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TITLE	AUTHOR	PAGE
The Concept of Stress	D.J. Goffey	1
The Behavioural Problems of Agricultural and Captive Animals	Marthe Kiley	2
Measuring Techniques in Veterinary Ethology	J.R. Barcham	4
Imprinting	J.R. Barcham	7
The Endocrine Basis of Behaviour	P.J.B. Slater	8
The Present Use of Animal Behaviour in Large Animal Practice	D.G. Williams	10
Pheromone Involvement in Pig Mating Behaviour	G.C. Perry	11
Aggression and Pig Production	H.J. Bryant	12
The Use of Conditioned Reflexes in the Study of Behaviour in Farm Animals	B.A. Baldwin	13
Maternal Behaviour of the Eve	R.J. Holmes	15
Practical Aspects of the Effects of Isolation on Behaviour	D.J. Coffey	17
The Effect of Floor Space on Maternal Behaviour and Growth in Mice	P. Brittain	19
Animal Behaviour for Veterinary Undergraduates	G.C. Perry	20
Future Direction of Research Projects into Veterinary Ethology	B.B. Howard	21

Edley

THE CONCEPT OF STRESS

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Stress is a word which means a variety of things to different people. To veterinary surgeons considering the various factors which precipitate disease, and to animal welfarists, it is used in a way that may be defined as "any factor which adversely affects the physiological and/or psychological functioning of an animal". Physiologists however consider stress to be a constant feature of an animal's life; the adaptive changes made by the individual to any alteration in the total environment to which the animal must adapt.

Difficulties arise when attempts are made to identify and quantify stress. Interest has to the present largely centred around the adrenal gland, both the medulla and more recently the cortex. Whilst it is clear that many changes in the environment do stimulate the adrenal cortex, stress should not be defined solely in terms of this response, since it has been shown that it is not consequential in all environmental changes.

Several workers have emphasised that adrenal cortex stimulation is only one peripheral response to stress. Many other physiological changes occur.

It has been claimed however the physiological measures of environmental changes may be far less subtle than behavioural adaptations. Indeed it has been suggested that behavioural change may be the only way of identifying stress in some situations. When the animal fails to adapt to the environmental alteration abnormal behaviour may be manifest or there may be changes in the quantity or the sequence of normal behaviour patterns.

It may be concluded that in the present state of knowledge no satisfactory unitary measure of stress exists. The animal's response to a change in the environment whether within or without the normal range of adaptability of the individual varies with the particular change and may be physiological, psychological or ethological.

In the same way that it is impossible to measure disease in a unitary way each stress should be examined separately. Thus it is impossible to measure x degrees of disease, but only to quantify the various factors affecting the manifestation of each individual disease. Each particular stress or change in the environment should therefore be examined in terms of the changes necessary in the individual in order to adapt. Thus it is with justification that it has been suggested the term stress is more useful if qualified with such modification as cold stress, heat stress and social stress.

DISCUSSION

Hughes: It is worth adding that a detailed clinical history is actually an account of alterations in behaviour under stress.

- Kiley: Your definition of stress is unhelpful - under clinical conditions rapid assessment of the degree of stress is required and at the moment physiological approaches seem more suitable.
- Howard: A more practical approach is to measure resultant deviations from the "ideal" - a definition of stress would evolve naturally.
- Coffey: I agree that the word 'stress', as we use it, is vague and refers only to outside influences on the animal - it incorporates many factors. However it is widely used and must be accepted until a replacement is found. No single criterion can be a reliable measure.

THE BEHAVIOURAL PROBLEMS OF AGRICULTURAL AND CAPTIVE ANIMALS

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For the past half century agriculturalists have been deeply concerned with nutrition, the provision of balanced cheap diets, cheap labour-saving housing and animal breeding. Only very recently have they begun to realise that the behaviour of the animals can grossly affect production, even within their cheap, hygienic, air-conditioned, labour-saving buildings. It is becoming more evident that a much more detailed understanding of the animal's psychological as well as physical requirements (while also considering economic controls) would lead to greater returns.

There are clearly a whole host of environmental factors that can affect the development and performance of abnormal behaviours and normal behaviours that interfere with management. Some evidence is presented to suggest that usually these behaviours are the result of summated environmental conditions, rather than due to any single condition. This evidence is presented in the form of a table indicating the environmental conditions along one axis, and the behavioural changes along the other. Cattle, horses, pigs, sheep, chickens, turkeys and dogs are considered. Much of the evidence is anecdotal although there is some experimental work. The main behavioural problems of the intensively reared animal are: an increase in aggression, increase in activity, smothering, reduction of fertility, non-recognition of oestrus, oestral behavioural disturbance, insufficient libido, abnormal egg-laying, mother ignoring young, mother preventing suckling, non-recognition by the mother of the young, non-suckling of the young, cannibalism of young, stereotypes, abnormal defaecation behaviour, intake reduced or increased, and resulting obesity.

One condition on which there is some experimental work in other species

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will be considered in detail, this is crowding. Crowding gives rise to various forms of abnormal behaviour that interfere with management, and it is of course, the central condition of intensive husbandry. Within the agricultural environment crowding cannot be defined as a population density in excess of a certain figure. Whether or not the general conditions of the environment will give rise to the physiological and psychological effects of crowding will depend not only on population density, but also on the balance of other environmental factors. The behavioural problems as a result of such conditions considered were:-

1) An increase in aggression

One of the behavioural effects of crowding is the formation of a rigid dominance hierarchy which appears to be an artefact of restricted or crowded animals. Secondly, with further increase in population density and restriction, social disorganisation may result.

