



# Animal welfare: review of the scientific concept and definition

Corrado Carenzi, Marina Verga

Dipartimento di Scienze Animali. Università di Milano, Italy

*Corresponding author:* Prof. Marina Verga. Dipartimento di Scienze Animali. Facoltà di Medicina Veterinaria, Università degli Studi di Milano. Via Celoria 10, 20133 Milano, Italy - Tel. +39 02 50318037 - Fax: +39 02 50318030 - Email: Marina.Verga@unimi.it

---

*Paper received April 23, 2007; accepted October 18, 2007*

---

## ABSTRACT

The aim of this paper is to present a review of the current scientific viewpoints about the concept and definition of animal welfare. The need of interaction among different disciplines is stressed, as well as the need to scientifically assess welfare, using validated indicators. The role of applied ethology in animal welfare science is stressed.

The paper provides a brief overview of the historical steps in the development of the concept and presents scientific viewpoints, briefly explaining their theoretical foundation.

The possibility of defining welfare on a scientific basis is explained, identifying the main problems according to the scientific, cultural and social background.

Another aspect considered is the relationship between welfare and ethics, evidencing the meaning of such an interaction and its possible evolution.

*Key words:* Animal welfare, Welfare concept, Welfare definition, Science, Ethics.

## RIASSUNTO

### CONCETTO E DEFINIZIONE SCIENTIFICI DEL BENESSERE ANIMALE: UNA REVIEW

*Scopo del presente lavoro è fornire una visione aggiornata sulle conoscenze scientifiche in merito al concetto ed alla definizione di 'benessere animale', prendendo in considerazione i punti di vista espressi dai vari ricercatori sui diversi aspetti che questi implicano. Viene presentata la complessità di tale concetto e la necessità di affrontarlo attraverso l'interazione di diverse discipline, sia nell'ambito delle scienze naturali che di quelle sociali.*

*Si prende in esame anche la possibilità di definire il termine 'benessere', attraverso un breve percorso storico in merito alle diverse scuole di pensiero e di ricerca. Si evidenzia inoltre la necessità di una visione scientifica del benessere animale, sia nella sua definizione che nelle metodologie di indagine utilizzate per valutarlo, sottolineando in particolare il ruolo dell'etologia applicata.*

*Infine si pone in relazione la scienza che studia il benessere animale con l'etica, identificando le possibilità di interazione tra le due discipline.*

*Parole chiave:* Benessere animale, Concetto di benessere, Definizione di benessere, Scienza, Etica.

## Introduction

Animal welfare is a multi-faceted issue which implies important scientific, ethical, economic and political dimensions (Lund *et al.*, 2006). Thus this science needs an interdisciplinary approach, bringing together researchers from different disciplines within the biological sciences, such as physiology, veterinary science, ethology and comparative psychology. Moreover, although the first steps had been based on the natural sciences, subsequently it appeared necessary to use a broad multi-faceted approach to scientific animal welfare questions. In fact this approach, mainly combining ethology, physiology, psychology and the studies of the human-animal interaction, may offer the advantages of improving the understanding of knowledge about animal welfare issues as well as to obtain methodological gains.

As far as ethology is concerned, this discipline has a key role in the development of animal welfare science (Millman *et al.*, 2004) and applied research. Applied ethologists have to use a “whole animal” approach, including the study of the causation and development of behavioural systems, which are related to the understanding of animals’ stress, linking behaviour to its physiological bases and processes (Broom and Johnson, 1993; Moberg and Mench, 2000). The practical application of the results of the research on applied ethology may contribute to improving the design of housing and equipment and of management practices (Grandin, 1993), allowing animals to express their behaviour and to cope with the environment.

Concepts and approaches from cognitive psychology have also been applied in animal welfare research, for example to develop theories and research methods regarding farm animals’ emotions (Désiré *et al.*, 2002). Analogues of consumer-demand studies, a

methodology first used in human micro-economics, have been used in order to discover how much animals value environmental resources (Cooper, 2004). Moreover, the collaboration among ethologists, physiologists and psychologists has produced a model to interpret stockperson-animal interactions (Hemsworth and Coleman, 1998). Thus the nature and consequences of such interactions for both the human and the animal may explain the effects of some stressors on reproductive processes, metabolism, and immune response on the one hand and the quality of animal husbandry on the other, which involve both animal welfare and productivity.

