Thus the term social dominance or dominance hierarchy probably refers to much the same factor in each case and yet the different workers reached different conclusions about its effect on feather pecking.

During this study data were accumulated from several experiments which made it possible to examine the relationship between feather pecking and the birds' position in the social hierarchy. Birds of a variety of ages and experience were used so that the findings would be relevant not only to young birds forming a hierarchy for the first time but also to older birds in more established groups. However, it must be stressed that no attempt was made to undertake a full analysis of aggressive behaviour and how this compared with feather pecking behaviour.

The birds used in these tests were members of several different experiments and since these findings have been written up separately from the main description of each experiment the birds have been labelled as batches 1 - 5, however, in each instance the original experiment in which the birds were subjects is also given.

Method of Assessing Social Rank.

Assessing the ranks of individuals in large groups of birds can be a difficult process and it is possible that different methods produce different results (McBride, 1959; Candland, Matthews and Taylor, 1968). The problems involved in ranking birds accurately were realised from the beginning but it was essential to use a method that did not involve many hours of observation and that would give a reasonably accurate description of the relationship existing in a group. Since small groups only were being used it was decided that paired or group contests in a competitive feeding situation would produce adequate results. It was realised that the measurement being made could be described as the ability to feed when in competition with others, but Guhl (1953), Tindall and Craig (1959) and Lowry and Abplanalp (1972) found that the length of time spent feeding and number of feeding bouts in a competitive situation correlated positively with position in the hierarchy. This suggests that the method is adequate for assessing the dominance order operating within groups of birds if not the actual levels of individual aggression.

Test Proceedure.

The group to be tested was fed from a hopper with a restricted opening, so that only one bird could feed at a time, for three days before testing. The birds were deprived of food for sixteen hours and then either presented with the hopper as a group, as in Batch 2 and 3, or in pairs, as in Batches 1, 4 and 5. In the latter case the birds were moved to a neutral environment for the test.

The food was presented for three minutes and the order in which the birds fed, the ease with which they displaced each other and the length of time spent feeding were recorded.

In the majority of groups a very clear linear hierarchy was discernable which suggested that what was being tested was more than just the ability to feed in a competitive situation. In Batch 3 each group was tested twice and the results remained stable so that this method would appear to be reliable in its findings.

This method of directly relating feather damage scores with social rank provides a very positive approach to the problem and one in which the evaluation of both social dominance and feather pecking are quite empirical and do not rely on distinguishing between feather pecks and aggressive pecks as has been done previously.

Statistical Analysis.

Except for the results from Batch 1 no attempt was made to analyse the results statistically. It was felt that the numbers in each experiment were so few that statistical methods could not be justified. The fact that the treatment of the groups of birds varied from trial to trial precluded combining the results from all batches. However, it was felt that the results were clear enough to allow interpretation despite the lack of statistical support. The results from Batch 1 were based on a

Table 8.1. Batch 1. Social rank at eight weeks with mean scores for Allopecking and Environment pecking. Days. 7 - 10.

	FEATHER PECKING GROUPS		NON - FEATHER PECKING GROUPS	
Social rank	Allopecking score	Environment pecking score	Allopecking score	Environment pecking score
1	14.0	3.25	8.25	6.25
2	11.25	3.75	4.25	5.75
3	15.75	5.25	4.5	7.75
4	26.2	3.5	6.0	7.0
5	10.25	4.75	9.0	7.0
Correlation with pecking	$r_s = +0.1$	$r_s = -0.5$	$r_s = -0.4$	$r_s = -0.8$
p	NS	NS	NS	NS

Table 8.2. Days 7 - 24.

	FEATHER PECKING GROUPS		NON - FEATHER PECKING GROUPS	
Social rank	Allopecking score	Environment pecking score	Allopecking score	Environment pecking score
1	25.0	2.39	6,.25	6.12
2	15.42	2.81	5.5	3.0
3	24.4	2.52	6.0	2.37
4	11.24	3.24	6.74	4.0
5	6.0	8.62	4.0	2.74
Correlation with pecking	$r_s = +0.9$	$r_s = -0.9$	$r_s = -0.7$	$r_s = +0.5$
p	*	*	NS	NS

* significant at the 0.05 level.

different type of data and so non-parametric tests of correlation were applied in this instance, (Spearman rank correlation; r_s).

Five batches of birds were used in the investigation. The method and results relating to each batch will be presented first and followed by a general discussion of all the results.

BATCH 1.

Method

Subjects

Thirty light hybrids in Experiment 1 were reared in single sex groups of five, there were three groups of each sex. Normal rearing procedures were used and observations were carried out on the birds during the first few weeks of life on the basis of which three feather pecking and three non-feather pecking groups were identified (see Chapter 3).

At eight weeks and again at twenty-four weeks each bird was tested against every other bird in its group in a competitive feeding situation.

This experiment was conducted before a scoring system for feather damage had been developed and so only comments on long term damage received by the birds were made.

Results

The relationship between rank at eight weeks of age and pecking behaviour of the birds recorded between seven and ten days when feather pecking had not occurred can be seen in Table 8.1. There was no evidence in this comparison that the rank held by a bird was in any way related to the sort of pecking that it had previously indulged in. However, once feather pecking had begun, days seven to twenty-four, Table 8.2, it can be seen that in the feather pecking groups there is a positive correlation between allopecking and rank; $r_s = 0.9$; $p = 0.05$, and a negative correlation between environment pecking and rank,

Table 8. 5. Batch 1. Social rank at eight and twenty-four weeks for each bird and whether or not birds received prolonged damage from repeated peckings by other group members.

GROUP 4			GROUP 5			GROUP 6		
Rank at 8 weeks	Rank at 24 weeks	Prolonged damage	Rank at 8 weeks	Rank at 24 weeks	Prolonged damage	Rank at 8 weeks	Rank at 24 weeks	Prolonged damage
1	1	0	1	2	✓	1	4	0
2	4	0	2	5	0	2	2	0
3	3	0	3	1	0	3	5	0
4	5	✓	4	4	✓	4	1	✓
5	2	0	5	3	✓	5	3	0

r_S = -0.9; p = 0.05. There were no significant correlations for the non-feather pecking groups.

When the ranks obtained by paired contests run at twenty-four weeks of age were related to the early behaviour it can be seen, Table 8.3. and 8.4. that there was no relationship between rank and behaviour once feather pecking had begun but there was a significant effect between rank at this age and the amount of allopecking indulged in during the second week of life; r_S = 1.0; p = 0.01, among the feather pecking groups.

Table 8.5. shows the rank of the birds in the three groups that were involved in feather pecking and whether or not they suffered from continuous feather damage. It can be seen that four out of the five birds that did have prolonged damage were near the bottom of their group's hierarchy. The fifth bird however, was at the top of the hierarchy in its group. The second column in this table shows the hierarchies that existed at twenty-four weeks, these bore very little relation to the earlier hierarchies and there was no connection between hierarchical position at this age and pecking damage early in life.

BATCH 2.

Method

Subjects

Twenty-five, fifty week old light hybrids from Experiment 3 were used. For the previous twenty-five weeks the birds had been housed in groups of three in normal battery accommodation. Five groups, each containing three birds, were selected, in which the amount of pecking sustained by each bird was very dissimilar. A further five groups each containing a pair of birds, the third member having died earlier, and this time with similar damage scores were also selected. The members of each pair never differed by more than one point on the feather damage scale (Chapter 2).

