



Guidelines for the treatment of animals in behavioural research and teaching

Behavioural studies are of great importance in increasing our understanding and appreciation of animals. In addition to providing knowledge about the diversity and complexity of behaviour in nature, such studies also provide information crucial to improvements in the welfare of animals maintained in laboratories, agricultural settings and zoos, and as companion animals. The use of animals in behavioural research and teaching does, however, raise important ethical issues. While many behavioural studies are noninvasive and involve only observations of animals in their natural habitat, some research questions cannot be addressed without manipulation of animals. Studies of captive animals necessarily involve keeping animals in confinement, and manipulative procedures and surgery may be necessary to achieve the aims of the research. Studies of free-living animals in their natural habitats can cause disruption, particularly if feeding, capture, marking or experimental procedures are involved.

While the furthering of scientific knowledge is a proper aim and may itself advance an awareness of human responsibility towards animal life, the investigator must always weigh the potential gain in knowledge against any adverse consequences for the animals and populations under study. This is equally true for the evaluation of animal use in animal behaviour teaching activities. In fact, animal behaviour courses provide an excellent opportunity to introduce students to the ethical obligations a researcher accepts when animals are studied.

To help the members make what are sometimes difficult ethical judgements about the procedures involved in the study of animals, the Association for the Study of Animal Behaviour and the Animal Behavior Society have formed Ethical and Animal Care committees, respectively. These committees jointly produced the following guidelines for the use of all those who are engaged in behavioural research and teaching activities involving vertebrate and invertebrate animals. These guidelines are general in scope, since the diversity of species and the study techniques used in behavioural research precludes the inclusion of prescriptive standards for animal care and treatment. The guidelines will be used by the Editors of *Animal Behaviour* in assessing the acceptability of submitted manuscripts. Submitted manuscripts may be rejected by an Editor, after consultation with the Ethical or Animal Care Committees, if the content violates either the letter or the spirit of the guidelines. These guidelines

supplement the legal requirements in the country and/or state or province in which the work is carried out. They should not be considered an imposition upon the scientific freedom of individual researchers, but rather as helping to provide an ethical framework that each investigator may use in making decisions related to animal welfare.

1. LEGISLATION

Investigators are accountable for the care and well-being of animals used in their research and teaching activities, and must therefore abide by the spirit as well as the letter of relevant legislation. It is their responsibility to acquire knowledge about local legislation, but here are some pointers. For example, for those who reside in Great Britain, a summary of the laws designed to ensure the welfare of animals is given by Crofts (1989); detailed guidance on the operation of the Animals (Scientific Procedures) Act, 1986 is provided by the Home Office (1990: available from the Home Office Web site: <http://www.homeoffice.gov.uk/animalsinsp/index.htm>). The Council of Europe convention on the use of vertebrate animals in research, together with Guidelines on the care and accommodation of animals can be found at: <http://conventions.coe.int/Treaty/EN/Treaties/Html/123.htm>. In the U.S.A., federal, state and local legislation and guidelines may apply. In particular, the care and use of many vertebrate laboratory animals are regulated under the Animal Welfare Act and its amendments and regulations (Code of Federal Regulations, Title 9, 1973) and/or the policies of the Public Health Service (PHS 1986; NRC 1996). Guidelines for farm animals used in research and teaching may also be applicable (Guide Development Committee 1988). In Canada, guidance can be obtained from the Guide to the Care and Use of Experimental Animals (Canadian Council on Animal Care 1992).

In Britain, lists of threatened species and laws aiming to protect them can be obtained from the International Union for the Conservation of Nature, Species Conservation Monitoring Unit (219C Huntingdon Road, Cambridge CB23 0DL, U.K.). In the U.S.A., information pertaining to the Endangered Species Act of 1973 may be found in the Code of Federal Regulations (Title 50). Lists of endangered species can be obtained from the Office for Endangered Species, U.S.

Department of Interior, Fish and Wildlife Service (Room 430, 4401 N Fairfax Drive, Arlington, VA 22203), or from the Committee on the Status of Endangered Wildlife in Canada, Canadian Wildlife Service (Environment Canada, Ottawa, Ontario K1A 0E7).

