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ASSESSING THE WELFARE OF HENS AND BROILERS

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1. INTRODUCTION

Welfare is a term which is restricted to animals, including man. It is regarded as particularly important by many people but requires strict definition if it is to be used effectively and consistently. A clearly defined concept of welfare is needed for use in precise scientific measurements, in legal documents and in public statements or discussion. If animal welfare is to be compared in different situations or evaluated in a specific situation, it must be assessed in an objective way. The assessment of welfare should be quite separate from any ethical judgement but, once an assessment is completed, it should provide information which can be used to take decisions about the ethics of a situation.

An essential criterion for a useful definition of animal welfare is that it must refer to a characteristic of the individual animal rather than something given to the animal by man. The welfare of an individual may well improve as a result of something given to it but the thing given is not itself welfare. The loose use of welfare with reference to payments to poor people is irrelevant to the scientific or legal meaning. However, it is accurate to refer to changes in the welfare of an initially hungry person who uses a payment to obtain food and then eats the food. The word welfare can be used in relation to a person, as above, or to an animal which is wild or is captive on a farm, in a zoo, in a laboratory or in a human home. Effects on welfare which can be described include those of disease, injury, starvation, beneficial stimulation, social interactions, housing conditions, deliberate ill treatment, human handling, transport, laboratory procedures, various mutilations, veterinary treatment or genetic change by conventional breeding or genetic engineering.

We have to define welfare in such a way that it can be readily related to other concepts such as needs, freedoms, happiness, coping, control, predictability, feelings, suffering, pain, anxiety, fear, boredom, stress and health.

(a) Welfare definition

If, at some particular time, an individual has no problems to deal with, that individual is likely to be in a good state including good feelings as indicated by body physiology, brain state and behaviour. Another individual may face problems in life which are such that the individual is unable to cope with them. Coping implies having control of mental and bodily stability and prolonged failure to cope results in failure to grow, failure to reproduce or death. A third individual might face problems but using an array of coping mechanisms, be able to cope but only with difficulty. The second and third individuals are likely to show some direct signs of their potential failure to cope or difficulty in coping and they are also likely to have had bad feelings associated with their situations. *The welfare of an individual is its state as regards its attempts to cope with its environment* (Broom, 1986). This definition refers to a characteristic of the individual at the time. The origin of the concept is how well the individual is faring or travelling through life and the definition refers to state at a particular time (for further discussion, see Broom, 1991a,b, 1993, 1996a; Broom and Johnson, 1993). A crucial aspect of the concept is that welfare refers to how much an individual has to do when trying to cope, as well as the extent of any failure to cope and the extent of positive correlates of successful coping. The concept refers to the state of the individual on a scale from very good to very poor. This is a measurable state and any measurement should be independent of

ethical considerations. When considering how to assess the welfare of an individual it is necessary to start with knowledge of the biology of the animal. The state may be good or poor. However, in either case, in addition to direct measures of the state, attempts should be made to measure those feelings which are a part of the state of the individual.

Welfare can be measured in a scientific way that is independent of moral considerations. Welfare measurements should be based on a knowledge of the biology of the species and, in particular, on what is known of the methods used by animals to try to cope with difficulties and of signs that coping attempts are failing. The measurement and its interpretation should be objective. Once the welfare has been described moral decisions can be taken.

(b) Welfare and needs

When attempting to determine what is an appropriate environment for an animal, most scientists involved in welfare research would agree with Appleby (1997) that a range of components of that environment, each of which is to some extent variable, should be considered. The environment is appropriate if it allows the animal to satisfy its needs. Animals have a range of functional systems controlling body temperature, nutritional state, social interactions, etc. (Broom, 1981). Together, these functional systems allow the individual to control its interactions with its environment and, hence, to keep each aspect of its state within a tolerable range. The allocation of time and resources to different physiological or behavioural activities, either within a functional system or between systems, is controlled by motivational mechanisms. When an animal is actually or potentially homeostatically maladjusted, or when it must carry out an action because of some environmental situation, we say that it has a need. A need can, therefore, be defined as *a requirement, which is part of the basic biology of an animal, to obtain a particular resource or respond to a particular environmental or bodily stimulus*. As pointed out by Broom (1997), these include needs for particular resources and needs to carry out actions whose function is to obtain an objective (Toates and Jensen, 1991; Broom, 1996a). Needs can be identified by studies of motivation and by assessing the welfare of individuals whose needs are not satisfied (Hughes and Duncan, 1988a,b; Dawkins, 1990; Broom and Johnson, 1993). Unsatisfied needs are often, but not always, associated with bad feelings whilst satisfied needs may be associated with good feelings. When needs are not satisfied, welfare will be poorer than when they are satisfied.