Table 8.3. and Table 8.4. Batch 1. Social rank at twenty-four weeks with mean scores for Allo- and Environment pecking.

Table 8.3. Days 7 - 10.

	Feather Pecking groups		Non-feather pecking groups	
Social rank	Allo-pecking score	Envir. pecking score	Allo-pecking score	Envir. pecking score
1	13.0	4.0	9.75	7.75
2	13.25	4.75	4.5	7.75
3	13.5	5.5	4.0	5.25
4	18.7	3.0	8.75	6.25
5	19.0	3.25	3.75	5.25
Correlation with pecking	$r_s = -1.0$	$r_s = +0.5$	$r_s = +0.7$	$r_s = +0.8$
p	**	NS	NS	NS

Table 8.4. Days 7 - 24.

	Feather Pecking groups		Non-feather pecking groups	
Social rank	Allo-pecking score	Envir. pecking score	Allo-pecking score	Envir. pecking score
1	19.07	2.65	8.37	6.37
2	20.22	1.74	6.0	2.37
3	11.87	8.74	5.62	1.49
4	16.49	3.76	9.74	3.62
5	11.4	2.69	6.75	4.49
Correlation with pecking	$r_s = +0.8$	$r_s = -0.5$	$r_s = -0.1$	$r_s = -0.1$
p	NS	NS	NS	NS

** significant at the 0.01 level.

Dominance Tests.

A competitive feeding situation was used to establish the social order within each group. This was compared with the scores of pecking damage suffered by the individual birds.

Results

The findings from this batch suggested no relationship between feather damage and social rank, (Tables 8. 6 and 8. 7.). In groups containing three birds with various degrees of damage there were badly pecked birds at the top, middle and bottom of the hierarchy and little damaged birds in the top and middle positions. It was interesting that there were no well feathered birds in the very bottom position.

Table 8. 6. Batch 2. Comparison of social rank with feather damage in five groups with three members each.

Rank feather damage. \ Social rank	1	2	3
1	2	3	0
2	1	1	3
3	2	1	2

In the groups containing only two birds with equal amounts of damage a very pronounced hierarchical order was found but this was not related to the feather damage observed.

Table 8.7. Batch 2. Comparison of social rank with feather damage in five groups with two members in each.

Rank feather damage \ Social rank	1	2
1	2	3
2	3	2

BATCH 3.

Method

Subjects

Ninety-five thirty week old female light hybrids from Experiment 20 were used. They were reared in normal battery conditions and at the time of testing were housed in groups containing between three and seven birds. Sixteen weeks before testing the birds had received one of four possible doses of long acting testosterone but this should have ceased to be effective ten to twelve weeks before testing began.

Dominance Tests.

A competitive feeding situation was again used to discover the identity of the dominant bird in each group. No attempt was made to rank the remaining birds in the group. Two separate assessments were made on each group so that the reliability of the group test could be confirmed. Pecking damage for the dominant bird was expressed as a score of 1, 2 or 3, corresponding to the least, medium and most damaged bird in the group. The scores were specific to each group and so no between-group comparisons can be made in these data.

Table 8.8. Batch 3. Feather condition of the top ranking bird in each of eighteen groups.

No. in group	Condition of Dominant Bird Test 1	Test 2	Composition of group
7	1	3 +	One undamaged member
7	1	1	
6	2	2	
5	3	3	
5	3	2 +	
5	2	2	
5	1	1	
5	3	3	
4	1	1	
4	3	3	
3	1	1	
7	3	3	One damaged member
7	2	3	
7	2	2	
6	3	3	
5	3	3	
4	2	3 +	
3	2	2	

\+ Groups in which the identity of the dominant bird changed between test one and test two.

SUMMARY OVER ALL GROUPS

	Feather condition 1	2	3
Number of dominant birds.	4	5	6

Results

No effect of hierarchical position on feather damage was found, (Table 8.8). Of the eighteen groups tested three changed their dominance order from one assessment to the next and so were discounted. Among the remaining fifteen groups, four had least damaged birds at the top of the hierarchy, five had intermediately damaged birds and six had the most damaged bird at the top.

The re-test showed that the majority of groups remained the same which would indicate that the method of measurement was reliable, especially since in two of the groups that had changed the condition of their dominant bird the change was only by one position, in which case it is possible that the bird at the top remained the same and its feather condition altered. This explanation is unlikely for the third group whose dominant bird changed from score 1 to score 3.

BATCH 4

Method

Subjects

Twenty, sixteen week old light hybrids, part of hatch G5 (Chapter 9) were used. The birds, of both sexes, were reared normally and separated as feather pecking developed into groups of pecker, pecked birds and neutrals. The birds used here came from two groups of peckers since there was a good range of damage scores in these groups. At the time of testing the birds were in battery cages. Group 1 contained nine birds and group 2, eleven birds.

Dominance Tests.

Paired contests were run between all the birds of the same sex within each group in a competitive feeding situation. Comparisons were made between the social rank of the bird and its score for feather damage at the time of testing.

Table 8.10. Batch 5. Number of paired contests won and feather damage score for one group of peckers and two groups of neutrals.

Bird	Contests won	Damage score	Sex
PECKERS 1			
A	6	1	Male
B	5	2	Male
C	4	2	Male
D	3	0	Male
E	1	2	Male
F	1	3	Male
G	1	3	Male
A	1	2	Female
B	1	2	Female
C	1	0	Female
NEUTRAL 1			
A	6	0	Male
B	4	0	Male
C	4	0	Male
D	3	0	Male
E	2	0	Male
F	1	2	Male
G	1	0	Male
A	5	0	Female
B	4	0	Female
C	3	1	Female
D	1	0	Female
E	1	0	Female
F	1	0	Female
NEUTRAL 2			
A	3	2	Male
B	2	2	Male
C	1	2	Male
D	0	0	Male
A	4	2	Female
B	4	0	Female
C	3	0	Female
D	3	3	Female
E	1	0	Female
F	0	0	Female

Table 8.9. Batch 4. Number of paired contests won and feather damage score for the two groups of peckers.

Bird	Contests won	Damage score	Sex
PECKERS 1			
A	5	3	
B	4	3	
C	2	2	Female
D	2	3	
E	1	6	
F	1	1	
A	1	2	
B	1	4	Male
C	1	5	
PECKERS 2			
A	2	0	
B	2	2	Female
C	1	0	
D	1	0	
A	5	0	
B	4	2	
C	3	0	
D	3	2	Male
E	2	0	
F	1	0	
G	1	2	

Results

Table 8. 9 shows the results of these tests. No relationship was found between social dominance and feather damage.

BATCH 5.

Method

Subjects

Thirty-two, twenty week old light hybrids of both sexes, part of hatch G6 (Chapter 9), were used. The rearing and experimental conditions were exactly the same as for Batch 4.

Dominance Tests.

Paired contests were run as for Batch 4. One group of peckers containing ten birds and two groups of neutrals containing thirteen and ten birds respectively were used.

Results

Table 8. 10 shows the results and again no relationship was found between social dominance and feather damage.

GENERAL DISCUSSION

The most obvious finding of all these trials was that feather pecking and social dominance were unrelated for most of the time. In all the trials in which adult birds were involved there were as many damaged birds at the top of the hierarchy as at the bottom. It was only during the development of the hierarchy for the first time, in Batch 1, that any relationship could be seen between these two factors.