Due to the fact that the study of animal welfare includes husbandry and human-animal interactions, the multi-faceted approach has to include collaboration between the natural and social sciences. This may improve knowledge on relevant aspects of human behaviour and of animals’ roles in society. From this viewpoint, also the collaboration with philosophers has revealed to be fruitful in recognising the value dimension in animal welfare science and in better understanding the whole concept of animal welfare (Lund *et al.*, 2006).

## State of art on the concept of welfare

Animal welfare as a ‘formal discipline’ started with the publication of the Brambell report on the welfare of farm animals, issued by the British government in 1965 (Brambell Report, 1965). The adoption of a conventional scientific approach, with experiments focusing on the effects of single factors under controlled circumstances (Sandøe *et al.*, 2003), allowed the new discipline to be established as a science, or as “a young science” (Millman *et al.*, 2004).

A very large amount of research has been carried out about animal welfare problems

involving very specific fields of interest, such as the development of welfare assessment methods in different environments, as well as more fundamental questions relating to the biological bases of welfare and stress.

Among the main issues involved in the concept of welfare are the concepts of 'suffering' and 'need,' as well as the 'five freedoms' which are more related to animal husbandry and management by man. These concepts are related to the fact that animals are now acknowledged as "sentient beings" as in Amsterdam Treaty in 1997, which confers special consideration for them under European Law (Millman *et al.*, 2004). The concept of 'sentience' had been already given scientific validity by Darwin (Webster, 2006). It is related to the strong debate opposing in the past behaviourists and ethologists. In fact at the beginning the American school of Behaviourism did not accept in the scientific vocabulary "all subjective terms such as sensation, perception, image, desire and even thinking and emotion" (Watson, 1928; Skinner, 1938). Initially ethologists also generally restricted their considerations to observable behaviour, although using terms such as 'hunger,' 'pain,' 'fear' and 'frustration' (Duncan, 2006). Also, positions such as the following were adopted by many scientists (Tinbergen, 1951): "Because subjective phenomena cannot be observed objectively on animals, it is idle to claim or to deny their existence." Animal sentience has become an important issue after the publication of Griffin's book on it (Griffin, 1976). Due to the development of research and to changes to the initial positions, psychology and ethology started to collaborate. Thus, contrary to the belief that we could never know how animals feel, but only how they behave, some ethologists, such as Dawkins (1980, 1993) and cognitive psychologists, such as Toates (1986), have carried out studies of perception, decision making, self-aware-

ness, or capacity to learn from others in order to understand the animal minds. These studies, besides making it possible to obtain a deeper knowledge of animal minds, also give a clear picture of how animals perceive the world and how environmental stimuli may affect their welfare level. Of course the stimuli perception and the consequent reaction to them are determined by the interaction between genotype (species and breed) and learning (experience and interpretation of that experience) (Webster, 1994). The possibility to deepen the knowledge of animals' minds also makes it possible to better understand animals' 'subjective experiences', both positive and negative. These latter may also involve 'suffering,' which consists of "a wide range of unpleasant emotional states" (Duncan and Dawkins, 1983). Suffering occurs "when unpleasant subjective feelings are acute or continue for a long time because an animal is unable to carry out the actions that would normally reduce risks to life and reproduction in those circumstances" (Dawkins, 1990).

The different aspects of the concept of animal welfare have always to be taken into consideration in the studies on animal science. This means that all the biological components, both physical and psychological, concurring in determining the welfare level, have to be studied and linked together. Moreover physiological, immune and behavioural measures should be validated and their underlying biological mechanisms should be adequately understood (Rushen *et al.*, 2003).