2) Reproductive defects

There is some evidence from rodent studies that the neuro-endocrinological feedback systems in crowded societies results in a drop in conception rate. Whether there is a similar physiological effect in farm animals has not been ascertained. However there is a drop in fertility as a result in particular of non-recognition of oestrus due to silent heats and defective management in large confined groups. In addition oestrus tends to lead to disturbed behaviour. Injury to individuals as a result of such disturbance in confined animals is common.

Synchronised oestrus by manipulation with hormones and day length results in the male being overloaded with work temporarily, he suffers as a result loss of libido (e.g.: in sheep).

Maternal behaviour

Ignoring the young or distracted behaviour in the mother of crowded rodents may result in an increase in infant mortality. In crowded sheep mis-mothering and high infant mortality is common. In close grazed dairy cattle on the other hand there is a frequent increase in infant mortality through over-solicitous behaviour of the mother and/or other members of the herd.

The farmer's approach to all these problems must be pragmatic. Therefore if there is a threat to production by, for example, injury to another animal, he retaliates by further restricting his animals (e.g.: tied stalled cattle, stalled sows). This however encourages the performance of other abnormal behaviours such as stereotypes. Such behavioural developments are 1) imitative and 2) habit-forming, thus they may persist into adulthood.

Drugs (e.g.: tranquillizers, hormone treatment) and/or surgery (dehorning, debeaking, docking of tails and ears etc.) can be used to overcome some of these problems although on a large scale they are neither economically nor aesthetically acceptable. Behavioural solutions to such problems rest on a much better understanding of the normal psychological requirements of that species than we have to date. Such an understanding might well also affect the outbreak of disease.

As Welsh (1964) points out it is the 'mean level of environmental stimulation' in both the physical and psychological environment that controls the physiological responses of the animal (corticosteroid levels for example). The environmental stimulus can be either too great, (over-crowding) or too low (isolation and stimulus deprived animals) with equally deleterious effects. The long term effects of high corticosteroid levels and autonomic action involve among other things decreased resistance to disease. Coupling this with the very high incidence of herd disease in many intensive units, one is forced to consider that more effort should be donated to understanding the physio-psychological requirements of the animals, if a reduction in disease is sought after.

In addition the stimulus level of the environment within these crowded conditions may well be corrected by employing operant conditioning and occupational therapy to increase environmental stimulus levels, or by providing more varied environments with 'retreat' areas to reduce the effects of crowding (over-stimulus).

Reference:

- Welsh, B.C. (1964) Psychophysical response to the mean level of environmental stimulation: A theory of environmental integration.
In Medical Aspects of Stress in a Military Climate.
U.S. Govt. printing office, Washington.

DISCUSSION

- Prof. Ewer: Have you any direct evidence that isolation in farm animals increases aggression?
- Kiley: No. However, isolated bulls are often more aggressive than those kept with the herd and parallel situations occur in laboratory animals. Keeping bulls in isolated conditions at A.I. centres may favour the development of aggression although there is selection against difficult bulls.
- D.J. Coffey: My experience supports this view. It may also apply to stallions.
- Kiley: Very probably.

MEASURING TECHNIQUES IN VETERINARY ETHOLOGY

A Discussion

- J.R. Bareham: I recently wished to study maternal behaviour in the

ewe. I started by preliminary observation, then discussion with the shepherd. Continuous observation, recording behaviour in a notebook, yielded too much data to be easily assimilated. Use of a simple scoring system, either writing the score down, or operating an event recorder at regular intervals (e.g. 1 min.) reduces the amount of superfluous information, but still produces huge quantities of data. Sampling (e.g. time lapse cinematography) limits the amount of data acquired, but may mask short-lasting events such as micturition and defaecation. Individual animals need to be marked.

Automation would probably be the ideal solution, but equipment must be robust and information may be lost - thus a position sensor does not indicate what an animal is doing, only where it is. Detailed observation of behaviour may only be possible if the observer is present at the time.

- A. Brownlee: The big danger with such methods is that important chance observations may be missed.
- B.A. Baldwin: Closed circuit TV can be useful. However, I agree that automation is important, and may be based on responses within conditioned reflexes. Radiotelemetry systems are also available and allow the collection of otherwise inaccessible physiological data; they are however, expensive to buy and run, and the need for observation and analysis remains.
- R. Holmes: I agree that on closed-circuit TV it is difficult to see what is happening. However, Roger Ewbank has shown that periodic sampling was as satisfactory as continuous observation for behaviour such as rumination, standing and lying.
- B.R. Howard: Radiotelemetry over short distances need not be expensive - my own transmitter cost about £5.00 for components and assembly. Ethologists must also think about automatic analysis of data, e.g. using a small on-line computer (current cost about £4000) or collecting information on magnetic tape and processing remotely. Only in this way can all observations be quickly and reliably collated.
- D.J. Coffey: There is a risk of missing vital information with such techniques, or of designing experiments around equipment rather than problems. The activity meter is a good example.
- J.R. Bareham: Activity monitoring may offer much reliable information - it has shown, for example, that the presence of a human observer is sufficient to greatly increase the activity of caged mice.