Although in Batch 1 all pecks at cage mates were recorded without making a distinction between feather pecking and aggressive pecking it is unlikely that much aggressive pecking would have occurred during the period of the observations (days 7-24). Thus the finding that some birds pecked more at cagemates than at the environment and vice versa during this period suggests that some birds would be a great deal more experienced at delivering pecks at other birds. When the peck-order developed at about ten weeks of age (Guhl, 1958) these birds might be at an advantage and thus gain relatively high places in the social hierarchy at this age. This would explain the results found in Batch 1 where one bird in group 6 began the feather pecking in its group and remained a rampant pecker for several weeks. When the hierarchy was tested at eight weeks it was found to be the dominant bird. Apart from showing very vicious pecking it also seemed to be insensitive to the usual signals of submission, such as avoidance. It was observed to peck repeatedly at birds that were lying prostrate on the floor and it did not restrict its pecks to the head or necessarily approach from the front. It is interesting that by week twenty-four this bird had dropped from top of the hierarchy to next to bottom. Presumably once it began to respond to the normal constraints associated with aggressive behaviour and once its cagemates became as efficient at pecking it lost its advantage over the other members of the group.

The other explanation for the apparent relationship between feather pecking and social dominance could be connected with the condition of the pecked bird rather than the social position of the pecker. It would be reasonable to assume that the bird which was badly damaged would avoid situations where further pain and injury could be inflicted, a competitive feeding situation would be just such an occasion. It was noted that well feathered birds did not react as strongly when pecked on the neck and back as did birds that were denuded of feathers on these areas and that the latter were easier to displace from the feeder if pecked on these unprotected areas. Thus a feather pecking bird might become top of the social hierarchy as much by avoidance on the part of feather pecked cage mates as by its own efforts.

Alternatively it might be that although feather pecking is causally quite distinct from the social hierarchy the way that birds in a group space themselves as a result of the hierarchy may affect which birds peck and which are pecked. Thus if two birds of differing rank are both peckers and if all other things are equal then the dominant bird may be presented with the stimulus for feather pecking (the side, back and tail) more often than the subordinate one and the latter will show more signs of damage.

Both these hypotheses are highly speculative but they might help to explain the apparent slight connection between feather damage and the dominance hierarchy, and more importantly they might explain the discrepancy between the results of earlier work; Hughes and Duncan (1972), Wennrich (1975abc) and Hoffmeyer (1969) Wennrich (1974). The latter two authors were comparing the types of pecking behaviour and not the actual ranks of individual birds and so no conflicting situations such as described above would have arisen. In this type of study very conclusive results could be obtained concerning the difference between aggressive pecks and feather pecks. The competitive feeding situation on the other hand would include all the factors associated with the maintenance of the social order and so although the information gained by this method would not necessarily give accurate information about the relationship between aggression and feather pecking it would reflect more fully the relationship between the total effect of the maintenance of the social hierarchy and feather pecking.

The evidence presented in this chapter would suggest that feather pecking is not simply the effect of the establishment and maintenance of the social hierarchy in a group of birds, a pecked bird can be the dominant bird in a group. However, it seems possible that the behaviour of the damaged bird and the more frequent opportunity for feather pecking by dominant birds could also affect the final picture.

CHAPTER 9

THE INFLUENCE OF GENETIC VARIATION ON FEATHER PECKING

The literature reviewed in Chapter 1 suggested that there was no convincing evidence for a genetic influence on feather pecking. However, in this study in addition to the finding that individuals show different amounts of feather pecking behaviour it was also noticed that strains of fowl differed in the extent to which they are prone to feather pecking and in the type of damage they inflict when they do peck. Hughes and Duncan (1972) have also reported this same finding. It therefore seems that a rejection of the hypothesis of a genetic influence on feather pecking is premature and that further investigation would be worthwhile.

Facilities were not available for detailed evaluation of the inheritance of this form of behaviour but it was decided to carry out some simple experiments to see whether the existence of an inherited component could be demonstrated in feather pecking behaviour and to determine the approximate magnitude of such a component if it existed.

Method

Subjects

Day old chicks were obtained from matings of White Leghorn-type males and females. housed at the Poultry Research Centre Stock farm. The matings were maintained for other experimental purposes and so the genetic structure of the population obtained could only be controlled to a limited extent.

The chicks were from seven different hatchings, the birds from each hatch being treated as a uniform group throughout.

Rearing was exactly as described in Chapter 2, however, when the chicks were first assigned to a cage care was taken to ensure that sibs were distributed evenly among all the groups.

Observations

The groups were checked regularly and as soon as signs of feather pecking were seen intensive observations were made to distinguish both the peckers and the pecked birds. These animals were then segregated into groups containing either all peckers or all pecked birds. Those that were not classified were left in the home cage. The numbers obtained by classifying the birds in this way provided the data for the genetic analysis.

Feather pecking began by eighteen days in all hatches and new instances were very prevalent for approximately four weeks. When new outbreaks ceased to occur regularly observations leading to classification of the birds were stopped although feather pecking continued at a low rate among the unclassified birds. For this reason the assumption was made that all birds are potentially classifiable. In some early experiments unclassified birds remained undamaged for a considerable period but it was only rarely that such groups were entirely free of damaged birds and in some instances the level of damage by fourteen weeks was approaching that found in other classified groups, for example see Experiment 6. Thus it was thought more appropriate to consider the previously designated 'neutrals' as unclassified peckers or pecked birds.

Method of Analysis

All analysis were carried out on a within-hatch basis. To test for evidence of significant differences between sire groups the proportions of birds classified in different ways were formed into 2 x N tables and the heterogeneity χ^2 calculated (Snedecor, 1956). The fact that some sire groups were represented in more than one hatch was ignored.

The same heterogeneity χ^2 values, estimated both for sire groups within hatches, and dam groups within sires and hatches, were used to estimate heritability (h^2) and their standard errors by the procedures of Robertson and Lerner (1949).

Table 9.4. Estimates of heritability for different measures of pecking behaviour.

	h_s^2 [1]	h_d^2 [2]
No. of birds classified	- 0.136	-0.314
No. of peckers in total	0.090 $\pm$ 0.0857 [3]	-0.441
No. of pecked birds in total	0.012 $\pm$ 0.0644	-0.544
No. of peckers/pecked in classified	0.560 $\pm$ 0.2524	-0.302

1 heritability estimated between sire groups within hatches.

2 heritability estimated between dams within sire groups and hatches.

3 standard deviation of h^2 value, not calculated for negative h^2 values.

Table 9.3. Values of hetrogeneity χ^2 values between sires within hatches for different measures of pecking behaviour.

		G1	G2	G3	G4	G5	G6	G7	Total
No. of birds Classified		1.90	4.43	0.12	0.59	0.39	0.69	0.01	8.13
	p	NS	NS	NS	NS	NS	NS	NS	NS
No. of peckers in total		2.82	11.78	4.21	0.89	2.02	8.29	0.03	30.04
	p	NS	**	*	NS	NS	NS	NS	NS
No. of pecked in total		4.42	5.91	2.93	2.04	0.98	6.19	0	22.47
	p	NS	*	NS	NS	NS	NS	NS	NS
No. of peckers/ pecked in classified.		10.02	8.54	4.36	1.62	2.16	18.77	0.03	45.50
	p	NS	*	*	NS	NS	**	NS	**

NS - not significant

* - p 0.05.