The animals' biological mechanisms are directed to simultaneously adapt to many environmental stimuli, sometimes conflicting and potentially stressful stimuli, whose importance determines priorities of action. The challenge for animal welfare research is to discover how animals 'feel' and how much it does matter to them. Following

this challenge, another important issue is to find out which are the animals' specific needs and how these needs may be fulfilled by the environment where they live. In fact the possibility to fulfil the biological needs is related to the welfare level. In this respect, a long debate has been raised among researchers on animal welfare about the term 'need.' According to Fraser and Broom (1997) "the general term 'need' is used to refer to a deficiency in an animal which can be remedied by obtaining a particular resource or responding to a particular environmental or bodily stimulus." Considering animal welfare in practice, the animal may be interacting with a variety of factors that may represent the fulfilling of the 'needs,' i.e. requirements for obtaining physical and mental health (Odendaal, 1998). The needs vary according to the species characteristics and evolution, and may be divided into different categories, which may be summed up in the following:

- environmental needs, such as housing and management which include handling and breeding, as well as hygiene, transport and environmental enrichment;
- physiological and behavioural needs, which include the possibility to express the main specific biological functions as well as the behavioural repertoire. This possibility also depends on the interaction with human beings and on the genetic selection of reared subjects for desirable traits.

The biological functional systems and the motivational state determine the variety of each organism's more or less urgent needs (Baxter, 1988; Broom 1988; Hughes and Duncan, 1988), and the impossibility of satisfying the needs may raise welfare problems.

In this respect, the concept of 'freedom' in animal husbandry has been introduced and plays a key role. In fact the knowledge about the needs of animals is related to the proposal of giving animals some 'freedoms'

(Brambell Report, 1965), revised by FAWC (1993) as follows:

- Freedom from thirst, hunger and malnutrition – by ready access to fresh water and diet to maintain full health and vigour
- Freedom from discomfort – by providing a suitable environment including shelter and a comfortable resting area
- Freedom from pain, injury and disease – by prevention or rapid diagnosis and treatment
- Freedom to express normal behaviour – by providing sufficient space, proper facilities and company of the animal's own kind
- Freedom from fear and distress – by ensuring conditions which avoid mental suffering.

According to Webster (1994), "absolute attainment of all five freedoms is unrealistic," but these freedoms are an "attempt to make the best of a complex and difficult situation." These have to be deeply considered in husbandry systems for farm animals, because they have to be given the possibility to adapt well to them, in order to avoid undue distress and consequently produce well in optimal conditions. In any case, animals' welfare has to be considered in a realistic way, avoiding anthropomorphism into its evaluation (Webster, 1994), as well as pure mechanistic consideration.

### **State of art on the definition of welfare**

The long debate about animal welfare includes the possibility of defining the term 'welfare' itself. This word must reflect a clear concept, which can be scientifically assessed (EFSA, 2006) and which can be used by the scientific community and can be included in laws (Broom, 1991). The definition should also explain the meaning of animal welfare to various categories of people, such as corporations, consumers, veterinarians, politicians and others (Hewson, 2003).

The term 'welfare' is not uniformly defined and used in the literature. This may be due to the different attitudes towards animals, but implies also the different methodologies used to evaluate welfare (Weber and Zarate, 2005). Thus many definitions of welfare have been proposed, according to cultural developments of the societal view about the relationship between man and animals. In the past welfare had been seen, mainly by veterinarians and farmers, chiefly in terms of the body and physical environment. But such a view has limitations: for example good physical outcomes, due to genetics and environment, do not mean that mental state is not compromised. Moreover, physical state may be affected by both positive and negative experiences (Hewson, 2003). Thus the definitions of animal welfare proposed by various researchers reflect their different backgrounds.

To date, the contribution of different disciplines to the definition of animal welfare implies stressing both the biological functioning and the relation between body and mind, considering the organism in a more comprehensive way.

Some confusion exists also between the terms welfare and well-being, which in dictionaries are respectively: "the state of being or doing well" and "a good or satisfactory condition of existence," which are linked to the concept of 'quality of life' (Fraser, 1998); however the two terms may be probably used also as synonyms (Fraser, 1998).

On a scientific basis, three main approaches have been followed in order to define and, consequently, to find methodologies to assess welfare level.

The first approach emphasises the biological functioning of organisms, such as growth and reproduction, as well as health and behaviour. Behaviour represents the first response to the environmental stimuli and may give at first a clear picture of the

coping success of the organism towards the stressors. A good welfare level means absence of distress or of a large stress response (Broom, 1986; Wiepkema, 1987; Broom and Johnson, 1993). Examples of this approach are the definitions stressing the coping success. Broom (1986) states that "the welfare of an animal is its state as regards its attempts to cope with its environment". This approach is linked to a hierarchy of biological 'needs' and to the evidence of the importance of their fulfilment or not in order to maintain good welfare levels (Duncan, 2005).