Perhaps we should now consider what techniques a Ministry Vet. could use in the investigation of a case of reported cruelty.

- D.L. Thomson: I think this must be done on a quantitative basis - e.g. counting the number of neck wounds in a pen of pigs. Although I am able to comment on the physiological welfare of farm animals, I need reliable criteria before I can speak of 'happiness'.
- D.J. Coffey: I agree that a quantitative approach to stress is essential, but it is rather more complex. The counting of neck wounds is only valid as a measure of welfare if their absence indicates a lack of cruelty.
- A.M. Brown: In one court case, an increase in the pulse rate of cattle cooped up in a market was accepted as evidence of cruelty. Welfare problems must be suspected if animals fail to thrive without obvious clinical cause.
- R.J. Clark: Perhaps it is more important to examine behaviour patterns in relation to the normal animal - we might then be better able to give guidance in husbandry practices.
- D.L. Thomson: The difficulty here is to define 'normal'. Genetic selection has greatly modified behavioural patterns of the domesticated species - one could argue, for example, that sheep shouldn't be left outdoors in the cold.
- R.J. Clark: I believe that 'normal' behaviour is that shown by stock under the least intensive conditions - e.g. cattle and horses at pasture, free range hens.
- P.A. Bloxham: It would be better to compare animals of the same productive performance under different systems - a broiler may prefer its intensive house.
- C.T. McCrea: Perhaps physiological tests (e.g. of adrenal function) would offer a more objective criterion - autopsy material could be examined at V.I. centres.
- Mrs. L. Mathieson: In some cases, post-mortem examination should be adequate proof of cruelty - I am thinking of hairball in the calf's rumen - such animals must have suffered.
- Miss K. Whitwell: These cases may also show abomasal ulceration. It is clear that pain is involved.
- J.R. Bareham: I think I can sum up by saying that we feel in need of an adequate definition of stress, in an ethological context. We should then be in a much better position to devise an objective approach to its assessment.

IMPRINTING

J. R. Bareham

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Lorenz described imprinting as a unique learning process whereby the young of precocial birds form an attachment with a "mother-figure". The process was characterised as very fast, irreversible, restricted to a brief sensitive period after hatching, and affected the bird's choice of sexual partner in later life.

Since then these views have been modified. The finding that naive birds will follow a variety of unnatural objects has been theoretically explained by Schnierla as showing initial preference for objects giving a quantitatively low level of stimulation. Bateson considers the most conspicuous objects are the most conducive to following. Neither of these theories encompasses all findings, recent evidence suggesting preference in approach is to stimuli in a biologically appropriate range for the species.

For birds imprinting is most easily evoked in a short period after hatch but not on so discrete a time scale as Lorenz implied. It starts as locomotor ability, matures and ends after a period of time which correlates with the animal's ability to discriminate fear evoking, unfamiliar objects against a background of the familiar. This progressively limits the range of stimuli effective in evoking a following response although the preference may be experimentally reversed if the animal has other learning opportunities.

The process is probably no faster or different in character from known learning mechanisms and can be reversed. The sensitive period is neither so brief nor so restricted as first thought. Related to this process, the following observations on lambs are being used in the assessment of behaviour and welfare problems in artificial rearing systems.

Soon after giving birth a ewe starts licking her lamb. Besides drying the lamb, this may stimulate its circulation, promote it to rise and orient it to the ewe. During this time the ewe may learn the taste, smell, noise and visual characteristics of her young. It is suggested the ewe may require a certain period of licking to obtain the recognition which enables her to tell her own from an alien lamb in removal experiments.

After standing at 5-10 minutes post-parturition, the lamb spends 10-15 minutes before getting to the udder; a function it can perform without the

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ewe's help.

Head contact by the lamb is not randomly directed to the ewe's body surface but concentrated in the leg regions, which may result from physical impediment to the lamb's passage or imply actively sought areas. After one hour nearly all contacts to the ewe are to the udder area compared with 25% just after birth, suggesting rapid learning.

Tests with models suggested initial preference for soft objects suggesting this may be the stimulus quality the udder area normally provides to elicit rooting reflexes and consequent nipple attachment.

To some extent the ewe indirectly determines the success of the lamb in udder location by correctly orienting the lamb as she turns to lick its hind end. Defective orientation was the main difference in lambs on a model ewe compared with natural ewes.

Early in life the lamb is indiscriminate in its choice of mother but continual interaction with the dam during sucking and butting off by alien ewes are important in establishing a one to one relationship.

DISCUSSION

Baldwin: The high metabolic rate of mammary tissue would be likely to increase inguinal temperature; moreover, cats at least have very thermosensitive muzzles so a temperature component is possible.

Lindsay: The inguinal area in the ewe is certainly very warm. Have you tried shaving the fleece off?

Bareham: No. I haven't measured the temperatures. Thermistors disturb the ewe; thermoradiography is the ideal approach but it is expensive.

Brownlee: In cattle the dam does not seem to be involved in the calf's teat seeking activities.

Bareham: Ewes seem to arouse unresponsive lambs, and may nudge the rear of the lamb into an appropriate position. One ewe spent 2 hours trying to arouse a dead lamb. However, the normally active lamb seems to get little direct help from the ewe, in udder location.