** - p 0.01.

Table 9. 2. Number of classified birds (Peckers and Pecked).

Sire No.	No. of dams	No. of offspring in hatch no. G1	G2	G3	G4	G5	G6	G7	Total	Range of full sib group sizes
F10	3	8	-	-	-	-	-	-	8	2 - 3
F9	4	6	-	-	-	-	-	-	6	1 - 3
F8	4	9	-	-	-	-	-	-	9	2 - 3
C4	3	10	-	-	-	-	-	-	10	2 - 6
C3	2	6	-	-	-	-	-	-	6	2 - 4
C2	3	5	-	-	-	-	-	-	5	1 - 2
C1	2	5	-	-	-	-	-	-	5	1 - 4
D9	11	-	13	-	13	14	1	-	41	1 - 8
D8	7	-	9	-	16	4	3	-	32	2 - 7
D7	10	-	8	-	5	15	-	-	28	1 - 6
D6	7	-	-	-	12	10	5	-	27	2 - 8
E9	9	-	-	16	-	-	-	-	16	1 - 4
E10	6	-	-	11	-	-	-	-	11	1 - 2
C9	8	-	-	-	-	-	10	-	10	1 - 2
C10	6	-	-	-	-	-	8	-	8	1 - 2
D71	2	-	-	-	-	-	3	-	3	1 - 2
F91	6	-	-	-	-	-	-	8	8	1 - 2
F101	11	-	-	-	-	-	-	17	17	1 - 3
Total numbers										
18	104	49	30	27	46	43	30	25	250	(1 - 8)

Table 9.1. Number of records and composition of population used for analysis in genetic experiments; total population.

Sire No.	No. of dams	No. of offspring in hatch no. G1	G2	G3	G4	G5	G6	G7	Total	Range of full sib group size, within hatch
F10	4	24	-	-	-	-	-	-	24	3 - 8
F9	4	22	-	-	-	-	-	-	22	4 - 8
F8	4	26	-	-	-	-	-	-	26	6 - 7
C4	3	24	-	-	-	-	-	-	24	5 - 13
C3	2	16	-	-	-	-	-	-	16	6 - 10
C2	4	21	-	-	-	-	-	-	21	3 - 7
C1	2	16	-	-	-	-	-	-	16	6 - 10
D9	11	-	25	-	13	27	6	-	71	1 - 6
D8	8	-	11	-	18	7	6	-	42	1 - 4
D7	11	-	9	-	6	25	-	-	40	1 - 5
D6	10	-	-	-	13	17	14	-	44	1 - 4
E9	9	-	-	22	-	-	-	-	22	1 - 4
E10	6	-	-	14	-	-	-	-	14	1 - 3
C9	10	-	-	-	-	-	30	-	30	2 - 4
C10	13	-	-	-	-	-	34	-	34	2 - 3
D71	5	-	-	-	-	-	9	-	9	1 - 2
F91	7	-	-	-	-	-	-	16	16	1 - 4
F101	12	-	-	-	-	-	-	33	33	1 - 5
Total numbers										
18	125	149	45	36	50	76	99	49	504	(1 - 13)

Results

A total of 504 chicks were involved. These were the offspring of 18 males and 125 females. The composition of the population is shown in Table 9.1.

Within hatches full-sib families varied in size from one to thirteen individuals and paternal half-sib families from nine to thirty-four but because of the limited amount of data none was rejected to achieve a more even family size distribution. The classified birds, peckers and pecked, numbered 250 in total and represented eighteen and one hundred and four paternal half-sib and full sib families respectively (see Table 9.2.)

The data were classified in four ways to investigate different aspects of the observed behaviour.

1. The proportion of birds placed into the pecker and pecked bird categories; as argued above this was taken to be measure of the rate of development of feather pecking behaviour.
2. The proportion of peckers in the total population.
3. The proportion of pecked birds in the total population.
4. The proportion of peckers (or pecked birds) amongst those classified.

For each analysis the heterogeneity χ^2 values for sire groups within hatches are shown in Table 9.3. and the results of the heritability analysis in Table 9.4.

Variation in the onset of feather pecking.

Almost exactly half the birds 250 out of 504 were classified. For individual hatches the proportion classified varied from 30 to 92 percent and the heterogeneity χ^2 between hatches was highly significant ($\chi^2 = 59.5$, df = 6; $p < 0.01$). However, within hatches, there was no evidence of significant heterogeneity between sire groups, either for individual hatches or pooled for all hatches (see Table 9.3. for χ^2 values), although at the extremes the percentage classified for individual sire groups varied from 17 to 100.

In view of these results the low estimates of heritability shown in Table 9.4. are to be expected. There is clearly no overall evidence of inherited differences between families in the rate of development of feather pecking behaviour.

Variation in the proportion of peckers in the total population.

Overall 141 birds out of the total of 504, or 28 percent, were classified as peckers. The porportions in individual hatches varied from 14 to 60 percent but were not significantly heterogeneous, ($\chi^2 = 8.0$; df = 6).

Within hatches there was significant evidence of heterogeneity amongst sire groups in hatches G1 and G3 (Table 9.3.) whilst the pooled χ^2 almost reached conventional levels of significance ($\chi^2 = 30.04$; df = 21; $0.10 > p > 0.05$). There is therefore slight evidence of genetic variation in this character.

The between sire group estimate of heritability, h^2_s was 0.0901 ± 0.0857, the between dam group estimate, h^2_d being negative (Table 9.4.) Again these indicate a low level of inheritance.

Variation in the proportion of pecked birds in the total population.

A lower proportion were classified as pecked birds than as peckers; 109 out of 504 or 22 percent. For separate hatches the incidence of pecked birds varied from 7 to 66 percent but again this heterogeneity was not significant ($\chi^2 = 7.5$; df = 6). Similarly there was no evidence of significant heterogeneity amongst sires within hatches (see Table 9.3) although the χ^2 value for hatch G2 was almost significant ($p = 0.05$).

As would be expected from these results the estimates of heritability were very low. The sire estimate, h^2_s was 0.0122 ± 0.0644 whilst h^2_d was again negative.

Variation in the proportion of pecker and pecked birds amongst those classified.

Out of the 250 birds classified during the experiment 141 or 56.4 percent were peckers and 109, 43.6 percent were pecked. Table 9.3 shows that in three out of the seven hatches, G2, G3 and G6 the heterogeneity χ^2 values for sires were statistically significant ($p < 0.05$)

and in a fourth, Gl it approached this level (p = 0.124). The pooled heterogeneity χ^2 for all hatches was highly significant (χ^2 = 45.5; df = 21; p = 0.0015). This number of significant results far exceeds that expected by chance and shows clear evidence of differences between sire groups in feather pecking behaviour when assessed in this way.

The values for heritability were also larger than those in the previous analyses. The sire estimate, h^2_s was 0.560 $\pm$ 0.252. The corrected dam estimate, h^2_d was again negative although before correction a similar positive value was found ; h^2_d (uncorrected) = 0.390.

Discussion

Although the results presented here are of a very preliminary nature they suggest that the inheritance of feather pecking behaviour would merit more thorough investigation.