A second approach states that the relationship between stress and welfare, which is a central issue and had been already stated by Wood-Gush *et al.* (1975), is a complex one and welfare could not be defined simply in terms of stress (Duncan, 2002). Already the Brambell Report (1965) acknowledged the role of mental processes in welfare. Its definition was the following: "welfare is a wide term that embraces both the physical and mental well-being of the animal. Any attempt to evaluate welfare, therefore, must take into account the scientific evidence available concerning the feelings of animals that can be derived from their structure and functions and also from their behaviour." Another definition states that "welfare is a state of complete mental and physical health, where the animal is in harmony with its environment" (Hughes, 1976). This definition is very similar to the one given by WHO (1946): "a state of complete physical, mental and social well being, and not merely the absence of disease or infirmity."

Thus this second approach emphasises much more the psychological aspects of welfare, considering feelings or emotions as key elements in determining the quality of life, which includes not only the state of the animal's body, but also its feelings. This approach was raised by some sort of

criticism to the functional approach. Duncan and Dawkins (1983), for example, state that there may be contradictions in welfare descriptors, such as when an animal is showing normal behaviour but also sub-clinical disease. Or it may be healthy and physiologically normal, but is performing stereotypies (Terlow *et al.*, 1991). Although in some cases physiological and psychological aspects of welfare do not agree, this does not imply that the animal's mental state has to be underestimated. In fact animals are defined as 'sentient.' According to Duncan (2002), their welfare corresponds also to the absence of "negative subjective emotional states, usually called suffering," and probably with the presence of "positive subjective emotional states, usually called pleasure." Following these considerations, it is possible that the presence of the physiological state of stress does not indicate reduced welfare, nor does the absence of a stress response always mean good welfare (Colborn *et al.*, 1991; Terlow *et al.*, 1991; Duncan, 2005).

The main problem in considering animal welfare as the expression of how the organism 'feels' is that feelings are impossible to be directly measured because subjective experiences are not available for scientific investigation. In any case it is possible, knowing the biological needs of animals, to maintain a scientific approach in research, studying the links between these biological needs and the consequences for the organism, of fulfilling or not them. In this respect, it is however necessary to maintain a critical viewpoint about the meaning of biological needs, avoiding anthropomorphic interpretations (Morton *et al.*, 1990).

More recently, the 'functional' approach is moving closer to the 'feelings' approach (Broom, 1998) because both of them stress the importance of considering the organism's biological functioning in a 'holistic' approach.

The third approach emphasises natural living, stating that animals should be allowed to live according to their natural attitudes and behaviour, mainly developing and using their natural adaptations. This approach may be very fascinating and close to the natural environment where animals developed through the natural evolution process. Many consumers and politicians tend to identify animals' welfare with their natural lives in the natural environment. However, from the scientific side, domestic animals differ in many ways from their co-specifics in nature due to the domestication process (Price, 1984). Thus it may be very difficult to evidence the implications for welfare of not living according to the natural features in animals differing from their wild ancestors.

More recently Dockès and Kling-Eveillard (2006) have proposed a more comprehensive approach to animal welfare, stressing that it should be viewed according to four main issues:

1) biological and technical definitions, which stress the fundamental needs of animals and the freedoms they should be given, as well as the possibilities to cope with the environmental challenges;

2) regulation approaches, which recognise the animal as a sensitive being and as such it has to be put in conditions 'compatible with the biological needs of the species.' This leads to translate the concepts into laws;

3) philosophical approaches, which consider the "animal's status" and its role in the human society;

4) communication between man and animal, which give much importance to the farmer-animal interaction and its effects on industrial breeding systems.

The four issues may represent the whole meaning of animal welfare and its implications for animal husbandry. In fact they

include the key points in defining animal welfare involving body and mind, as well as its consequences for humans in order to understand how to treat animals, also at the legislative level. Moreover, they stress the importance of including animals in the human social environment, giving them a role both for ethical and for practical reasons.