Hens need to (Broom, 1992):

1. obtain adequate nutrients and water,
2. grow and maintain themselves in such a way that their bodies can function properly.
3. avoid damaging environmental conditions, injury or disease, and
4. be able to minimise the occurrence of pain, fear and frustration.

In order to achieve these ends, hens carry out a variety of activities, respond to certain stimuli and maintain certain physiological states.

Hence they have other needs such as to:

5. show certain foraging and investigatory movements,
6. have sufficient exercise,
7. show preening and dust-bathing behaviour,
8. explore and respond to signs of potential danger,
9. interact socially with other hens,
10. search for, or create by building, a suitable nest-site.

(c) Welfare and feelings

The subjective feelings of an animal are an extremely important part of its welfare (Broom, 1991b) . Suffering is a negative unpleasant subjective feeling which should be recognised and prevented wherever possible. However, whilst there are many measures which give information about injury, disease and both behavioural and physiological attempts to cope with the environment, fewer studies tell about the feelings of the animal. Information can be obtained about feelings using preference studies and other information giving indirect information about feelings can be obtained from studies of physiological and behavioural responses of animals.

Feelings are aspects of an individual's biology which must have evolved to help in survival (Broom, 1998) just as aspects of anatomy, physiology and behaviour have evolved. They are used in order to maximise fitness, often by helping to cope with the environment. It is also possible, as with any other aspect of the biology of an individual, that some feelings do not confer any advantage on the animal but are epiphenomena of neural activity (Broom and Johnson, 1993). The coping systems used by animals operate on different time scales. Some must operate during a few seconds in order to be effectual, others take hours or months. Optimal decision-making depends not only on an evaluation of energetic costs and benefits but on the urgency of action, in other words the costs associated with injury, death or failure to find a mate (Broom, 1981). In the fastest acting urgent coping responses, such as avoidance of predator attack or risk of immediate injury, fear and pain play an important role. In longer time-scale coping procedures, where various risks to the fitness of the individual are involved, feelings rather than just intellectual calculations are amongst the causal factors affecting what decisions are taken. In attempts to deal with very long-term problems which may harm the individual, aspects of suffering contribute significantly to how the individual tries to cope. In the organisation of behaviour so as to achieve important objectives, pleasurable feelings and the expectation that these will occur have a substantial influence. The general hypothesis advanced is that whenever a situation exists where decisions are taken which have a major effect on the survival or potential reproductive output of the individual, it is likely that feelings will be involved. This argument applies to all animals with complex nervous systems, such as vertebrates and cephalopods, and not just to humans. Feelings have not just a minor influence on coping systems, they are a very important part of them.

(d) Welfare and stress

The word stress should be used for that part of poor welfare which involves failure to cope . If the control systems regulating body state and response to danger are not able to prevent displacement of state outside the tolerable range, a situation of different biological importance is reached. The use of the term stress should be restricted to the common public use of the word to refer to a deleterious effect on an individual (Broom and Johnson, 1993). A definition of stress as just a stimulation or an event which elicits adrenal cortex activity is of no scientific or practical value. A precise criterion for what is adverse for an animal is difficult to find but one indicator is whether there is, or is likely to be, an effect on biological fitness. *Stress is an environmental effect on an individual which over-taxes its control systems and reduces its fitness or seems likely to do so* (Broom and Johnson, 1993, see also Broom, 1983; Fraser and Broom, 1990). Using this definition, the relationship between stress and welfare is very clear. Firstly, whilst welfare refers to a range in the state of the animal from very good to very poor, whenever there is stress, welfare is poor. Secondly, stress refers only to situations where there is failure to cope but poor welfare refers to the state of the animal both when there is failure to cope and when the individual is having difficulty in coping. For instance, if a person is severely depressed or if an individual has a debilitating disease but there is complete recovery with no long term effects on fitness then it would still

be appropriate to say that the welfare of the individual was poor at the time of the depression or disease.

(e) Welfare and health

The word "health", like "welfare", can be qualified by "good" or "poor" and health varies over a range. However, health refers to the state of body systems, including those in the brain, which combat pathogens, tissue damage or physiological disorder. Welfare is a broader term covering all aspects of coping with the environment and taking account of a wider range of feelings and other coping mechanisms than those which affect health, especially at the positive end of the scale. Although people regularly refer to poor health they sometimes use the word to mean absence of illness or injury in the same way that people refer to welfare when they mean good welfare. However, the precise and scientific use of health and welfare must refer to states varying from very good to very poor. "Health" is encompassed within the term "welfare" and indeed is a very important part of welfare.