Investigators working in other countries must familiarize themselves with legislation both on animal welfare and on threatened and endangered species and conform with the spirit and letter of the laws. When submitting manuscripts to *Animal Behaviour*, all authors must confirm in their cover letter that they have adhered to the legal requirements of the country in which the study was conducted.

2. CHOICE OF SPECIES AND NONANIMAL ALTERNATIVES

Investigators should choose species for study that are appropriate and well suited for investigation of the questions posed, and this usually requires knowledge of natural history and phylogenetic level. Knowledge of an individual animal's previous experience, such as whether or not it has spent a lifetime in captivity, is also important. When research or teaching involves procedures or housing conditions that may cause pain, discomfort or stress to the animal, and when alternative species can be used, the researcher should use the species that, in the opinion of the researcher and other qualified colleagues, is least likely to suffer (OTA 1986). The majority of invertebrate species are usually excluded from legislation regulating scientific research on animals. This does not mean that they are all unable to experience pain, discomfort or stress (Sherwin 2001). Researchers using such species should take any evidence on this matter relating to their species into account when designing experiments, and should endeavour to minimize potential harm wherever possible. Live animal subjects are generally essential in behavioural research, but nonanimal alternatives such as video records from previous work or computer simulations can sometimes be used (Smyth 1978). Material of this kind also exists for teaching purposes and can be used instead of live animals to teach aspects of the behavioural sciences. The fact that a species being studied is classified as 'vermin' in the country concerned does not free the researcher from normal obligations to the experimental animals.

3. NUMBER OF INDIVIDUALS

The researcher should use the smallest number of animals necessary and sufficient to accomplish the research goals, especially in studies that involve manipulations that are potentially detrimental to the animal or the population. The number of animals used in an experiment can often be dramatically reduced by pilot studies, good experimental design and the use of statistical tests that enable several factors to be examined simultaneously (Festing 2001). Hunt (1980), Still (1982) and McConway (1992) discuss ways of minimizing the numbers of animals used in experiments, while retaining scientific validity,

through alternative designs. Useful reference works are Cox (1958) and Cochran & Cox (1966).

4. PROCEDURES

Investigators are encouraged to discuss with colleagues both the scientific value of their research proposals and possible animal welfare and ethical considerations. There are several models for evaluating animal research that can be of use when making ethical decisions (Bateson 1986; Orlans 1987; Shapiro & Field 1988; Donnelley & Nolan 1990; Porter 1992; de Cock Buning & Theune 1994; Fraser et al. 1997; Sandøe et al. 1997). If procedures used in research or teaching involve exposure to painful, stressful or noxious stimuli, the investigator must consider whether the knowledge that may be gained is justified. This will partly depend upon the goal of the research (e.g. research designed to enhance our understanding of animal welfare issues may be judged differently to research designed for other purposes). It must be borne in mind that the welfare costs of animal use may reflect not only the infliction of that which is unpleasant, but the denial of that which is pleasurable. Bateson (1991) and Flecknell (1994) discuss the assessment of pain and suffering. Additional information can be obtained from the U.S. National Academy of Sciences Publication, 'Recognition and Alleviation of Pain and Distress in Laboratory Animals' (NRC 1992), the American Veterinary Medical Association panel report on animal pain and distress (AVMA 1987) and from Hellbrekers (2000) and Flecknell & Waterman-Pearson (2000). Researchers are urged to consider the use of more refined procedures before using techniques that are likely to cause physical or psychological discomfort to the animal. Pain or suffering should be minimized both in duration and magnitude to the greatest extent possible under the requirements of the experimental design, bearing in mind that studies of factors, such as housing or management procedures, that may induce states of stress, anxiety and fear, may be a necessary part of research aimed at improving animal welfare. Attention should be given to proper pre- and postoperative care to minimize preparatory stress and residual effects. Unless specifically contraindicated by the experimental design, procedures that are likely to cause pain or discomfort should be performed only on animals that have been adequately anaesthetized. Analgesics should be used after such procedures to minimize pain and distress whenever possible (Flecknell 1985; Benson et al. 1990).