### **Welfare and ethics**

Although “the assessment of welfare can be carried out in a scientific way without the involvement of moral considerations” (Fraser and Broom, 1997), the whole concept of animal welfare and its assessment may involve values and judgements and the ethical decisions about how animals ought to be treated. Thus the scientific approach to animal welfare may be connected, although not necessarily, to the ethical viewpoints in an increasing convergence of science and philosophy. In fact ethicists began to look at empirical research to solve ethics issues, while animal welfare science started to recognise the importance of subjective experiences (Lund *et al.*, 2006).

Scientists studying animal welfare and philosophers writing about animal ethics have basically two distinct cultures, although both work to understand and articulate man’s proper relationship to animals of other species (Fraser, 1999). Philosophers tend “to focus only at the level of the individual, advocating single ethical principles and seeking solutions through ethical theory with little recourse to empirical knowledge. On the other hand, scientists were at first stressing that suffering and other subjective experiences of animals are beyond scientific enquiry, and that science could “measure” animal welfare (Fraser, 1999). Thus some positions can be seen as totally opposite. For example the efforts to understand animal welfare, mainly in farm animals, could

probably be irrelevant or useless in the case of the positions taken by some very well known authors theorising ‘animal liberation’ and, consequently, the impossibility to rear animals for whatever aim (for example Regan, 1983).

In spite of these oppositions, the lack of communication between ethicists and scientists should be avoided, as well as extreme views both from the mechanistic and from the welfarist side. In fact, in order to address ethical concerns about the treatment of animals, the scientists need ethical reflection to complement their empirical information; and the ethicists need to base their arguments in sound knowledge about animals and animal use practices. A rather comprehensive approach to the possible links between animal welfare and ethics may be found in Fraser (1999), who underlines the need for collaboration between scientists and philosophers, integrating the two cultures which only together may contribute to advance in explaining human-animal interaction.

From the ethics viewpoint, some questions have been identified, such as “what is the baseline standard for morally acceptable animal welfare? What is a good animal life? What farming purposes are legitimate? What kind of compromises are acceptable in a less-than-perfect world?” (Sandoe *et al.*, 2003). The possibility to answer these difficult questions relies also on science, which has to go on in understanding the basic and applied meaning of animal welfare. The advances in knowledge may make it possible to improve animals’ quality of life in the perspective of including both human beings and all the other animals in the whole natural environment where they live. How this knowledge may affect each one depends on the results of the interaction between man and the other species. Animals show to us their welfare level through their physiological and behavioural reactions to treatment

by humans, and these reactions can be measured and evaluated. Taking these responses into account implies that it is unavoidable to consider the importance of the concept of welfare and its complex implications in the human-animal interaction.

## Conclusions

In conclusion, the broadest definition of animal welfare should include the comprehensive state of the organism, considering body and mind together along with everything that links them.

Taking into account all the complex aspects involved in the concept of welfare, it could be stated, according to Webster (1994), that "the welfare of an animal is determined by its capacity to avoid suffering and sustain fitness." This means that the welfare of organisms depends on many factors linked to the environment where they live and to their biological role and position.

Animal welfare has always to maintain a scientific position in order to gain an increasingly precise role in animal science. In fact welfare level, which depends on the individual's coping ability and varies from very poor to very good, can be scientifically assessed. The methodology utilised has to be validated and to find its roots mainly in applied ethology, which makes it possible to obtain the more comprehensive view of the whole organism and of its coping ability and success.

Animal welfare directly involves animal

husbandry, because human beings have to care about the animals they rear. Thus it has an important role from the technical side, because animal production is directly related to the possibility for animals to positively adapt as much as possible to the environment in order also to better produce.

Ethics may help in giving a basis for how animals have to be treated and used, and should be related to science, because the scientific knowledge may affect ethicists' viewpoint and scientists may be affected by ethical values.

Moreover, the interaction among different disciplines is needed in order to carry on studies on animal welfare. These disciplines include social science, due to the role that animals play in the human society and the fact that human attitudes towards animals and their products affect consumers.

The role of all the living organisms in the natural and social world has, however, to be considered in a biologically comprehensive view, avoiding extreme positions, which only create confusion.