The size and structure of the opoulation available were very limiting, especially for the estimation of heritability from the between dam group component of variance h^2_d. For these estimates the correction for small group size was large and the corrected h^2 values were negative in all cases. Such results must be regarded as invalid. The distribution of data for the estimate of h^2_s is much better and the corrections for group size are only trivial.

The evidence for a genetic influence on pecking behaviour varies between the different measures of response. There was no evidence, under the conditions used, that the rate of development of pecking behaviour differed amongst families since the proportion of individuals classified did not differ significantly.

When the proportions of either peckers or pecked birds in the whole population are considered there is little evidence of genetic variability in either case although there was a slight suggestion that the incidence of peckers was more subject to genetic variation than the incidence of pecked birds. Much larger populations would be required to verify this. On the other hand when only classified birds are considered there is considerable evidence of familial differences in the proportions of peckers and pecked birds and the value of h_s^2 obtained was relatively high.

It is suggested that this latter estimate is the most valid measure of the inheritance of pecking behaviour in these data. Estimates based on the whole population are inevitably affected by the high incidence of non-classified birds which, although not varying significantly between sire groups, was numerically very variable between groups, leading to a masking of any real differences. Such an argument would also be justified if the unclassified birds were in fact a third category and not just late in showing their behaviour.

It is concluded that there is a substantial genetic component in the pecking behaviour measured here. The separate analysis for peckers and pecked birds did not indicate any difference in the inheritance of the separate behaviours although, for the reasons already noted, this comparison is very imprecise.

One of the outstanding features of the feather pecking phenomenon is the difficulty of finding reproducible results. As described in the literature review there are a great many suggested causes of feather pecking but for each positive result obtained there is at least one to contradict it. It is argued here that none of the previously suggested causes of feather pecking behaviour are in fact of prime importance. They may be contributory factors and increase the likelihood of feather pecking but there must also be some central variable which has not been identified or controlled. If, for example, a factor such as inheritance is postulated then the conflicting findings of previous work can be better understood. In a flock high in the incidence of feather peckers any contributory factor, such as lighting or density, could trigger off an outbreak and appear to be responsible for feather pecking. In a flock with few feather peckers this behaviour would not be found irrespective of environmental conditions, thus giving rise to the conflicting views on the causation of feather pecking. No direct evidence was found to suggest in what way a genetic effect might have its influence but a possible mechanism will be discussed in the next chapter.

Dickerson, Kashyap and Lamoreux (1961) reported an earlier investigation into the heritability of feather "picking" and concluded that, 'even under managements designed to promote picking, heritability was lower than for general mortality and restricted to aggressiveness'. They also found that "vunerability to pecking had an estimated heritability of zero". In this instance much older birds were being studied, 20-24 weeks, and the "picking" appeared to refer mainly to vent pecking around point of lay. It would also seem that this study has not distinguished between agressive pecking and feather picking and therefore cannot establish effects on feather pecking alone.

The only other work reporting genetic influences on feather pecking was carried out by Richter (1954). He noticed considerable strain differences in the amount of feather pecking found and subsequently carried out a number of cross breeding experiments. From the results of these he concluded that, "feather eating is a faculty which is primarily connected with hereditary characteristics". He also suggested that both parents were probably involved in the transmitting of this behaviour and although he felt unable to come to any final conclusions about the heriditary processes involved he suggested that feather eating could be controlled by principles of sound breeding. The results reported here would support Richter in this opinion.

The estimate of heritability found here for the incidence of peckers and pecked birds among those classified compares favourably with many production traits Lerner (1958). Characters with h^2 values which fall within the same range include bird size and conformation, egg production and egg quality. Since it is possible to breed strains to maximise these effects it should in theory be possible to breed to minimise the effects of feather pecking. However, in as far as any inadvertant selection pressure has been applied for feather pecking behaviour in selected strains of hens it is likely to have increased rather than reduced the incidence of pecking behaviour, since any selection for "type" would favour the sleekest and best feathered birds. In such a case it is more than probable that the peckers are being selected whereas the pecked birds, those with less uniform plumage, are being rejected.

Unfortunately it is not clear whether being a pecker or a pecked bird is associated genetically with any other production traits. It was found in Experiment 6 that pecked birds laid more eggs than peckers during thefirst few weeks of lay. Similarly Dickerson, Kashyap and Lamoreux (1961) found that probability of feather damage was 1. 5 times higher for the first of a pair of birds to begin laying.

In summary, these results suggest that a more intensive study of the genetic component of feather pecking would be worthwhile and that an attempt should be made to relate this behaviour, both pecking and being pecked, to production traits to assess whether a breeding programme to reduce feather pecking in certain strains would be practicable.

CHAPTER 10

FINAL DISCUSSION

It is clear from this study that feather pecking is an expression of individual bird behaviour and not a reflection of some general environmental factor. Feather pecking did not develop in groups of young chicks in a random fashion, but gradually, as different birds showed specific behaviour patterns which in turn influenced their cagemates. It became obvious that in a group of young chicks there are some birds that are inclined to feather peck and some that are inclined to be pecked and that these two types can be separated and reared in differently behaving groups. Further, the behaviour of birds that peck and are pecked is basically different in ways other than the amount of pecking given or received. This distinction is independent of experience and rearing conditions and can only be explained on the basis of some fundamental difference between birds, such as a genetic variation.

If genetic variation is of fundamental importance to the development of feather pecking, which seems probable since there are strain differences in susceptibility to feather pecking; it would help to explain why the many studies relating feather pecking to environmental variables have not produced consistent results (Chapter 1). As well as differences between strains in the amount of feather pecking it has been shown here that there is also considerable variation within strains. If this factor were controlled more consistent findings might be obtained in studies of feather pecking.

The exact means of expression of this variation is uncertain but it is evident that hormonal influences are implicated to some extent, altering the behaviour of both the pecker and the pecked bird. The result presented in Chapter 7 show that differences in the amount of exogenous testosterone and oestrogen affected both the amount of pecking done and tolerated and that the greater the number of pecks administered the fewer the number tolerated. Little work has been done on either the genetic or hormonal influences on feather pecking, but it would appear from this study that both are of fundamental importance and that they require further investigation if the problem of feather pecking is to be solved.

The genetic influence may involve aspects of behaviour other than simply the giving and receiving of pecks. In the experiments reported in this thesis habitual peckers were found to be active birds which spent less time pecking at food and the environment than some of their cagemates; were very responsive when pecked by another bird; were likely to peck at bird-like rather than environment-like stimuli; appeared to be positively reinforced by the consequences of the pecking act - such as the taste of blood and removal of feathers - and by definition indulged in a large amount of pecking at cagemates. The pecked birds on the other hand were quite the opposite in all these aspects of behaviour. These characteristics support the view that there are tangible differences in behaviour that could be genetically influenced. But are peckers and pecked birds at opposite ends of the same continuum or are the two types of bird quite distinct? Treatments with oestrogen and testosterone produced behaviour that appeared to be quite different and there was also some slight evidence that the inheritance of pecker or pecked behaviour might be marginally different.