The following more specific points may be of use.

(a) Fieldwork

Investigators studying free-living animals must take precautions to minimize interference with individuals as well as the populations and ecosystems of which they are a part. Capture, marking, radiotagging, collection of physiological data such as blood or tissue samples or field experiments may have delayed consequences such as a reduced probability of survival and reproduction.

Investigators should consider the effects of such interference, and use less disruptive techniques such as individual recognition by the use of natural features rather than marking (Scott 1978), or other minimally invasive techniques (Cooper 1998; Gedir 2001) where possible. Cuthill (1991) discusses the ethical issues associated with field experiments, and recommends pilot investigations to assess potential environmental disruption and follow-up studies to detect and minimize persistent effects. Pilot studies may be used to determine the minimally effective doses of chemicals required for field experiments. If favourable, results from pilot studies of other manipulations such as mark/recapture, restraint of free-living animals and disturbances of and alterations to nests and offspring, including eggs, may be used in ethical notes to justify procedures that might otherwise be questioned by the Animal Care or Ethical Committee. The pilot studies themselves should be available for scrutiny by the relevant committee. Investigators should weigh the potential gain in knowledge from field studies against the adverse consequences of disruption for the animals used as subjects and also for other animals and plants in the ecosystem. When an experimental protocol requires that animals be removed from the population either temporarily or on a long-term basis, investigators should ensure that suffering or discomfort are minimized not only for the removed animals but for others dependent on them (e.g. dependent offspring). Removed individuals and their dependants must be housed and cared for appropriately. Sources of further information on field techniques are the books edited by Stonehouse (1978) and Amlaner & Macdonald (1980).

(b) Aggression, Predation and Intraspecific Killing

The fact that the agent causing harm may be another nonhuman animal does not free the experimenter from the normal obligations to experimental animals. Huntingford (1984), Elwood (1991), Bekoff (1993) and Bekoff & Jamieson (1996) discuss the ethical issues involved and suggest ways to minimize suffering. Wherever possible, field studies of natural encounters should be used in preference to staged encounters. Where staged encounters are necessary, the use of models or video/film playback should be considered, the number of subjects should be kept to the minimum needed to accomplish the experimental goals, and the experiments made as short as possible. Suffering can also be reduced by continuous observation with intervention to stop aggression at predefined levels, and by providing protective barriers and escape routes for the subjects.

(c) Aversive Stimulation and Deprivation as Motivational Procedures

Aversive stimulation or deprivation can cause pain or distress to animals. To minimize suffering, the investigator should investigate whether there is an alternative reward strategy that could be used to motivate the animal in the study. If not, they should ensure that the levels of

deprivation or aversive stimulation used are not greater than necessary to achieve the goals of the experiment. Alternatives to aversive stimuli and deprivation strategies include the use of highly preferred foods and other rewards that may motivate even satiated animals. Use of minimal aversive stimuli levels requires a knowledge of the technical literature in the relevant area: quantitative studies of aversive stimulation are reviewed by Church (1971) and Rushen (1986) and the behaviour of satiated animals is considered by Morgan (1974). Further comments on reducing distress caused by motivational procedures are to be found in Lea (1979) and Moran (1975).

(d) Social Deprivation, Isolation and Crowding

Experimental designs that require keeping animals in overcrowded conditions, or that involve social deprivation or isolation, may be extremely stressful to the animals involved. Because the degree of stress experienced by the animal can vary with species, age, sex, reproductive condition, developmental history and social status, the natural social behaviour of the animals concerned and their previous social experience must be considered to minimize such stress.