The research on animal welfare may be considered as a tool to improve knowledge regarding animals, especially as respects their physical and mental aspects. This tool is a dynamic one evolving with human society and the changes in the biological world and it may offer advantages for both animals' quality of life as well as for humans who rear animals and rely on their performance, but who also have to care for animals themselves.

## REFERENCES

- Baxter, M.R., 1988. Needs – behavioural or psychological?. *Appl. Anim. Behav. Sci.* 19:345-348.
- Brambell Report, 1965. Report of the Technical Committee to enquire into the welfare of animals kept under intensive livestock husbandry systems. Her Majesty's Stationery Office, London, UK.
- Broom, D.M., 1986. Indicators of poor welfare. *Br. Vet. J.* 142:524-526.
- Broom, D.M., 1988. Needs, freedoms and the assessment of welfare. *Appl. Anim. Behav. Sci.* 19:384-386.



- Broom, D.M., 1991. Animal welfare: concepts and measurement. *J. Anim. Sci.* 69:4167-4175.
- Broom, D.M., 1998. Welfare, stress and the evolution of feelings. *Adv. Stud. Behav.* 27:371-403.
- Broom, D.M., Johnson, K.G., 1993. *Stress and Animal Welfare*. Chapman and Hall, London, UK.
- Colborn, D.R., Thompson, D.L., Roth, T.L., Capehart, J.S., White, K.L., 1991. Responses of cortisol and prolactin to sexual excitement and stress in stallions and geldings. *J. Anim. Sci.* 69:2556-2562.
- Cooper, J.J., 2004. Consumer demand under commercial husbandry conditions: practical advice on measuring behavioural priorities in captive animals. *Anim. Welfare* 13:47-56.
- Dawkins, M.S., 1980. *Animal Suffering, the Science of Animal Welfare*. Chapman and Hall, London, UK.
- Dawkins, M., 1990. From an animal's point of view: motivation, fitness and animal welfare. *Behav. Brain Sci.* 13:1-61.
- Dawkins, M.S., 1993. *Through Our Eyes Only? The Search for Animal Consciousness*. Freeman, Oxford, UK.
- Désiré, L., Boissy, A., Veissier, I., 2002. Emotions in farm animals: a new approach to animal welfare in applied ethology. *Behav. Process.* 60:165-180.
- Dockès, A.C., Kling-Eveillard, F., 2006. Farmers' and advisers' representations of animals and animal welfare. *Livest. Sci.* 103: 243-249.
- Duncan, I.J.H., 2002. Poultry welfare: science or subjectivity? *Brit. Poultry Sci.* 43:643-652.
- Duncan, I.J.H., 2005. Science-based assessment of animal welfare: farm animals. *Rev. Sci. Tech. OIE.* 24:483-492.
- Duncan, I.J.H., 2006. The changing concept of animal sentience. *Appl. Anim. Behav. Sci.* 100: 11-19.
- Duncan, I.J.H., Dawkins, M.S., 1983. The problem of assessing 'well-being' and 'suffering' in farm animals. In: D. Smidt (ed.) *Indicators relevant to farm animal welfare*. Martinus Nijhoff, The Hague, The Netherlands, pp 13-24.
- EFSA, 2006. The risks of poor welfare in intensive calf farming systems. An update of the Scientific Veterinary Committee Report on the Welfare of Calves. *EFSA Journal* 366:1-36.
- FAWC, 1993. *Second Report on Priorities for Research and Development in Farm Animal welfare*. MAFF Publ., Tolworth, London, UK.
- Fraser, D., 1998. *Encyclopedia of Animal Rights and Animal Welfare*. Greenwood Press, Westport, CT, USA.
- Fraser, D., 1999. Animal ethics and animal welfare science: bridging the two cultures. *Appl. Anim. Behav. Sci.* 65:171-189.
- Fraser, A.F., Broom, D.B., 1997. *Farm animal behaviour and welfare*. CAB International, London, UK.
- Grandin, T., 1993. *Livestock Handling and Transport*. CAB International, Wallingford, Oxon, UK.
- Griffin, D., 1976. *The Question of Animal Awareness*. Rockefeller, New York, NY, USA.
- Hemsworth, P.H., Coleman, G.J., 1998. *Human-livestock interactions. The stockperson and the productivity and welfare of intensively farmed animals*. CAB International, Bristol, UK.
- Hewson, C.J., 2003. What is animal welfare? Common definitions and their practical consequences. *Can. Vet. J.* 44:496-499.
- Hughes, B.O., 1976. Behaviour as index of welfare. pp. 1005-1018 in *Proc. 5<sup>th</sup> Eur. Poultry Conf.*, Malta.
- Hughes, B.O., Duncan, I.H.J., 1988. Behavioural needs: can they be explained in terms of motivational models? *Appl. Anim. Behav. Sci.* 20:352-355.
- Lund, V., Coleman, G., Gunnarsson, S., Appleby, M.C., Karkinen, K., 2006. *Animal welfare science-Working at the interface between the natural and social sciences*. *Appl. Anim. Behav. Sci.* 97:37-49.
- Millman, S.T., Duncan, I.J.H., Stauffacher, M., Stookey, J.M., 2004. The impact of applied ethologists and the International Society for Applied Ethology in improving animal welfare. *Appl. Anim. Behav. Sci.* 86:299-311.
- Moberg, G.P., Mench, J.A., 2000. *Biology of Animal Stress: Implications for Animal Welfare*. CAB International, Wallingford, Oxon, UK.
- Morton, D.B., Burghardt, G., Smith, J.A., 1990. *Critical Anthropomorphism, Animal Suffering and the ecological context*. Hasting's Center Re-