Health is a part of welfare and, hence, disease always has some adverse effect on welfare. There can also be effects in the other direction because specific aspects of health may be made worse when welfare in general is poor (Broom, 1988b). These relationships are summarised below.

Disease effects: poor welfare.

Difficult conditions: poor welfare, immunosuppression, increased disease.

Overall: poor welfare disease

The sequence could start with infectious disease which then causes poor welfare. Alternatively, inadequate housing conditions could lead to poor welfare and hence to increased disease susceptibility. If animals became diseased as a consequence, this would result in worse welfare than that caused directly by the housing conditions.

The general conclusions about the inter-relationships between welfare improvement attempts and disease are firstly, that disease is an aspect of poor welfare and many actions will be of benefit in both respects. Secondly, that the possible trade off between reduced immunosuppression and increased disease transmission risk should be carefully considered in all attempts to improve welfare. Thirdly, that there are differences between production- or system-related diseases and dangerous infectious diseases. While there is quite a lot of information about the former, the latter should also be borne in mind when new systems are being developed for housing and managing animals. The overall aim should be to improve welfare in total, including consideration of the effects on individuals of any disease which they might contract (Broom, 1992).

(f) Welfare assessment

The general methods for assessing welfare are summarised in Table 1 and a list of measures of welfare is presented in Table 2. Most indicators will help to pinpoint the state of the animal wherever it is on the scale from very good to very poor. Some measures are most relevant to short-term problems, such as those associated with human handling or a brief period of adverse physical conditions, whereas others are more appropriate to long-term problems. (For a detailed discussion of measures of welfare, see Broom 1988a; Fraser and Broom, 1990; Broom and Johnson, 1993).

Table 1. Summary of welfare assessment (modified after Broom, 1990a).

General Methods		Assessment
Direct indicators of poor welfare		How poor?
Tests of	(a) avoidance and (b) positive preference	(a) Extent to which animals have to live with avoided situations or stimuli. (b) Extent to which that which is strongly preferred is available.
Measures of ability to carry out normal behaviour and other biological functions.		How much important normal behaviour or physiological or anatomical development cannot occur?
Other direct indicators of good welfare		How good?

The net welfare at any moment will be the extent of good welfare indicated less the extent of poor welfare. If the extent of a problem is being evaluated and there are indications that net welfare is poor, the longer this state persists the worse is the evaluation. If the severity of the effect on the individual is measured and is plotted against time the total amount of poor welfare is indicated by the area under the curve produced (Broom, 1999b). A further factor to consider is the number of individuals involved. When a judgement is made about the overall magnitude of a problem the total amount of poor welfare in each individual whose welfare is poor should be summed. Most people would not consider it acceptable to allow compensation among individuals between good and poor welfare. If there are five thousand
contented people and two hundred desperately unhappy people in a town this does not add up to no problem. The large numbers of individual animals in the poultry industry mean that poor welfare in a small proportion of individuals is still a serious matter. If a high proportion of individuals are affected, the problem is greater.

Table 2. Measures of welfare.

Physiological indicators of pleasure.
Behavioural indicators of pleasure.
Extent to which strongly preferred behaviours can be shown.
Variety of normal behaviours shown or suppressed.
Extent to which normal physiological processes and anatomical development are possible.
Extent of behavioural aversion shown.
Physiological attempts to cope.
Immunosuppression.
Disease prevalence.
Behavioural attempts to cope.
Behaviour pathology.
Brain changes, e.g. those indicating self narcotisation.
Body damage prevalence.
Reduced ability to grow or breed.
Reduced life expectancy.

II. KEY DATA CONCERNING THE WELFARE OF HENS AND BROILERS

(a) Space for movements

If hens need to carry out a range of normal movements how much space is required for these? Measurements of the space occupied by a hen when carrying out such movements have been made (Dawkins and Hardie, 1989) (Table 3).

Table 3. Area required by hens for different behaviour patterns (cm^2).

Standing	428 - 592
Turning	771 - 1377
Preening	818 - 1270
Ground-scratching	540 - 1005
Wing-stretching	653 - 1118
Wing-flapping	860 – 1980

If there are five hens in a cage these will not show all of the different movements simultaneously and some hens might be relatively inactive whilst one bird uses more space. Some possible combinations of movement are considered in Table 4. It is clear from the calculations presented in Table 4 that a cage for five hens allowed 450 cm^2 each, and hence occupying 2250 cm^2, severely inhibits normal movements. Wing-flapping is not possible with commonly used cage heights of 50 cm or less.