(e) Deleterious Conditions

Studies aimed at inducing deleterious conditions in animals are sometimes performed to gain scientific knowledge of value to human or animal problems. Such conditions include inducing disease, increasing parasite loads, and exposing animals to pesticides or other environmental stressors. Special care should be taken in studies involving genetically modified animals (e.g. transgenic animals, or those with induced mutations), because such modifications may compromise welfare even if this is not the primary goal of the modification. Genetically modified animals should be checked or screened for possible welfare problems and their suitability as the most appropriate species/strain carefully considered. Studies inducing a deleterious condition in animals should address the possible treatment or alleviation of the condition induced. Animals exposed to deleterious conditions that might result in suffering or death should be monitored frequently and, whenever possible, considering the aims of the research, treated or humanely killed as soon as they show signs of distress. If the goals of the research allow it, the investigator should also consider experimental designs in which the deleterious condition is removed (e.g. removing rather than adding parasites as the experimental treatment) or in which naturally occurring instances of deleterious conditions are observed.

5. ENDANGERED SPECIES

All research on endangered or locally rare species must comply with relevant legislation and be coordinated with

official agencies responsible for the conservation effort for the particular species under study. Legislation and sources of help in identifying endangered species have been outlined in Section 1. Members of threatened species should not be placed at risk except as part of a serious attempt at conservation. Observation alone can result in serious disturbance, including higher predation rates on nests of young, or their abandonment, and should be undertaken only after careful consideration of techniques and of alternative species. Investigators should also consider further adverse consequences of their work, such as opening up remote areas for subsequent access or teaching techniques of anaesthetization and capture that might be misused (e.g. by poachers).

6. PROCUREMENT OF ANIMALS

When it is necessary to procure animals either by purchase or by donation from outside sources, only reputable suppliers should be used. For workers in the U.K., advice about purchasing animals may be obtained from the Laboratory Animal Breeder's Association, Charles River (U.K.) Ltd, Manson Research Centre, Manson Road, Margate, Kent CT9 4LP. In the U.S.A., information on licensed animal dealers can be obtained from the local office of the U.S. Department of Agriculture (USDA). Other sources of information on laboratory animal suppliers in North America are the American Association for Laboratory Animal Science (70 Timber Creek Drive, Suite 5, Cordova, TN 38018) and the Canadian Association for Laboratory Animal Science (M524 Biological Sciences Building, University of Alberta, Edmonton, Alberta T6G 3E9). If animals are procured by capture in the wild, this must be done in as painless and humane a manner as possible and must comply with any relevant legislation. Individuals of endangered species or populations should not be taken from the wild unless they are part of an active conservation programme and are subsequently to be returned unharmed. The investigator should ensure that those responsible for handling purchased, donated, or wild-caught animals en route to the research facilities are advised of requirements for the species being transported and that animals are provided with adequate food, water, ventilation, space and protection from wastes, and are not subjected to undue stressful situations during transport. Furthermore, the investigator should carefully consider modes of transport, transport schedules (so as to reduce or eliminate layovers, unless rest periods are desirable), and shipping containers to ensure that they are suitable for the species being shipped. The relevant transport regulations for the species concerned (local, national and international) must be complied with.

7. HOUSING AND ANIMAL CARE

The researcher's responsibilities extend also to the conditions under which the animals are kept when not being studied. In certain species, appropriate training of ani-

mals to be used as experimental subjects can reduce the stress of some experimental procedures (see Reinhardt 1997; Grandin 2000). Caging conditions and husbandry practices must meet, at the very least, minimal recommended requirements of the country in which the research is carried out. Guidance can be obtained from the Universities Federation for Animal Welfare (U.F.A.W.) handbook (Poole 1999), the UK Home Office Web site (<http://www.homeoffice.gov.uk/ccpd/aps.htm>), a Council of Europe Web site (<http://conventions.coe.int/Treaty/EN/Treaties/Html/123-A.htm>), the National Research Council guide (NRC 1996), the U.S.D.A. Animal Welfare Act Regulations (Code of Federal Regulations, Title 9), the Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching (Guide Development Committee 1988), the Canadian Council on Animal Care's Guide to the Care and Use of Experimental Animals (1992), Perry (1998) and Reinhardt & Reinhardt (2002).