THE ENDOCRINE BASIS OF BEHAVIOUR

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The endocrine system has advantages over nervous communication in its capacity to convey information to every cell in the body and to maintain a constant signal over protracted periods. The two systems are thus adapted for different roles. Contact between them is achieved through neurosecretion and through the effects of hormones on the brain.

External stimuli such as light have long been known to affect hormone secretion: more recently many other stimuli, both from conspecifics (e.g. courtship) and from other factors in the environment (e.g. nest material), have also been found to be potent in this way. These priming stimuli lead to the endocrine state in which releasing stimuli can bring about behavioural change by a direct effect on the nervous system. Ring doves will only incubate if the hormone progesterone is present: it is secreted in response to stimuli from the mate and nest material before the eggs are laid. The organisation of the breeding cycle results from a complex interaction between the behaviour of the individual, the external stimuli which impinge upon it and the internal state, which changes continuously as a result of experience and hormone secretion. Each of these three factors, behaviour, external stimuli and internal state, may result in an alteration of either of the others, thus giving a complex network of interactions.

Several examples are known of hormones affecting behaviour through direct action on the brain. For example, oestrogen implants have been found to lead to the lordosis posture in ovariectomised cats at doses too low to affect peripheral structures. These effects are usually in rather widespread areas within and around the hypothalamus. Although hormones do affect the sensitivity of the mammalian penis and the brood patch of birds, there is little evidence for these peripheral changes having other than a modifying effect on behaviour. Other peripheral effects which alter behaviour are those which lead to changes in external characteristics (e.g. nuptial plumage in birds) and to the release of pheromones (e.g. "copulin" in rhesus monkeys). The changes induced by these signals on the behaviour of others may in turn feed back to alter the behaviour of the signaller.

DISCUSSION

Spratling: How important are hormones in the development of very young animals?

Slater: There are three major stages of differentiation between the sexes:-

- 1) PRIMARY differentiation - important in e.g. Freemartin cattle.
- 2) NEURAL differentiation, around the time of birth.
- 3) DEVELOPMENT of secondary sexual characteristics.

Brownlee: Why do cattle often show aberrant sexual behaviour? Also, how important is play in the development of behaviour?

Slater: The hormone dependency of behaviour varies in different species and is probably much less in cattle than in some laboratory animals. Early play and other experiences may exert a strong influence on adult behaviour patterns.

THE PRESENT USE OF ANIMAL BEHAVIOUR

IN LARGE ANIMAL PRACTICE

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The study of animal behaviour is not new. Man's selection of species for domestication was largely based on the results of behavioural observations and in so doing founded the basis for present day veterinary practice. Having received no orthodox training in animal behaviour most of one's comments are anecdotal in addition to being anthropomorphic; they are mainly related to the reproductive and associated disorders of both cattle and horses.

A knowledge of behaviour is the oldest, cheapest, most valuable and dependable aid to diagnosis possessed by the practising veterinarian. The efficient application of veterinary science demands a sound knowledge of what a normal healthy animal looks like and how it behaves in its usual environment. This underlines the importance of veterinary undergraduates in their preclinical years spending as much time as possible working with and observing animals in the various livestock enterprises from intensive beef units to zoological collections.

The application of animal behaviour in large animal practice can be considered in two main categories.

1. As an aid to the diagnosis of clinical and sub-clinical disease in an individual or group of animals and as an aid when attempting to ascertain the cause of sub-optimal or lowered production in a livestock enterprise which may or may not be associated with clinical or sub-clinical disease. In such cases it is often the stockman's observations of abnormal behaviour that initiates veterinary assistance.
2. The application of behavioural knowledge is playing an increasingly important part in the various intensive livestock enterprises where advice is sought on the management and husbandry of apparently normal healthy animals in an attempt to maintain or improve current levels of production. Similar advice is also sought prior to the adoption of a new livestock enterprise on a farm. Such situations demand a broader and deeper knowledge of normal behaviour and the conditions which in turn may modify them.

Often no attempt is made to be complementary to the animal's normal behaviour patterns. It always pays to take advantage of an animal's natural behavioural tendencies rather than trying to overcome them and force behaviour into an abnormal pattern.

As practising veterinary surgeons we must not lose sight of the prime object of our existence, namely the welfare needs of our patients; these must not be overshadowed by the financial interests of our clients. It is in this aspect that our knowledge of behaviour has its most important part to play.

PHEROMONE INVOLVEMENT IN PIG MATING BEHAVIOUR

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and

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At mating time a considerable proportion of encounters between male and female pigs are initiated by a head to head confrontation. Previously, the reasons for this were not clear.

Recently work at the Agricultural Research Council's Meat Research Institute has demonstrated the presence in boar saliva of a steroid compound, markedly similar to that found in the carcass fat of entire male pigs. This steroid is responsible for the characteristic odour liberated during the cooking of meat from entire males.

In a previous experiment the sub-maxillary gland was removed from two entire male litter-mates when they were approximately four weeks of age. A third litter-mate was used as an intact control. Two other groups of three pigs were similarly treated. Subsequent growth rate of all treated and control males did not differ significantly when comparisons were made at 7 months of age.