Both these factors suggest that pecking and being pecked are in fact different behaviour patterns and not on the same continuum. It is possible that the behaviour that leads to a bird being pecked stems from an inappropriate sexual response. Birds given large doses of oestrogen were found to crouch at the approach of the experimenter's hand and were generally less responsive to physical contact than untreated birds. Perhaps a less intense form of this behaviour is present in some birds which leads them to become targets for pecking. The mechanism behind the behaviour of the birds that peck is less obvious, it seems that aggression is an unlikely influence (see below) but both Wennrich (1975, a, b and c) and Hoffmeyer (1969) have likened feather pecking to food pecking, so perhaps feather pecking is misdirected food pecking. There is no work relating directly to the description of different types of pecks in this study but birds were invariably seen to ingest any particles they removed from cagemates during feather pecking. Thus although there is no firm evidence it seems most likely that pecking and pecked are quite distinct and not on the same continuum.

It is evident that the effect of hormones is not just on the amount of pecking shown but on other aspects of behaviour too. For example birds given high doses of testosterone were more active than controls and more responsive to unfamiliar objects, perhaps this hormonal effect is responsible for the "nervous" and flighty-birds reported to do so much feather pecking (van Manen, 1934; Calet, 1965; Hughes and Duncan, 1972). Birds treated with oestorgen on the other hand were generally more docile and less easily disturbed and therefore ideal objects at which to peck. Thus the influence of hormones on feather pecking is not necessarily expressed simply as an increase in the inclination to peck, but also as a change in responsiveness to the environment which could result either in greater opportunity to give pecks (fewer quiescent periods) or, in the case of oestrogen, a more receptive attitude towards pecks.

Other than the influence of hormones and genetics five more factors have been suggested as causes for feather pecking; stimuli from feathers or accidental injury, an unsatiated pecking drive or boredom, aggression, nutritional deficiences and management factors. These can now be reconsidered in relation to the results obtained in this study.

It seems that the accidental start of an out-break of feather pecking due to some slight stimuli from cagemates plumage or an injury (van Manan 1934; Kull 1948; Whittle 1957) is very improbable. It was observed in this study that those stimuli that were just visually "arresting" had little effect on pecking behaviour, whilst stimuli that had other properties such as mechanical stability, lack of response and destructableness were responded to with vigour. Thus the purely visual stimulus of new feather growth or misplaced feathers is unlikely to have aroused an out-break of feather pecking.

Even a bird with a bloody injury would not be an automatic stimulus that evoked feather pecking. Birds that were predominently pecked were found not to peck even at severely damaged cagemates, whereas peckers did. Thus the composition of the group concerned, in terms of potential peckers and pecked is much more important in determining the occurrence of out-breaks of feather pecking than inadvertent changes in feather condition.

The effect of different stimuli and environmental components on pecking behaviour is difficult to define. Disregarding the behaviour of individuals for the moment, the evidence provided in this study suggests that pecks are to a large extent elicited by the environment and that a rich environment will result in greater pecking than an impoverished one. Birds in cages with litter on the floor, for example, showed more pecking overall than those in cages with wire floors. Thus a straight forward drive hypothesis (Levy, 1938; Höffmeyer, 1969) that predicts a "quota" of pecks that must be fulfilled in all circumstances is not appropriate.

A further restriction on the use of the concept of a drive comes from the finding that the most important variable in the feather pecking situation has been identified as the behaviour of the individual; this must be taken into consideration when describing a birds requirements. Would a pecker be able to "satiate" its "drive" if placed in a cage with litter on the floor or onto free range, or would a more appropriate environment for this type of bird be a collection of non-responsive cagemates in any environment. The observations made in this study suggest that peckers are not particularly affected by the environment and so if a drive state is to be postulated the only way of meeting the birds requirements would be to house it with potentially pecked birds. General terms such as "drive states" and "boredom" were useful in categorising behaviour when there was little detailed information about the feather pecking syndrome but they now seem redundant.

There is no doubt that the modern cage environment for poultry leaves the bird with more time than a free range situation once it has fulfilled its basic requirements but this is no explanation in itself for feather pecking.

The assumption that aggression is an underlying factor in feather pecking is common (Whittle 1957; Pullianen 1965) and in some ways the results reported in this thesis would appear to support this view. Levels of aggression are, to a large extent, genetically determined and mediated by hormones (Guhl and Fischer 1969). There is a peck order in which some birds give the majority of pecks and receive very few and other birds that are in the opposite position. All this appears very similar to the influences and behaviour patterns related to feather pecking that are reported here. However, there is no strong evidence, either in this thesis or in the work of other investigators (Hoffmeyer, 1969; Wennrich 1974 and 1975 a, b and c; Hughes and Duncan, 1972), to suggest that relationship exists between these two phenomena. If, as outlined in the discussion of Chapter 8, there are some superficially related factors these are not major variables in the normal feather pecking situation.

The review of the literature on feather pecking showed that studies involving modification of the diet in an attempt to affect the incidence of feather pecking were numerous as were those considering management factors. No consistent effect was apparent in either case and no attempt has been made in this thesis to try and investigate these findings further.

Now that this study is complete it is possible in retrospect to evaluate some of the methods of investigation used and to discuss problems of interpretation of the data. The main tool used was observation of the behaviour of groups and individuals. As a result of this work it is possible to say that although the group observations were a necessary part in forming a model of pecking behaviour the observations on individuals within groups were in many ways more informative, and further work on this basis would be the more useful.

The collection of information about the other activities of birds involved in feather pecking meant that a global picture of peckers and pecked could be formulated. This has not previously been attempted but is very necessary if a thorough understanding of the feather pecking phenomenon is to be gained (Kiley, 1977).

However, there were drawbacks to some of the methods used. Firstly the use of a time sampling technique, although adequate for activities that occurred at low or medium frequencies, not more than once every thirty seconds for each bird, was not adequate for high frequency behaviour patterns on which a ceiling was probably imposed. Despite this failing the time sampling method continued to be used since in no other way could records covering several types of behaviour in groups of birds be made. However, once the limitations of this method were realised additional periods of continuous observation on high frequency behaviours were included.

There was also a problem in the interpretation of the effects of feather pecking in some instances. For example, in young birds that were in the process of changing down for feathers, the signs of pecking damage could disappear in only a few days, whereas in older birds, that had an almost full set of feathers, it would take a little longer for the damaged areas to re-grow and finally an hours pecking damage might take several months to disappear in mature pullets. In all instances the feather scores that were given were appropriate for the amount of denuding suffered, but the regrowth time would affect the rate of reduction of feather damage shown by groups of pecked birds housed together.

The population on which the genetic experiments were based was obviously very limited and it would have been useful to have been able to control the size of the family groups more precisely. This is clearly essential for any further work on this topic.

The most difficult factor in the whole study was the lack of certainty of obtaining any feather pecking behaviour to observe. This made it necessary to design experiments to fulfill a purpose whether or not feather pecking occurred, ,and so some experiments may seem unnecessarily complex. This lack of repeatability of the feather pecking behaviour also made it extremely difficult to construct an empirical model of feather pecking and much of the work was based on intuitive considerations of the problem. It was partly for this reason that such a large area was covered; it was not obvious at the beginning of the study which of the many possible influences were fundamental to the feather pecking situation.

Until very recently feather pecking, although wide-spread, was not seen as a particularly serious condition in the poultry industry unless cannibalism developed. However, with the increasing attention paid to economic factors it is now appreciated that a featherless bird uses more energy to maintain its body temperature (Richards, 1977). To raise the house temperature to compensate for feather loss can be just as costly as the alternative, increasing level of feeding. A recent estimate (Emmans, 1977) was that a bird denuded of feathers cost an extra 45p. per annum to keep, and this was without considering the drop in egg production, and possibly other factors, that may accompany feather loss.