- port Spring Issue on Animals. *Ethics. Sci. Med.* 20(3):13-19.
- Odendaal, J.S.J., 1998. Animal Welfare in practice. *Appl. Anim. Behav. Sci.* 5:93-99.
- Price, E.O., 1984. Behavioral aspects of animal domestication. *Q. Rev. Biol.* 59:1-32.
- Regan, T., 1983. *The Case for Animal Rights*. University of California Press, Berkeley, CA, USA.
- Rushen, J., Wdowski, T., Mench, J., 2003. Changing concepts of farm animal welfare: bridging the gap between applied and basic research. *Appl. Anim. Behav. Sci.* 81:199-214.
- Sandoe, P., Christiansen, S.B., Appleby, M.C., Webster, A.J.F., Main, D.C.J., 2003. Farm animal welfare: the interaction of ethical questions and animal welfare science. *Anim. Welfare* 12:469-478.
- Skinner, B.F., 1938. *The Behavior of Organisms: An Experimental Analysis*. Appleton-Century-Crofts, New York, NY, USA.
- Terlouw, E.M.C., Lawrence, A.B., Ladewig, J., de Passillé, A.M.B., Rushen, J., Schouten, W., 1991. A relationship between stereotypes and cortisol in sows. *Behav. Process.* 25:133-153.
- Tinbergen, N., 1951. *The Study of Instinct*. Clarendon Press, Oxford, UK.
- Toates, F., 1986. *Motivational Systems*. Cambridge Univ. Press, Cambridge, UK.
- Watson, J.B., 1928. *Behaviorism*. Routledge and Keegan Paul, London, UK.
- Weber, R.E.F., Zarate, A.V., 2005. Welfare in farm animal husbandry – current definitions and concepts as basis for practical oriented research with focus on fattening pig husbandry. *Arch. Tierzucht.* 48:475-489.
- Webster, J., 1994. *Animal Welfare - A cool eye towards eden*. Blackwell Science, Oxford, UK.
- Webster, J., 2006. Animal sentience and animal welfare: What is it to them and what is it to us? *Appl. Anim. Behav. Sci.* 100: 1-3.
- WHO, 1946. Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, June 19-22, 1946. Official Records of the World Health Organization, no. 2.
- Wiepkema, P.R., 1987. Behavioural aspects of stress. In: P.R. Wiepkema and P.W.M. Van Adrichem (eds.) *Biology of Stress in Farm Animals: An Integrative Approach*. Martinus Nijhoff, Dordrecht, The Netherlands, pp 113-133.
- Wood-Gush, D.G.M., Duncan, I.J.H., Fraser, D., 1975. Social stress and welfare problems in agricultural animals. In: E.S.E. Hafez (ed.) *The Behaviour of Domestic Animals*. Tindall and Cassell, London, UK, pp 182-200.