At 9 months of age each treated boar was tested with a gilt to determine the efficiency with which the male could induce the oestrous gilt to stand to the riding test. The entire boars were used as control comparisons. The testing period covered a seven to ten day period, embracing the period before oestrus proper and lasting until a base-line response was again reached. The test consisted of a five minute duration when the boar and gilt were allowed head to head contact only. During each test detailed records were kept of the boar and gilt responses to each other. Testing was repeated at twelve-hourly intervals.

A preliminary analysis of the results indicates the inadequacy of the treated boars to induce the standing response from oestrous gilts. Intact control boars however can initiate and maintain such a response. Further examination of the data suggests that in oestrus proper it is a decrease in negative rather than an increase in positive responses from the gilt which leads to a reciprocation of courtship activities.

AGGRESSION AND PIG PRODUCTION

M. J. Bryant

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The characteristics and modifying influences of intraspecific aggression were considered as demonstrated by the pig.

Consideration of the role of aggression in pig production practice was confined to:-

a) the first week of life.

Considerable competition may occur for teats during the first week of life. There appears to be little information on the form of this competition but it seems unlikely to be active aggression as typified by the motor patterns of fighting seen in later life.

b) the formation of social relationships.

Dominance-subordination relationships are probably formed in the litter by fighting before 2-3 weeks of age. New relationships are formed each time strange pigs are mixed. The possibility of a sensitive period for the development of social relationships could be of considerable importance in the mixing of weaners and older pigs.

c) the maintenance of social relationships.

An important function of social organisation is to reduce aggression and social tension in the group. Thus energy is conserved and this may be demonstrated by production traits. There is little information of the relative importance of social stability upon the efficiency of production.

d) the influence of competition.

Dominance ensures the assertion of the individual. When competition for food or space increases, agonistic behaviour increases. In some circumstances there is the possibility of a weakening of the social relationships. The resulting instability might be reflected by lower performance.

e) abnormal behaviour.

Some aspects of abnormal behaviour may be associated with pathological aspects of aggression.

DISCUSSION

- Slater: Is there evidence for the pig, to support the theory that a successful agonistic encounter may lead to an increase in testosterone secretion?
- Bryant: Not that I am aware of. Adrenalectomy certainly doesn't markedly alter agonistic behaviour.
- O'Donovan: Are attacks by older pigs more aggressive than those by younger ones?
- Bryant: No; if anything, behaviour becomes more stereotyped. Alterations in the attack are usually a consequence of space restrictions.
- Mrs Mathieson: Is physical size important in dominance ranking?
- Bryant: Probably only at low stocking densities.

THE USE OF CONDITIONED REFLEXES IN THE STUDY OF BEHAVIOUR IN FARM ANIMALS

B. A. Baldwin

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There are two main types of conditioning procedures which are commonly used in the experimental study of behaviour in the laboratory. The first type, usually termed Classical conditioning, is associated with the work of Pavlov while the second type, often called Operant conditioning, has been extensively investigated by Professor B. F. Skinner and his associates in the United States (Kimble, 1961). Some of the basic features of these conditioning procedures are briefly outlined below and mention is made of their application to domesticated farm animals.

(1) Classical conditioning - also known as Respondent conditioning or Type 1.

This may be considered as a method for achieving a degree of stimulus equivalence. It involves a previously neutral stimulus becoming capable of eliciting a conditioned response. The essential procedure in Classical conditioning involves repeated presentations of an unconditioned stimulus (U.S.) in a fixed and regular arrangement with the stimulus to be conditioned. After a sufficient number of pairings of the two stimuli, the conditioned stimulus (C.S.), when presented alone, will elicit the conditioned response (C.R.) which closely resembles the relatively automatic reflex response (unconditioned response or U.R.). For conditioning to occur it is essential that the C.S.

precedes or overlaps with the U.S. but never follows it. For example, if a bell (the C.S.) was sounded just before the presentation of food (the U.S.) and this procedure was repeated a number of times, Pavlov observed that the C.S. came to evoke a response (salivation) which he termed the conditioned response. This example illustrates 'alimentary conditioning'. It is also possible to study 'defensive conditioning' in which the unconditioned stimulus might be electrical shock to the foreleg and the conditioned response would be anticipatory flexion of the foreleg to the sound of the C.S.

Relatively little work has been carried out on Classical conditioning in farm animals although conditioned salivation has been studied in the pig and defensive leg flexion responses in the goat and sheep. Classical conditioning methods are particularly useful in investigation of the sensory systems in animals as the nature and strength of the C.S. can be quantitatively controlled.

(2) Operant conditioning - also known as Instrumental conditioning or Type II.

Basically, Operant conditioning is a procedure which will reliably increase the frequency of any behaviour in the repertoire of an organism. The wide variety of operant conditioning techniques which have been developed have in common the feature that performance of the activity selected to be the conditioned response achieves a "reinforcing situation" which is usually either the termination of a noxious stimulus (negative reinforcement) or the satisfaction of needs for food or water (positive reinforcement). Put simply, animals will learn to respond to obtain something they need or to remove something they dislike. As an example, a hungry rat is placed in a small cage into which protrudes a lever and the experimenter arranges that depression of the lever results in the immediate delivery of a food pellet. During its exploratory activity the rat will depress the lever and will eat the delivered food pellet. The rat soon learns to depress the lever in order to obtain food and is said to have acquired the lever-pressing response.