If hens are allowed more space than 450 cm^2 per bird the amount of disturbed behaviour shown is decreased (Hughes and Black, 1974; Hansen, 1976; Zayan and Doyen, 1985; Cunningham *et al*., 1987; Nicol, 1987). Hens will work for a larger space allowance of up to 1125 cm^2 per bird and they continue to space themselves out in cages of 1410 cm^2 per bird but in much larger space allowances of 5630 cm^2 per hen, they cluster. The effects of space allowance on the extent of injurious behaviour are not a linear relationship in battery cages (Polley *et al.,* 1974; Al Rawi and Craig, 1975) but depend upon the complexity of the environment. In order to provide opportunities to escape and to hide from birds which tend to feather-peck or cause tissue damage by pecking, more space allowance than that normally provided in a battery cage is needed. Such escape possibilities are important in order to minimise injuries caused by other birds. As long as they are available injurious behaviour can be low at various space allowances.

Table 4. Space required for hens in a cage holding five birds.

	cm^2 used	space per bird
4 hens crowded together plus 1 wing flapping	2720	544
4 hens crowded together plus 1 wing stretching	2185	437
4 hens crowded together plus 1 preening	2342	468
3 hens crowded, 1 turning, 1 wing flapping	3469	694
2 crowded, 2 turning, 1 wing flapping	4218	844
4 hens standing, preening	3074	615
4 hens standing, 1 wing flapping	3460	692

2 hens standing, 2 turning, 1 wing stretching	4050	810
2 hens standing, 2 turning, 1 wing flapping	4584	917

The space requirements of broilers in normal housing conditions, are those which allow normal movements, exploration and social interactions. At least enough space to exercise, maintain leg condition and have access to resources is needed. The problem arises in the latter stages of growth when birds are crowded together. Increasing stocking density above 25 kgm^{-2} increases mortality, reduces locomotion, reduces litter quality, increases leg disorders and dermatitis, reduces calm behaviour and nesting and makes the finding of sick and injured birds more difficult.

(b) Bone fragility

The diet of hens is adequate for bone development, with calcium and vitamin D being key factors, but the bones of hens from battery cages break easily. In a series of studies, 25-40% of end-of-lay hens from battery cages were found to have at least one broken bone following handling prior to stunning and 98% of carcasses had a broken bone (Gregory and Wilkins, 1989; Gregory *et al*., 1990, 1991). The numbers of broken bones from percheries and aviaries were much lower although hens from poorly designed or over-crowded percheries sometimes broke bones in the living conditions. The strength of the bones in wings and legs were reduced if there was insufficient opportunity for exercise. Birds which lived in cages in which they could not flap their wings had wing bones which were only half as strong as those of birds in a perchery which could and did flap (Knowles and Broom, 1990; Nørgaard-Nielsen ,1990).

(c) Investigatory pecking and dust bathing

Chickens strongly prefer litter floors to wire floors (Dawkins, 1982; Appleby *et al*., 1988). The opportunity to peck at objects on the floor, scratch on the floor and dust bathe in a suitable substratum reduces the likelihood that injurious behaviour will be shown by hens and broiler breeders (Blokhuis, 1986; Vestergaard *et al*., 1990). Studies of the development and motivation basis of feather-pecking behaviour indicates links with deprivation of ground-pecking and dust-bathing opportunities.

(d) Nest boxes and egg laying

An appropriate nest box is used by almost all hens if it is readily accessible (Wood-Gush, 1975) and behaviour is clearly disturbed if none is available. The abnormal behaviour most frequently observed when no suitable nest site is present is stereotyped pacing (Wood-Gush and Gilbert, 1969; Fölsch, 1981; Heil *et al*., 1990). This stereotypy is a sign of long-term, intense frustration.

(e) Perching

Perches are preferred resting places for all but the youngest chickens. The design should be right and early experience of perches facilitates effective use (Appleby *et al.,* 1993). The presence of perches can increase leg strength (Hughes and Appleby, 1989). Where cloaca-pecking is a possibility, the perch should not be sited at such a height that the heads of some birds are level with the vents of others. This has been an important reason for the failure of some "getaway" cages because of injurious pecking (Moinard *et al*., 1998). Young

broilers use platforms and straw bales more than perches but appropriate perching facilities could improve welfare in general and leg strength in particular.