Thus on both purely humanitarian grounds and in relation to the economic considerations of egg production it is important that feather pecking be prevented. It is unlikely that the present 'cure' of reducing light intensity is going to do more than hide the problem and that what is necessary is a means of prevention which is effective and acceptible to modern poultry farming.

A thorough investigation into the inheritance of feather pecking would be very valuable and if this factor is as important as it appears in this study then the breeding of lines low in feather pecking behaviour could be considered. Further studies on the behaviour of individuals towards their environment and their cagemates would give greater insight into the activities associated with feather pecking and with the toleration of the pecks by damaged birds. Additional investigations into the mechanisms connecting the role of hormones to the feather pecking situations might be of considerable value in increasing understanding of the behaviour of both the pecker and the pecked bird.

BIBLIOGRAPHY

Allen, J. and Perry, G.C. (1975). Feather pecking and cannibalism in a caged layer flock. Br. Poult. Sci., 16, 441-451.

Andrew, R.J. (1963). Effect of testosterone on the behaviour of the domestic chick. J. comp. physiol. Psychol., 56, 993-940.

Andrew, R.J. (1972a). Changes in search behaviour in male and female chicks, following different doses of testosterone. Anim. Behav., 20, 741-750.

---- (1972b). Testosterone, search behaviour and persistance. Nature, 237, 343-346.

---- (1972c). Recognition processes and behaviour, with special references to effects of testosterone on persistance. Advances in the Study of Behaviour, 4, 175-208.

Archer, J. (1976). Testosterone and fear behaviour in male chicks. Physiol and Behav., 17, 561-564.

Bareham, J.R. (1976). A comparison of the behaviour and production of laying hens in experimental and conventional battery cages. Appl. Anim. Ethol., 2, 291-303.

Beach, F.A. (1965). Sex and Behaviour. John Wiley and Sons, New York.

Bearse, G.E., Berg, L.R., McClary, C.F., and Miller, J.L. (1949). The effect of pelleting chicken rations on the incidence of cannibalism. Poult. Sci., 28, 756.

Borchelt, P.L., (1977). Development of dust bathing components in Bobwhite and Japanese quail. Devel. Psycho. Biol., 10, 97-103.

Braulas, G.C. (1974). Unpublished results from Spelderholt Institute for Poultry Research, Beekbergen, Holland.

Calet, C. (1965). The relative value of pellets versus mash and grain in poultry nutrition. Wld. Poult. Sci. J., 21, 23-52.

Candland, D.K. Mathew, T.J. and Taylor, D.B. (1968). Factors affecting reliability of dominance orders in the domestic chick. J. comp. physiol. Psychol., 66, 168-174.

Carpenter, C.D. (1940). Unusual cannibalism. J. Am. vet. med. Assoc., 97, 326.

Carver, J.S. (1931). Control of cannibalism in battery brooders and fattening batteries. Poult. Sci., 10, 275-277.

Creek, R.D. and Dendy, M.Y. (1957). The relationship of cannibalism and methionine. Poult. Sci., 36, 1093-4.

Davidson, J.A., Schaible, P.J., Brant, A.W. and Card, G.C. (1941). Canniablism in white leghorn pullets in the laying house. Poult. Sci., 20, 458.

Dickerson, G., Kashyap, T. and Lamoreux, W.F. (1961). Heritable variation in pecking behaviour in chicks. Poult. Sci. 40, 1394-1395.

Duncan, I.J.H., Horne, A.R., Hughes, B.O. and Wood-Gush, D.G.M. (1970). The patterns of food intake in female brown leghorn fowls as recorded in a Skinner box. Anim. Behav., 18, 245-255.

Duncan, I.J.H., and Hughes, B.O. (1973). Some environmental factors influencing feather pecking in growing birds. Br. vet. J., 129, 503-504.

Emmans, G.C., (1977). Personal communication.

Ewbank, R. (1969). Behavioural implications of intensive animal husbandry. Outlook on Agriculture, 6, 41-46.

(1973). Abnormal behaviour and pig nutrition. An unsuccessful attempt to induce tail biting by feeding a high energy, low fibre vegetable protein ration. Br. vet. J., 129, 366-369.

Gadd, J. (1967). Tail biting. Pig farming. 15, 57-59.

Gallup, G.G., Mash, R.F., Potter, R.J. and Donegan, M.H. (1970). Effect of varying conditions of fear on immobility reactions in domestic chickens, (Gallus gallus). J. comp. physiol. Psychol., 73, 442-445.

Goodwin, E.B. and Hess, E.A. (1969). Innate visual form preferences in the pecking behaviour of young chicks. Behaviour, 34, 223-237.

Guhl, A.M. (1953). Social behaviour in the domestic fowl. Tech. Bull. Kans. agric. Exp. stn., 73, 3-48.

Guhl, A.M. (1958). The development of social organisation in the domestic chick. Anim. Behav., 6, 92-111.

Guhl, A.M. (1961). Gonadal hormones and social behaviour in infra human vertibrates. In sex and internal secretions, Ed. it. W.C. Young; Williams and Wilkins.

Guhl, A.M. and Fischer, G.J. (1969). The behaviour of chickens. In Behaviour of Domestic Animals, 3rd Edition, Edit. Hafez; Bailliere, Tindall and Cassell Ltd.

Hafez, E.S.E. (1969). Behaviour of Domestic Animals, 3rd Edition, Bailliere, Tindall and Cassell Ltd.

Hamilton, J.B. and Golden, W.R.C. (1939). Responses of the female to male hormone substances. Endocrinology, 25, 737-748.

Hauschka, T.S. (1952). Whisker-eating in mice. J. Hered., 43, 77-80.

Heywang, B.W. and Morgan, R.B. (1944). Comparison of pelleted and unpelleted all-mash diet for chicks. Poult. Sci., 23, 16-20.

Hill, A.T. and Binns, M.R. (1973). Effect of varying population density and size on laying performance. Proceedings of the 4th European Poultry Conference, 605-609.

Hinde, R.A. (1970). Animal Behaviour. A synthesis of Ethology and Comparative Psychology. Second Edition - McGraw-Hill.

Hoffmeyer, I. (1969). Feather pecking in pheasants, an ethological approach to the problem. Danish Review of Game Biology, 6, 1-36.

Horne, A.R. and Wood-Gush, D.G.M. (1970). Exploratory activity following oestrogen treatment in ovariectomised brown leghorn females. Rev. Comp. Animal, T4, 3e Trim. 46-50.

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

Hughes, B.O. (1973). The effect of implanted gonadal hormones on feather pecking and cannibalism in pullets. Br. Poult. Sci., 14, 341-348.

Hungerford, T.G. (1962). Diseases of Poultry. 3rd Edition. Angus and Robertson, Sydney (London).

Jensen, L.S. (1962). Observations on eating patterns and rate of food passage of birds fed pelleted and unpelleted diets. Poult. Sci., 41, 1414-1419.

Jericho, K.W.F. and Church, T.L. (1972). Cannibalism in pigs. Can. Vet. J., 13, 156-159.

Kar, A.B. (1947) see page 212.

Kiley-Worthington, M. (1977). Behavioural Problems of Farm Animals. Oriel Press.

Kull, K-E. (1948). The prevention and treatment of cannibalism and feather eating in fowls. Proc. 8th Wld. Poult. Congress. 124-5.