Although these publications provide general guidance, the housing and care regimes established for the commonly used laboratory animals are not necessarily suitable for wild animals or for individuals of wild species born in captivity. Special attention may be required to enhance the comfort and safety of these animals. Normal maintenance of captive animals should incorporate, as much as possible, aspects of the natural living conditions deemed important to welfare and survival. Consideration should be given to providing biologically relevant features such as natural material, refuges, perches and dust and water baths. Companions should be provided for social animals where possible, providing that this does not lead to suffering or injury. Frequency of cage cleaning should represent a compromise between the level of cleanliness necessary to prevent diseases and the amount of stress imposed by frequent handling and exposure to unfamiliar surroundings, odours and bedding. Researchers in the U.S.A. should also ensure that the requirements outlined under the 1985 Amendment to the Animal Welfare Act to provide exercise for laboratory-housed dogs and to ensure the psychological well-being of captive nonhuman primates are met.

The nature of human-animal interactions during routine care and experimentation should be considered by investigators. Depending upon species, rearing history and the nature of the interaction, animals may perceive humans as conspecifics, predators or symbionts (Estep & Hetts 1992). Special training of animal care personnel can help in implementing procedures that foster habituation of animals to caretakers and researchers and minimize stress. Stress can also be reduced by training animals to cooperate with handlers and experimenters during routine husbandry and experimental procedures (Biological Council 1992).

8. FINAL DISPOSITION OF ANIMALS

When research projects or teaching exercises using captive animals are completed, it may sometimes be appropriate to distribute animals to colleagues for further study

or breeding, if permitted by local legislation. However, if animals are distributed care must be taken to ensure that the same animals are not used repeatedly in stressful or painful experiments, and that they continue to receive a high standard of care. Animals should never be subjected to major surgery more than once unless it is an unavoidable and justifiable element of a single experiment. Except as prohibited by national, federal, state, provincial, or local laws, researchers may release field-trapped animals if this is practical and feasible, especially if it is critical to conservation efforts. However, the researcher should assess whether releases into the wild might be injurious or detrimental both to the released animal and to existing populations in the area. Because of potential impacts on the genetic structure of local populations in the area, animals should be released only at the site where they were trapped (unless conservation efforts dictate otherwise), and only when their ability to survive in nature has not been impaired and when they do not constitute a health or ecological hazard to existing populations. If animals must be killed subsequent to a study this must be done as humanely and painlessly as possible; death should be confirmed before their bodies are discarded. A veterinarian should be consulted for advice on methods of euthanasia that are appropriate for the particular species being used. Additional information on euthanasia methods can be found in Close et al. (1996) and the AVMA Report on Euthanasia (AVMA 2001).

9. OBTAINING FURTHER INFORMATION

There are a number of organizations that provide publications and detailed information about the care and use of animals. These include the Canadian Council on Animal Care (1105-151 Slater Street, Ottawa, Ontario, K1P 5H3 Canada), the Scientists' Center for Animal Welfare (7833 Walker Drive, Suite 410, Greenbelt, MD 20770, U.S.A.) and the Universities Federation for Animal Welfare (The Old School, Brewhouse Lane, Wheathampstead, Hertfordshire AL4 8AN, U.K.). The Animal Welfare Information Center at the National Agricultural Library (Room 205, Beltsville, MD 20705, U.S.A.) publishes a series of bibliographies on special topics, and can also provide individualized database searches for investigators on potential alternatives, including techniques for replacement with nonanimal models or alternative species, methods for reducing the total number of animals necessary to address the research question, and experimental refinements that can reduce pain and stress.