In farm animals, Operant conditioning is a most useful method for the quantitative study of many basic behavioural and physiological problems. It has recently been shown that a pig, placed in a cold environment, will learn to push a panel with the snout in order to obtain infra-red heating. The goat, sheep and calf will learn to press panels with their muzzles to obtain food and goats depleted of sodium will respond to obtain salt solutions. Provided an appropriate response is selected, the domesticated farm animals make good subjects for operant conditioning.

It is possible that Operant conditioning methods, in which animals kept under intensive conditions (or in isolation, as with bulls) have to "work" for their food, could alleviate the "boredom" of their uninteresting environments. Rats will respond for sensory stimuli such as light or odours, and perhaps such stimuli would be useful in intensive situations. Operant techniques provide a behavioural technology which may find some application in intensive husbandry.

Reference

Kimble, G.A. Hilgard and Marquis' Conditioning and Learning (2nd Ed.) New York. Appleton Century Crofts 1961.

DISCUSSION

Spratling: How long do animals remember, and what happens afterwards?

Mrs Mathieson: Can the pig count, or does the delivery of food stop it knocking?

Baldwin: Animals hardly ever forget, even after a rest of 2-3 months. Afterwards there seem to be no ill effects. I don't know whether animals count. I've known systems where an animal had to press ten times for a pay-off, and will stop at ten; some work precisely for several rewards before collecting the food. One gets much respect for the intelligence of animals.

MATERNAL BEHAVIOUR OF THE EWE

R. J. Holmes,

Department of Animal Husbandry,
University of Bristol

Expressed in its broadest sense, maternal behaviour concerns the hearing and delivery of the lamb; the provision of maternal care (epimeleia) and the relationship of dam to offspring subsequent to its ceasing to be dependent upon her.

After approximately 8,000 years of domestication, there is little recorded information about the behaviour of the Genus *Ovis*.

Reports differ about shelter-seeking during late pregnancy but both wild and domestic types move to secluded and sheltered areas for lambing. Failure to seek protection from weather has been regarded as a deficiency of behaviour, associated with domestication, as the neonate's homeothermic mechanism takes 3 days to mature. With impending parturition, increased interest in the lambs of others is frequently shown. This varies from a brief nosing to attempted or permanent adoption. Ewes persistently interfering can cause some mortality and considerable disturbance. The use of individual lambing pens, by providing for the tendency for isolation, can reduce the problem of pre-lambing interest.

Once straining has started, expulsion is rapid, delivery usually occurring within 30 minutes and achieved in a lying position. Standing almost immediately, the dam turns to nose and starts licking the wet amnion-covered neonate. Interspersed with low rumble calls, this phase of care-giving occupies most of the first hour, unless distracted by more deliveries. After a short period of licking the latest-born, the ewe moves about, apparently randomly, licking all the litter but with the most active attracting the

greatest attention. Starting with the head, the first and most actively moving lamb part, the ewe rapidly licks over the upper surface and umbilicus. It appears that the wetness and smell attract the dam but the primary factor is the lamb itself. The licking is important to the lamb's survival as the drying-off reduces heat loss and additionally the lamb is stimulated to activity. Also the mother/offspring bond is initiated with the ewe learning the smell and taste of her lamb, which in turn has a large mobile object to struggle towards and subsequently imprint upon. After about 30 minutes of attempting to rise towards her, the lamb usually stands and teat-seeks along the body. In progressing towards the inguinal region there is licking of the neonatal perineum and the experienced ewe will stand still. Primipara, especially year-old Finn sheep, are frequently reluctant to permit exploration around the udder, becoming disturbed and even agonistic towards the lamb. Some ewes facilitate sucking by abducting the hind legs and arching the back.

For about 8 hours after parturition a ewe will accept the first lamb presented and the permanent ewe/lamb bond is formed after approximately 20 minutes licking. Thereafter an alien lamb can be substituted only with difficulty. During the first few hours free access to the udder is allowed but later becomes ewe-determined. Identification of lambs is by nosing of the perineum, which characterises each suckling. Aliens' attempts to suck are thereby detected and are then vigorously repelled.

It is reported that Bighorn ewes (*Ovis canadensis*) form nursery groupings of up to 9 lambs whilst the dams move off to graze. As suckling frequency and duration decline, the separation of ewe and lamb increases and the lamb becomes less dependent. Feral and domestic hill sheep are known to remain in matrilinear groupings of several generations on a particular hill area.

Variant maternal behaviour is not thought to cause significant lamb loss in the multiparous ewe. Tranquillisers and anaesthesia of the nasal mucosa have been used with some success in modifying certain behavioural patterns.

It can be concluded that maternal behaviour has central importance in survival of the Genus and is particularly relevant to production.

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DISCUSSION

Hughes: Do Finnish shepherds spend much time with their flock?

Holmes: Often sheep are integrated into the household, almost as pets - maternal behaviour is less important and may have been neglected genetically.

Miss Whitwell: Mis-mothering may be unimportant in favourable climates, but in bad weather, time to first suckling may be prolonged and the lamb may be in danger.

Holmes: Cold is probably the most important single cause of loss.

Bloxham: Suckling Hampshires seem to favour second lambs over first - have you seen this?