*Kull, K-E. (1951). Proc. 6th Nordic Vet. Congress, Stockholm. p. 426.

Lerner, I.M. (1958). The Genetic Basis of Selection. John Wiley.

Levy, D.M. (1938). On instinct satiation - an experiment on the pecking behaviour of chickens. J. Gen. Psychol., 18, 327-348.

Long, S.Y. (1972). Hair nibbling and whisker trimming as indicators of social hierarchy in mice. Anim. Behav., 20, 10-12.

Lowry, D.C. and Abplanalp, H. (1972). Social dominance difference, given unlimited access to common food, between hens selected and unselected for increased egg production. Br. Poult. Sci., 13, 365-376.

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

Madsen, H. (1966). On feather picking and cannibalism in pheasant and partridge chicks. Acta. vet. scand., 7, 272-287.

Marsboon, R. and Sierens, G. (1962). Treatment and prophylaxis of cannibalism in poultry with Laloanisone R 2028. Poult. Sci., 41, 776-781.

Masic, B., Wood-Gush, D.G.M., Duncan, I.J.H., McCorquodale, C. and Savory, C.J. (1974). A comparison of the feeding behaviour of young broiler and layer males. Br. Poult. Sci., 15, 499-505.

Mather, F.B. and Gleaves, E.W. (1970). Performance of commercial stocks of layers as influenced by cage density. Poult. Sci., 49, 1412.

Miller, M.W. and Bearse, G.E. (1937). The cannibalism preventing properties of oat hulls. Poult. Sci., 16, 314-321.

Miller, M.W. and Bearse, G.E. (1938). The cannibalism preventing properties of oat hulls. Poult. Sci., 17, 466-471.

Morgan, R.B. and Heywang, B.W. (1940). A comparison of pelleted and unpelleted all-mash diet for laying chickens. Poult. Sci., 20, 62-65.

Neal, W.M. (1956). Cannibalism, pickouts and methionine. Poult. Sci., 35, 10-13.

*Oetell, R. (1873). Der Huhner-oder Geflugelhof. Bernhard Friedrich Boigt, Weimar.

Penny, R.H.C., Hill, F.W.G., Field, J.E. and Plush, J.T. (1972). Tail biting in pigs - a possible sex incidence. Vet. Rec., 91, 482-483.

Pulliainen, E. (1965). Cannibalism in the pheasant during the egg laying period. Annales Zoologici Fennici, 2, 208-214.

Quadagno, D.M., Shryne, J., Anderson, C. and Gorski, R.A. (1972). Influence of gonadal hormones on social, sexual, emergence and open field behaviour in the rat. Anim. Behav., 20, 732-740.

Richards, S.A. (1977). The influence of loss of plumage on temperature regulation in laying hens. J. agric. Sci., Camb., 89, 393-398.

Richter, Fr. (1954). Experiments to ascertain the causes of feather-eating in the domestic fowl. Proceedings 10th Worlds Poultry Congress, 258-262.

Robertson, A. and Lerner, M. (1949). The heritability of all-or-none traits: viability of poultry. Genetics, 34, 395-411.

Sanctuary, W.C. (1934). Vicious habits and cannibalism. Wld. Poult. Sci., 10, 356-357.

Schaible, P.J., Davidson, J.A. and Bandemer, S.L. (1947). Cannibalism and feather picking in chicks as influenced by certain changes in a specific ration. Poult. Sci., 26, 651-656.

Schumaier, G., Harrison, P.C. and McGinnis, J. (1968). Effect of coloured flourescent light on growth, cannibalism and subsequent egg production of single comb white leghorn pullets. Poult. Sci., 47, 1599-1602.

Sherwood, D. H. (1958). Failure of methionine and niacine to prevent feather picking in layers. Poult. Sci., 37, 1242.

Siren, M. J. (1963). Cannibalism in cockerels and pheasants. Acta vet. scand., 4, 7-48.

Slater, P. J. B. (1974). The temporal pattern of feeding behaviour in the zebra finch. Anim. Behav., 22, 506-515.

Snedecor, G. W. (1956). Statistical Methods, 5th Edition. Iowa State College Press.

Spearman, R. I. C. (1971). The Integumentary system. In Physiology and Biochemistry of the Domestic Fowl, Vol. 2. Edit. Bell and Freeman. Academic Press, London and New York.

Sturkie, P. D. (1965). Gonadal Hormones, Chapter 5. In Avian Physiology. Balliere, Tindall and Cassell.

Tindell, D. and Craign, J. V. (1959). Effects of social competition on laying house performances in the chicken. Poult. Sci., 38, 95-106.

Tolman, C. W. (1965). Emotional behaviour and social facilitation of feeding in domestic chicks. Anim. Behav., 13, 493-496.

Turner, E. R. A. (1964). Social feeding in birds. Behaviour, 24, 1 - 45.

van Manen, E. (1934). The control of cannibalism in chicks by the use of ruby red glass in brooder houses. S. Afr. vet. med. Ass., 5, 245-250.

van Oordt, G. J. (1963). Male gonadal hormones, Chapter 5. In Comparative Endocrinology, Vol. 1. Edit. von Euler and Heller.

van Putten, G. (1967). Tail biting in pigs. Tijdschr. Diergeneesk, 92, 705-712.

von Faber, H. (1964). Feather eating as a stressor in the Muskovy duck. Poult. Sci., 43, 1432-1434.

Voss, B. (1933). Kannibalisme hos kyllinger. Medlemsbl danske Dyrlaeg. Forkand., 16, 259-260.

Weaver, C.H. and Bird, S. (1934). The nature of cannibalism occurring among adult domestic fowls. J. Am. vet. med. Ass., 85, 623-637.

Wells, R.G. (1973). Stocking density and colony size for caged layers. Proceedings 4th European Poultry Conference, London, 617-622.

Wennrich, G. (1974). Ethological studies of feather pecking and cannibalism in the domestic chick. Proceedings 15th World Poultry Congress, 553-554.

Wennrich, von G.(1975a). Ethological studies of domestic chicken (Gallus domesticus) of different hybrid origin in floor management with special reference to aggressive behaviour as well as feather pecking and cannibalism.
5. Communication: Feather pecking behaviour. Arch. Geflugelk., 4, 37-44.

——— (1975b) 6. Communication: Behaviour patterns in cannibalism. Arch. Geflugelk., 4, 78-83.

——— (1975c). Relations between rank, feather pecking activity and aggressiveness of chickens (Gallus domesticus). Arch. Geflugelk., 4, 167-171.

Whittle, T.E. (1957). Cannibalism in poultry - a review. Scot. J. Agric., 37, 75-80. and 149-154.

Willimon, C.P. and Morgan, C.L. (1953). Effect of minor nutrient mineral elements in the diet of chickens on feather pulling and cannibalism. Poult. Sci., 32, 309-315.

Wolter, R., Thion, F. and Baratou, J. (1971). Trial of essential amino acids supplements to prevent feather picking in pheasants. Rec. Med. Vet., 147, 257-267.

Ziegenhagen, E.H., Corman, L.B. and Hayward, J.W. (1947). Feed particle size as a factor affecting turkey poults. Poult. Sci., 26, 212-214.

Kar, A.B. (1947). The hormonal influence in the normal functioning of the uropygial gland in the fowl. Anat. Rec., 99, 75-89.

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