For those with access to it, the Internet provides a wealth of information on animal care and welfare issues. Many of these are government web pages, particularly those of NIH, USDA and the U.K. Home Office. Good starting places are the Office of Laboratory Animal Welfare, which contains considerable policy information and many links (www.grants.nih.gov/grants/olaw/olaw.html) and the USDA/APHIS Animal Welfare Information Center at www.nal.usda.gov/awic. In the U.K., legal requirements and Home Office Codes of Practice for the

housing and care of animals and for humane killing can be obtained from <http://www.homeoffice.gov.uk/ccpd/aps.htm>. Additional information on the APHIS site can be found at <http://www.aphis.usda.gov/ac>. Further on in the NIH site is [/grants/oppr/library](http://www.grants.nih.gov/grants/olaw/olaw.html), from which one can gain access to the 1996 Institute of Laboratory Animal Resources (ILAR) Guide for Care and Use of Laboratory Animals (published by the National Academy Press), as well as information on the IACUC Guidebook published by ARENA (Applied Research Ethics National Association). The Animal Welfare Information Center (AWIC) at the National Agricultural Library (NAL) can be reached via the USDA home page (above), and they also have available a Compendium of Animal Resources (CARE) CD ROM. For more information contact Michael Kreger at the NAL: email: mkreger@nal.usda.gov or write to AWIC, National Agricultural Library, 5th floor, 10301 Baltimore Avenue, Beltsville, MD 20705. AAALAC International (Association for Assessment and Accreditation of Laboratory Animal Care) also has a home page: <http://www.aaalac.org> and a toll-free phone number: 1-800-926-0066.

The Scientists' Center for Animal Welfare (SCAW) is at 7833 Walker Drive, Suite 410, Greenbelt, MD 20770. Their email is scaw@erols.com and their Web site is www.scaw.com.

Additional sources of information are NetVet at <http://netvet.wustl.edu/>, the National Academy of Sciences at <http://www.nas.edu/homepage/pus/pubs.html>, the National Academy Press at <http://www.nap.edu/readingroom/> and the Universities Federation for Animal Welfare (UFAW) at <http://www.ufaw.org.uk/>.

References

- Amlaner, C. L. J. & Macdonald, D. G. 1980. *A Handbook on Biotelemetry and Radio Tracking*. Oxford: Pergamon.
- AVMA (American Veterinary Medical Association) 1987. Colloquium on recognition and alleviation of animal pain and distress. *Journal of the American Veterinary Medical Association*, **191**, 1184-1296.
- AVMA (American Veterinary Medical Association) 2001. Report of the Panel on Euthanasia. *Journal of the American Veterinary Medical Association*, **218**, 669-696.
- Bateson, P. 1986. When to experiment on animals. *New Scientist*, **1496**, 30-32.
- Bateson, P. 1991. Assessment of pain in animals. *Animal Behaviour*, **42**, 827-839.
- Bekoff, M. 1993. Experimentally induced infanticide: the removal of females and its ramifications. *Auk*, **110**, 404-406.
- Bekoff, M. & Jamieson, D. 1996. Ethics and the study of carnivores: doing science while respecting animals. In: *Carnivore Behavior, Ecology, and Evolution*. Vol. 2 (Ed. by J. L. Gittleman), pp. 15-45. Ithaca, New York: Cornell University Press.
- Benson, G. J., Thurman, J. C. & Davis, L. E. 1990. Laboratory animal analgesia. In: *The Experimental Animal in Biomedical Research*, Vol. 1, *A Survey of Scientific and Ethical Issues for Investigators* (Ed. by B. E. Rollin & M. L. Kessel), pp. 319-329. Boca Raton, Florida: CRC Press.
- Biological Council 1992. *Guidelines on the Handling and Training of Laboratory Animals*. Potters Bar, Hertfordshire: U.F.A.W. (Universities Federation for Animal Welfare).