Holmes: During the interval between lambing, the ewe may be restless and wander up to 100 yards away; if the first lamb is on its feet, it may try to follow. I don't think the ewe is trying to desert her offspring.

PRACTICAL ASPECTS OF THE EFFECTS OF ISOLATION ON BEHAVIOUR

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It is important to understand the practical aspects of the effects of isolation on behaviour in terms of production, organic disease and welfare. This is especially important in the calf, since this is the agricultural species most commonly subjected to isolation.

PRODUCTION:

There are conflicting reports in the literature concerning the effects of isolation on weight gain. Many factors may be involved, including the conservation of heat possible during huddling behaviour in grouped animals, the inter-relationship between food quality and the social situation, social facilitation of feeding and psychological aspects. In one series of observations the weight gain in isolated and grouped guinea pigs and calves was followed; grouped calves showed a 50% better weight gain than those in isolation.

Concurrent behavioural observations suggested that a possible contributing factor to this result was social facilitation among the groups when feeding.

ACTIVITY:

The measure of activity, that is distance travelled in unit time, may not be an accurate index of behavioural motivation, but its practical importance to agriculture has been recognised, since the relationship between exercise and production is clearly established. Other studies have indicated a possible relationship between quality and activity.

Experimental studies have also shown meat quality to be affected by activity differences. Studies with guinea pigs showed that animals in groups are significantly more active in the maintenance cage than animals in isolation.

REPRODUCTIVE EFFICIENCY:

The detrimental effect of the isolation of young animals on imprinting and socialisation has long been recognised. The consequential failure to recognise a member of its own species as a potential mate, later in life, has been demonstrated in several species. Whilst this has not been studied in cattle it may be a contributing factor in some cases of sub-libido in the bull.

PSYCHO-BEHAVIOUR AND ORGANIC DISEASE:

Socio-behavioural aspects of disease are very important and there have been several experimental studies on the relationship between social isolation and disease manifestation. It appears from these studies that the effect of social isolation is far from constant but depends on interaction with other factors involved in producing the disease.

WELFARE:

It is unfortunately very difficult to interpret behavioural observations in terms of welfare. Observations on calves have shown that isolated animals spend less time lying dozing with head resting on the ground (asleep?) than those in groups.

Whilst it is possible to deduce from this that isolated calves were less inclined to relax without the security of a group such an interpretation is subjective and open to criticism. Behavioural measures however may prove to be the simplest way of identifying inadequate adaptation to the environment by the animal.

DISCUSSION

- Perry: Purdie isolated Holstein-Friesian calves until 18 weeks, then ran them as a group - they subsequently produced less milk than group reared animals. Holstein crosses responded in the opposite way.
- Coffey: I find this work difficult to interpret, without further reference to the original paper.
- Brownlee: How old were the calves? When young calves ruminate, they may extend their heads forward, resting on the ground.
- Coffey: It was difficult to make detailed observations under the experimental conditions. We found no difference in time spent ruminating between the groups.
- Baldwin: Was there any evidence for synchronous behaviour in the group?

Coffey: Yes, often if one was lying or ruminating, several of the others were doing the same.

THE EFFECT OF FLOOR SPACE ON MATERNAL BEHAVIOUR AND GROWTH IN MICE

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In a long term experiment to investigate the effect of floor area on productivity in mice, three experimental conditions were studied. Aluminium cages with removable spacers were used so that the internal cage area could be adjusted to house groups of 1-8 mice, maintaining a constant floor area per mouse. The three experimental conditions were defined by unit areas of 40cm², 160cm², and 360cm². The animals were derived from a four way cross of 4 pure strains, and a specific breeding programme was utilised both to establish and maintain the stock. 25 breeding pairs were allocated to each line and their successors determined by selection for weight at eight weeks of age.

Twenty-four hours before the calculated date of parturition, males were removed from the breeding cages and female maternal behaviour and litter growth were monitored.

Results from generation 1 showed no significant difference between the numbers of mice born in the three treatments, although by five days there was a highly significant difference in survival ($p < 0.001$), losses being greater in the medium and large cages.

Mortality in later generations was associated with a marked slowing down of growth rate in the medium and large cages, and by generation 3 this was severe enough to necessitate a postponement of weaning from twenty-one to twenty-eight days of age. At this stage growth rate was significantly higher in the small cages than in either of the other two conditions.

Tests of maternal behaviour were designed to quantify specific parameters relevant to the care of the young, and these scores were totalled to give an index for each dam. This was recorded on the day of birth of the litter, and on alternate days thereafter until the litter was ten days of age. These tests showed significant differences between females in small and large cages, the former obtaining higher scores.

In a secondary experiment using small- and large-line breeding pairs from Generation 4, fifteen females were allowed to rear their first litters in small cages and were then remated in large cages, while a second group reared two litters in large and small cages respectively. The results confirmed the established pattern of poor maternal ability and high litter

losses in large cages. Behaviour and mortality were significantly related to immediate cage size, and not to the line from which the breeding mice were selected.

Subsequent growth trial experiments, together with trials monitoring activity over twenty-four hour periods, yielded no evidence to suggest that floor area affects growth in weanling mice within the ranges studied. The prime effects seem to be exerted on maternal behaviour and physiology and consequently are of critical importance in the early growth of the young.