(f) Lighting

If hens, broilers or broiler breeders are kept in low light levels they are not able to show normal exploratory behaviour. At the lowest levels eye development is impaired. A review by Manser (1994) indicated clear welfare problems at light levels lower than 20 lux.

(g) Beak-trimming

Mutilations which involve tissue damage are painful at the time of the operation and can sometimes cause neuromas which result in lasting pain. Beak-trimming also seriously impairs sensory input and pecking behaviour. The effect on welfare of beak-trimming is substantial but is much greater if neuromas are present.

(h) Leg problems and ascites

The major causes of poor welfare in modern strains of broilers are leg disorders and ascites. The clinical conditions which impair walking include femoral head necrosis (Thorp *et al.,* 1993), dyschondroplasia (Lynch *et al*., 1992), valgus-varus deformity (Lynch *et al*., 1992), rickets and, in older birds, degenerative disorders (Hocking *et al.,* 1996). These conditions have become much commoner as growth rates have increased. The conditions must be painful as walking ability of birds with moderate lameness was improved after administration of the analgesic and anti-inflammatory drug carprofen (McGovern *et al*., 1999).

Ascites is another pathological condition associated with fast growth in broiler chickens. It is also known as pulmonary hypertension syndrome and results in fluid from the blood leaking into abdominal cavities. It affects 5% of young broilers and 15-20% of the larger birds and whilst it can kill, it certainly weakens the birds and results in carcass condemnation. The main cause of ascites is failure of heart function associated with lack of oxygen supply to tissues. It is extremely rare in old strains of broilers and results from failure of the cardiovascular and pulmonary systems to grow fast enough to keep pace with the demands from the muscles and gut.

(i) Genetic selection

Farm animals have been selected for breeding on the basis of a range of criteria but by far the most important has been efficiency of production per animal. Fast growth, good feed conversion efficiency and high egg production have been selected for and this has had various consequences.

Broiler chickens have been selected, and their nutrition and management have been designed, so that they grow to market weight quickly and convert food to muscle efficiently. Thirty years ago chickens reached market weight at 12 weeks of age. Now the weight is often reached in 35 days and the age has been reduced by one day per year for the last five years. The change in the bird has been that muscle and gut grow very fast but problems can arise because the bones and cardiovascular system do not grow as fast. As a consequence, the birds may suffer from leg problems even when the diet is ideal. Some broiler chickens have leg damage and leg pain especially in the last week before slaughter, one consequence being that their ability to walk is impaired. Kestin *et al*. (1994) reported that 90% of broiler chickens had some walking ability impairment in the last week before slaughter and 26% had a severe impairment. Sanotra (1999) studying a broiler strain used in many countries found that 30%

of birds on commercial farms had severe walking difficulties by market age. It is widely known that birds with weak legs sit on litter and when the litter quality is not good many chickens, as a consequence, have contact dermatitis visible on carcasses as breast or hock burn. A comparison of 1957 and 1991 strains of broilers showed that growth rates and, hence, leg problems have an origin which is much more a consequence of genetics than of food quality (Havenstein *et al*., 1994).

The poor welfare which occurs in broiler chickens as they near the age of slaughter affects a very large number of individuals and may well be the most serious animal welfare problem in the world today. However, the problems are soluble. Birds can be bred for stronger legs but some slowing of growth, by genetic selection or management, is essential for a real solution. Leg problems can be reduced if food intake is limited for a period during growth (Classen, 1992). Some problems are exacerbated by high stocking density so this should be limited to a maximum of 25 kg m^{-2}.

For broiler breeders, the major welfare problem is probably hunger. Selection for fast growth means that the breeding birds would eat too much if fed *ad libitum*. However, the level of feeding normally used means that broiler breeders are hungry for most of their lives.

The selection of hens has taken insufficient account of the need to minimise injurious pecking and other welfare problems. Successful genetic lines in future will have to be those for which good welfare, as well as egg-production, has been a major factor in selection procedures.

III. CONCLUSIONS

There are very serious problems for hens in battery cages which result in poor welfare. In order to solve these, the basic needs of hens, including those to show certain behaviours must be met. This is not possible unless the space available and design allows the provision of: a nesting place, a perch, possibilities for dust-bathing and investigatory pecking, and room for walking and wing-flapping. No small cage can provide this. Design of hen accommodation and genetic selection of birds should be such that injurious pecking is minimised.

Broiler chickens must be genetically selected for stronger legs and slower growth. Stocking density must be limited and methods of enriching the environment in adequately illuminated conditions should be used.

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