- Canadian Council on Animal Care** 1992. *Guide to the Care and Use of Experimental Animals. Vols 1 and 2*. Ottawa, Ontario: Canadian Council on Animal Care.
- Church, R. M.** 1971. Aversive behaviour. In: *Woodworth and Schleasberg's Experimental Psychology*. 3rd edn (Ed. by J. W. Kling & L. A. Riggs), pp. 703–741. London: Methuen.
- Close, B., Banister, K., Baumans, V., Bernoth, E-M., Bromage, N., Bunyan, J., Erhardt, W., Flecknell, P., Gregory, N., Hackbarth, H., Morton, D. & Warwick, C.** 1996. Recommendations for euthanasia of experimental animals: part 1. *Laboratory Animals*, **30**, 293–316.
- Cochran, W. G. & Cox, G. M.** 1966. *Experimental Designs*. 2nd edn. New York: J. Wiley.
- de Cock Buning, T. & Theune, E.** 1994. A comparison of three models for ethical evaluation of proposed animal experiments. *Animal Welfare*, **3**, 107–128.
- Code of Federal Regulations, Title 9 (Animal and Animal Products), Subchapter A (Animal Welfare), Parts 1–3.** Available from: Regulatory Enforcement and, APHIS, U.S.D.A., Federal Building, 6505 Belcrest Road, Hyattsville, MD 20782.
- Code of Federal Regulations, Title 50 (Wildlife and Fisheries), Chapter 1 (Bureau of Sport Fisheries and Wildlife Service, Fish and Wildlife Service, Department of Interior).** Washington, D.C.: U.S. Government Printing Office.
- Cooper, J. E.** 1998. Minimally invasive health monitoring of wildlife. *Animal Welfare*, **7**, 35–44.
- Cox, D. R.** 1958. *Planning of Experiments*. New York: J. Wiley.
- Crofts, W.** 1989. *A Summary of the Statute Law Relating to the Welfare of Animals in England and Wales*. Potters Bar, Hertfordshire: U.F.A.W. (Universities Federation for Animal Welfare).
- Cuthill, I.** 1991. Field experiments in animal behaviour: methods and ethics. *Animal Behaviour*, **42**, 1007–1014.
- Donnelley, S. & Nolan, K. (Eds)** 1990. *Animals, Science and Ethics*. New York: The Hastings Center.
- Elwood, R. W.** 1991. Ethical implications of studies on infanticide and maternal aggression in rodents. *Animal Behaviour*, **42**, 841–849.
- Estep, D. Q. & Hetts, S.** 1992. Interactions, relationships, and bonds: the conceptual basis for Scientist–Animal relations. In: *The Inevitable Bond: Examining Scientist-Animal Interactions* (Ed. by H. Davis & D. Balfour), pp. 6–26. Cambridge: Cambridge University Press.
- Festing, M. F. W.** 2001. Guidelines for the design and statistical analysis of experiments in papers submitted. *ATLA, Alternatives to Laboratory Animals*, **29**, 427–446.
- Flecknell, P. A.** 1985. The management of post-operative pain and distress in experimental animals. *Animal Technology*, **36**, 97–103.
- Flecknell, P. A.** 1994. Refinement of animal use: assessment and alleviation of pain and distress. *Laboratory Animals*, **28**, 222–231.
- Flecknell, P. & Waterman-Pearson, A.** 2000. *Pain Management in Animals*. London: W.B. Saunders.
- Fraser, D., Weary, D. M., Pajor, E. A. & Milligan, B. N.** 1997. A scientific conception of animal welfare that reflects ethical concerns. *Animal Welfare*, **6**, 187–205.
- Gedir, J. V.** 2001. A noninvasive system for remotely monitoring heart rate in free ranging ungulates. *Animal Welfare*, **10**, 81–89.
- Grandin, T.** 2000. Habituating antelope and bison to cooperate with veterinary procedures. *Journal of Applied Animal Welfare Science*, **3**, 253–261.
- Guide Development Committee** 1988. *Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching*. Washington, D.C.: Consortium for Developing a Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching. Available from: Association Headquarters, 309 West Clark Street, Champaign, IL 61820.
- Hellbrekers, L. J. (Ed.)** 2000. *Animal Pain*. Utrecht, Netherlands: Van Der Wees.
- Home Office** 1990. *Guidance on the Operation of the Animals (Scientific Procedures) Act, 1986*. London: H.M.S.O.