Post-mortem examination of breeding females showed that litter loss was associated with normal ovarian corpora lutea, but only partial mammary gland development. This, together with the lack of normal maternal behaviour, enlarged adrenals, and raised plasma corticosterone levels, suggests that the mechanism of the observed breakdown is hormonal in origin, and could be symptomatic of a maladaptive response to non-specific environmental stress.

The results indicate the profound effects which adverse environmental conditions may exert upon productivity and early growth, and suggest that this effect may be mediated by the behaviour of the dam. It is also apparent that the provision of a confined breeding area is not necessarily associated with detrimental effects.

DISCUSSION

- Bloxham: Was the whole floor area used, or are there self-imposed boundaries?
- Mrs. Kylie: Was the defect one of adaptation?
- Mrs. Brittain: There was no evidence that any part of the floor wasn't used although nest building tended to be confined to corners, or around the walls. In one large cage containing ten parturient females, small boxes were provided in the corners - only two females used these as nests and survival was no different. Often if mice were left in the medium and large cages after rearing the first litter (of which many young were lost), survival improved greatly.

ANIMAL BEHAVIOUR FOR VETERINARY UNDERGRADUATES

Dr. G. C. Perry,

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University of Bristol

Two factors influenced the design of the Animal Behaviour course

at Bristol. Firstly, trends in the veterinary profession particularly in agriculture, and secondly, the fact that fewer Bristol graduates entered general practice than the average for all veterinary schools in the U.K.

It is expected that the process of intensification in agriculture will continue and new techniques of animal production will be developed and become commercial practice. As a result of this process it is desirable to understand the basic mechanisms controlling the elicitation of behavioural responses of the species concerned. Furthermore, if the past trend of employment of Bristol graduates continues a considerable proportion will be engaged in activities other than general practice, for example in the administrative, advisory and commercial fields. This will necessitate an intimate knowledge of applied behaviour.

The course consists of twelve lectures and these are divided approximately into two parts. The first half is concerned with the basics of behaviour and includes coverage of aspects such as inherited and acquired behaviour, development of behaviour patterns, physiological involvement and genetical determinants. The latter half consists of the descriptive species - specific patterns and includes for example reproductive, ingestive, eliminative behaviours particularly in the context of commercial practice.

Finally, some consideration is given to the concepts of sociality, aggression and maladaptive behaviour.

FUTURE DIRECTION OF RESEARCH PROJECTS INTO VETERINARY ETHOLOGY

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Until about 50 years ago agricultural holdings in the U.K. were under little pressure to increase productivity. Labour was cheap and markets were restricted. Since this time, however, agricultural research in the U.K. has been directed largely toward improving reproductive efficiency and food conversion. Whether or not Great Britain enters the E.E.C., it is highly likely that, during the foreseeable future, agriculture will become increasingly more intensive with a view either to reducing imports (currently over 1m tons of carcass meat) or to increasing exports to Europe.

Since 1960 there has been a steady annual output of 8 or 9 papers on veterinary ethology in the U.K. This trend compares with a progressive increase in global research, on which scale the number of reports has increased fourfold. Because husbandry techniques in Britain are not the same as those overseas, particularly in intensive units, material published elsewhere in the world may have little practical value here. The U.K. research effort into Veterinary Ethology shows little relationship to the economic importance of particular species of animals within the national

economy; sheep (which account for less than 4% of indigenous meat production) are currently receiving more attention than any other species of livestock, including cattle and poultry (Ewbank & Howard, 1971). The lack of direct information on the behaviour of farm livestock was pointed out in the Brambell Committee Report (1965).

Commercial interests in intensive farming systems still influence the orientation of research, a condition fostered by the present economic climate. Even in universities, most ethological research is sponsored by outside bodies (Ewbank & Howard, loc. cit.). However, the incremental financial gain from such efforts declines as the standard of husbandry improves, and it is doubtful whether research on such topics will always be economically rewarding.

There is every case for a shift in research emphasis toward a study of the effects of the new husbandry techniques on livestock welfare and performance. It is our duty as a community to ensure that methods of farming are as humane as is compatible with the growing requirement for economic productivity. This is particularly important as aid programmes build up agriculture within emergent communities - a sound working knowledge of the welfare requirements of livestock within the new husbandry systems adopted is of paramount importance.

An additional requirement is revealed when research effort in the U.K. is compared with the number of published reports for this period. While 82 projects were identified for the period 1970-71 only 7 publications are listed in the Index Veterinarius. Thus an alternative outlet for research findings is clearly required. It is likely that a body such as the Society for Veterinary Ethology could assume this role.

References

- Ewbank, R. and Howard, B.R. (1971). Farm Animal Ethology in the British Isles. Vet. Rec. 88, 632-7.
- Brambell Committee Report (1965). H.M.S.O.

DISCUSSION

Bloxham: What research techniques should we be developing?

Howard: One of the most exciting aspects of ethology is the advent of new equipment - activity monitors, radio-telemeters, computing facilities and automatic picture analysers (these may soon be applied to T.V. pictures). These lead to an increase in quantification; this is the most important aim for us.

McCrea: Should we study individuals or groups of animals?

Howard: Although individual studies are interesting, we are faced with the problem of rapid intensification within the livestock industry; I think that currently we should study animals in

this context.

Baldwin: Are you advocating a form of behavioural engineering?

Howard: At this stage, yes.

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