- Hunt, P.** 1980. Experimental choice. In: *The Reduction and Prevention of Suffering in Animal Experiments*, pp. 63–75. Horsham, Sussex: Royal Society for the Prevention of Cruelty to Animals.
- Huntingford, F. A.** 1984. Some ethical issues raised by studies of predation and aggression. *Animal Behaviour*, **32**, 210–215.
- Lea, S. E. F.** 1979. Alternatives to the use of painful stimuli in physiological psychology and the study of behaviour. *Alternatives to Laboratory Animals Abstracts*, **7**, 20–21.
- McConway, K.** 1992. The number of subjects in animal behaviour experiments: is Still right? In: *Ethics in Research on Animal Behaviour* (Ed. by M. Stamp Dawkins & L. M. Gosling), pp. 35–38. London: Academic Press.
- Moran, G.** 1975. Severe food deprivation: some thoughts regarding its exclusive use. *Psychological Bulletin*, **82**, 543–557.
- Morgan, M. J.** 1974. Resistance to satiation. *Animal Behaviour*, **22**, 449–466.
- NRC (National Research Council)** 1992. *Recognition and Alleviation of Pain and Distress in Laboratory Animals*. A Report of the Institute of the Committee on Pain and Distress in Laboratory Animals. Institute of Laboratory Animal Resources, Commission on Life Science, National Research Council, Washington, D.C.: National Academy Press.
- NRC (National Research Council)** 1996. *Guide for the Care and Use of Laboratory Animals*. A Report of the Institute of Laboratory Animal Resource Committee on the Care and Use of Laboratory Animals. NIH publication no. 85-23. Washington, D.C.: U.S. Department of Health and Human Services.
- Orlans, F. B.** 1987. Research protocol review for animal welfare. *Investigations in Radiology*, **22**, 253–258.
- OTA (Office of Technology Assessment), U.S. Congress** 1986. *Alternatives to Animal Use in Research, Testing and Education*. Washington, D.C.: U.S. Government Printing Office, OTA-BA-273.
- Perry, M.** 1998. Revised Australian Code of Practice for the care and use of animals for scientific purposes. *Australian Veterinary Journal*, **76**, 286.
- PHS (Public Health Service)** 1986. *Public Health Service Policy on Humane Care and Use of Laboratory Animals*. Washington, D.C.: U.S. Department of Health and Human Services. Available from: Office for Protection from Research Risks, Building 31, Room 4809, NIH, Bethesda, MD 20892.
- Poole, T. (Ed.)** 1999. *UFAW Handbook on Care and Management of Lab Animals*. 7th edn. Oxford: Blackwell Scientific.
- Porter, D. G.** 1992. Ethical scores for animal experiments. *Nature*, **356**, 101–102.
- Reinhardt, V.** 1997. Training nonhuman primates to cooperate during handling procedures: a review. *Animal Technology*, **48**, 55–73.
- Reinhardt, V. & Reinhardt, A.** 2002. *Comfortable Quarters for Laboratory Animals*. Washington, D.C.: Animal Welfare Institute.
- Rushen, J.** 1986. The validity of behavioural measures of aversion: a review. *Applied Animal Behaviour Science*, **6**, 309–323.
- Sandøe, P., Crisp, R. & Holtug, N.** 1997. Ethics. In: *Animal Welfare* (Ed. by M. C. Appleby & B. O. Hughes), pp. 3–17. Wallingford: CAB International.
- Scott, D. K.** 1978. Identification of individual Bewick's swans by bill patterns. In: *Animal Marking: Recognition Marking of Animals in Research* (Ed. by B. Stonehouse), pp. 160–168. London: Macmillan.
- Schapiro, K. J. & Field, P. B.** 1988. A new invasiveness scale: its role in reducing animal distress. *Humane and Innovative Alternatives to Animal Experiments*, **2**, 43–46.
- Sherwin, C. M.** 2001. Can invertebrates suffer? Or how robust is argument-by-analogy? *Animal Welfare*, **10**, S103–S118.
- Smyth, D. H.** 1978. *Alternatives to Animal Experiments*. London: Scolar Press, Research Defence Society.

Still, A. W. 1982. On the number of subjects used in animal behaviour experiments. *Animal Behaviour*, **30**, 873–880.

Stonehouse, B. (Ed.) 1978. *Animal Marking: Recognition Marking of Animals in Research*. London: Macmillan.

